UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 12,640,274 B2
APPLICATION NO. : 19/092400
DATED : May 26, 2026
INVENTOR(S) : Bate et al.

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

1. In Line 6 of Claim 7 (Column 34, Line 17) change "whether not said diagnostic" to --whether or not said diagnostic--.

2. In Line 7 of Claim 7 (Column 34, Line 18) change "attribute indicating whether not" to --attribute indicating whether or not--.

3. In Line 6 of Claim 24 (Column 38, Line 25) change "applications programming interface" to --application programming interface--.

Signed and Sealed this
Fourth Day of August, 2026

John A. Squires
Director of the United States Patent and Trademark Office

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
19/092,400	03/27/2025	Carl BATE	RCVRP002C1C5	6474

58766 7590 08/04/2026

Beyer Law Group LLP
P. O. Box 51887
Palo Alto, CA 94303-1887

EXAMINER
SAINT CYR, LEONARD

ART UNIT	PAPER NUMBER
2658	

NOTIFICATION DATE	DELIVERY MODE
08/04/2026	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

USPTOmail@beyerlaw.com

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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Alexandria, Virginia 22313-1450
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APPLICATION NO.	ISSUE DATE	PATENT NO.
19/092,400	04-Aug-2026	12640274

Beyer Law Group LLP
Palo Alto, CA 94303-1887

ELECTRONIC CERTIFICATE OF CORRECTION NOTIFICATION

Your electronic certificate of correction is now available, and can be accessed via Patent Center at https://patentcenter.uspto.gov.

The electronic certificate of correction is the official certificate of correction under 35 U.S.C. 254 or 255. For more information, please visit https://www.uspto.gov/electronicgrants.

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BMJ Publishing Group v. Evidium

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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
19/092,400	03/27/2025	Carl BATE	RCVRP002C1C5	6474

58766 7590 07/14/2026

Beyer Law Group LLP
P. O. Box 51887
Palo Alto, CA 94303-1887

EXAMINER
SAINT CYR, LEONARD

ART UNIT	PAPER NUMBER
2658	

NOTIFICATION DATE	DELIVERY MODE
07/14/2026	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

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Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

USPTOmail@beyerlaw.com

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Patent No.: 12640274
Issue Date: 05/26/2026
Appl. No.: 19/092,400
Filed: 03/27/2025

PART (A) RESPONSE FOR CERTIFICATES OF CORRECTION

This is a decision on the Certificate of Correction request filed 17 June 2026.

The request for issuance of Certificate of Correction for the above-identified correction(s) under the provisions of 37 CFR 1.322 and/or 1.323 is hereby:

(Check one)
☑ Approved ☐ Approved in Part ☐ Denied

Comments: ____

PART (B) PETITION UNDER 37 CFR 1.324 OR 37 CFR 1.48

☐ This is a decision on the petition filed ____ to correct inventorship under 37 CFR 1.324.

☐ This is a decision on the request under 37 CFR 1.48, petition filed ____. In view of the fact that the patent has already issued, the request under 37 CFR 1.48 has been treated as a petition to correct inventorship under 37 CFR 1.324.

The petition is hereby: ☐ Granted ☐ Dismissed

Comment: ____

The patented filed is being forwarded to Certificate of Corrections Branch for issuance of a certificate naming only the actual inventor or inventors.

/RICHEMOND DORVIL/
Supervisory Patent Examiner, Art Unit 2658
Technology Center 2600
Phone: (571) 272-7602

Certificates of Correction Branch email: CustomerServiceCoC@uspto.gov CoC Central Phone Number: (703) 756-1814

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/092,400	**06/17/2026 03:26:52 PM Z ET**	**RCVRP002C1C5**

Title of Invention

TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	12640274
CONFIRMATION #	6474	FILED BY	Alyssa Beyer
PATENT CENTER #	77555999	FILING DATE	03/27/2025
CUSTOMER #	58766	FIRST NAMED INVENTOR	Carl BATE
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jonathan Scott

Documents

TOTAL DOCUMENTS: 0

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/092,400	**06/17/2026 03:26:52 PM Z ET**	**RCVRP002C1C5**

Title of Invention

TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	12640274
CONFIRMATION #	6474	FILED BY	Alyssa Beyer
PATENT CENTER #	77555999	AUTHORIZED BY	Jonathan Scott
CUSTOMER #	58766	FILING DATE	03/27/2025
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Carl BATE

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
DA / 504481	**E20266GF28467103**	**Alyssa Beyer**

PRE-AUTHORIZED ACCOUNT	PRE-AUTHORIZED CATEGORY
504481	**37 CFR 1.16 (National application filing, search, and examination fees); 37 CFR 1.17 (Patent application and reexamination processing fees); 37 CFR 1.19 (Document supply fees); 37 CFR 1.20 (Post Issuance fees); 37 CFR 1.21 (Miscellaneous fees and charges)**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
2811	CERTIFICATE OF CORRECTION	172.00	1	172.00
			TOTAL AMOUNT:	**$172.00**

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: BATE et al.

Attorney Docket No.: RCVRP002C1C5

Patent No.: 12,640,274

Issued: May 26, 2026

Title: TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

Certificate of Transmission via USPTO Patent Electronic Filing System
I hereby certify that this correspondence is being transmitted via the U.S. Patent and Trademark Office (USPTO) patent electronic filing system to the USPTO on June 17, 2026.

Signed: _____/Alyssa Beyer/_____
Alyssa Beyer

REQUEST FOR CERTIFICATE OF CORRECTION OF APPLICANT'S MISTAKE (35 U.S.C §255, 37 C.F.R. §1.323)

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450
Attn: Certificate of Correction

Dear Commissioner:

Attached is Form PTO-1050 (Certificate of Correction) at least one copy of which is suitable for printing.

A mistake of a clerical or typographical nature, or minor in character appears in the above-referenced patent; however, the mistake occurred in good faith. The correction introduces no new matter nor requires reexamination.

The errors together with the exact page and line number where the errors appear in the application file are as follows:

CLAIMS:

1. In line 6 of claim 7 (column 34, line 17) change "whether not said diagnostic" to –whether or not said diagnostic--.

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BMJ Publishing Group v. Evidium

2. In line 7 of claim 7 (column 34, line 18) change "attribute indicating whether not" to –attribute indicating whether or not--.

3. In line 6 of claim 24 (column 38, line 25) change "applications programming interface" to –application programming interface--.

The Commissioner is hereby authorized to charge the amount of $172.00 to Deposit Account 50-4481 (Order No. RCVRP002C1C5) in accordance with 37 CFR § 1.20(a). If it is determined that any additional fees are due, the Commissioner is hereby authorized to charge such fees to Deposit Account 50-4481 (Order No. RCVRP002C1C5).

Respectfully submitted,
BEYER LAW GROUP LLP

/Jonathan Scott/

Jonathan O. Scott
Registration No. 39,364

P. O. Box 51887
Palo Alto, CA 94303-1887
650-842-1300

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PTO/SB/44 (10-96)
Approved for use through 6/30/99. OMB 0651-0033
Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB Control number
(Also Form PT-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. US 12,640,274 B2

APPLICATION NO.: 19/092,400

ISSUE DATE May 26, 2026 :

INVENTOR(S) : Bate et al.

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

1. In line 6 of claim 7 (column 34, line 17) change "whether not said diagnostic" to –whether or not said diagnostic--.

2. In line 7 of claim 7 (column 34, line 18) change "attribute indicating whether not" to –attribute indicating whether or not--.

3. In line 6 of claim 24 (column 38, line 25) change "applications programming interface" to –application programming interface--.

MAILING ADDRESS OF SENDER (Please do not use customer number below):
Jonathan O. Scott
BEYER LAW GROUP LLP
P. O. Box 51887
Palo Alto, CA 94303-1887

This collection of information is required by 37 CFR 1.322, 1.323, and 1.324. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 1.0 hour to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Attention Certificate of Corrections Branch, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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UNITED STATES
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P.O. Box 1450
Alexandria, VA 22313 - 1450
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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/092,400	**06/17/2026 03:23:12 PM Z ET**	**RCVRP002C1C5**

Title of Invention

TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	12640274
CONFIRMATION #	6474	FILED BY	Alyssa Beyer
PATENT CENTER #	77544931	FILING DATE	03/27/2025
CUSTOMER #	58766	FIRST NAMED INVENTOR	Carl BATE
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jonathan Scott

Documents

TOTAL DOCUMENTS: 2

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
RCVRP002C1C5_Certificate of Correction_Applicant.pdf	2	Transmittal Letter	23 KB
RCVRP002C1C5_Certificate of Correction.pdf	1	Request for Certificate of Correction	21 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
RCVRP002C1C5_Certificate of Correction_Applicant.pdf	3FDF142FE3EE01FA43EB73831A1E7E4672A4E4CF49F027732285BFCECB9F12523BFE9DE3D193BE923EA51AEBC8682F9DF05182D2DBBE9564BD462D3A53EBDEE1

RCVRP002C1C5_Certificate of Correction.pdf

8EE77FE0C210FF7EFB92E4B7BBB9DBA4DCAA9D2D45C6D377660C4E385F34B38B14321862709439D0F5D0E1D9A313C561149818E632E7A0932836CFE3C85650D4

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

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National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
19/092,400	03/27/2025	Carl BATE	RCVRP002C1C5	6474

58766 7590 05/26/2026

Beyer Law Group LLP
P. O. Box 51887
Palo Alto, CA 94303-1887

EXAMINER
SAINT CYR, LEONARD

ART UNIT	PAPER NUMBER
2658	

NOTIFICATION DATE	DELIVERY MODE
05/26/2026	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

USPTOmail@beyerlaw.com

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.
19/092,400	26-May-2026	12640274

Beyer Law Group LLP
Palo Alto, CA 94303-1887

EGRANT NOTIFICATION

Your electronic patent grant (eGrant) is now available, which can be accessed via Patent Center at https://patentcenter.uspto.gov

The electronic patent grant is the official patent grant under 35 U.S.C. 153. For more information, please visit https://www.uspto.gov/electronicgrants

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
19/092,400	05/26/2026	12640274	RCVRP002C1C5	6474

58766 7590 05/13/2026

Beyer Law Group LLP
P. O. Box 51887
Palo Alto, CA 94303-1887

ISSUE NOTIFICATION

The projected patent number and issue date are specified above. The patent will issue electronically. The electronically issued patent is the official patent grant pursuant to 35 U.S.C. § 153. The patent may be accessed on or after the issue date through Patent Center at https://patentcenter.uspto.gov/. The patent will be available in both the public and the private sides of Patent Center. Further assistance in electronically accessing the patent, or about Patent Center, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

The USPTO will automatically mail a courtesy ceremonial copy of the electronic patent grant to the correspondence address of record if the issue fee was paid before March 9, 2026. If the issue fee was paid on or after March 9, 2026, a courtesy ceremonial copy will be mailed if the applicant opted-in to receiving it. Additional copies of the patent (i.e., certified and presentation copies) may be ordered for a fee from the USPTO's Certified Copy Center at https://certifiedcopycenter.uspto.gov/index.html. The Certified Copy Center may be reached at (800)972-6382.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Center (https://patentcenter.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Patents Stakeholder Experience (OPSE), Stakeholder Support Division (SSD) at (571)-272-4200.

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

INVENTOR(s) (Please see PATENT CENTER site https://patentcenter.uspto.gov for additional inventors):

Carl BATE, San Francisco, CA;
Wian STIPP, San Francisco, CA;
Thomas UNGER, Tiburon, CA;
David A. EPSTEIN, Croton-on-Hudson, NY;
Matthew MCSORLEY, Pittsburgh, PA;

APPLICANT(s) (Please see PATENT CENTER site https://patentcenter.uspto.gov for additional applicants):

Evidium, Inc., San Francisco, CA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

Form 1449 (Modified) **Information Disclosure Statement By Applicant** (Use Several Sheets if Necessary)	**Atty Docket No.**	RCVRP002C1C5
	Application No.:	19/092,400
	Applicant	Evidium, Inc.
	Filing Date	March 27, 2025
	Group	2658
		Page 2 of 2
	Date Submitted	August 27, 2025

02/2025

/L.S/	25.	2025/0059224	~~02/24/22~~	~~Tulley et al.~~ Bierbach et al.			08/19/21
/L.S/	26.	2025/0182911	06/05/25	Bate et al.			02/04/25
/L.S/	27.	2025/0253062	08/07/25	Bate et al.			04/24/25
/L.S/	28.	2003/0065535	04/03/03	Karlov et al.			05/01/02
/L.S/	29.	2025/0253061	08/07/25	Bate et al.			03/27/25

Change(s) applied to document,
/J.E./
4/28/2026

Foreign Patent or Published Foreign Patent Application

Examiner Initial	No.	Document No.	Publication Date	Country or Patent Office	Class	Sub-Class	Translation Yes	Translation No
	30.							
	31.							
	32.							
	33.							

Other Documents

Examiner Initial	No.	Author, Title, Place (e.g. Journal) of Publication, Date
	34.	
	35.	
	36.	
	37.	

Examiner	/LEONARD SAINT-CYR/	Date Considered	09/10/2025

Examiner: Initial citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via the USPTO patent electronic filing system.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 6 should be completed where appropriate. All further correspondence will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

58766 7590 04/16/2026

Beyer Law Group LLP
P. O. Box 51887
Palo Alto, CA 94303-1887

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via the USPTO patent electronic filing system or by facsimile to (571) 273-2885, on the date below.

Alyssa Beyer	(Typed or printed name)
/Alyssa Beyer/	(Signature)
April 24, 2026	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
19/092,400	03/27/2025	Carl BATE	RCVRP002C1C5	6474

TITLE OF INVENTION: TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$516	$0.00	$0.00	$516	07/16/2026

EXAMINER	ART UNIT	CLASS-SUBCLASS
SAINT CYR, LEONARD	2658	704-009000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Beyer Law Group LLP
2
3

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: Evidium, Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): San Francisco, CA

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required)

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

☒ Electronic Payment via the USPTO patent electronic filing system ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 504481

5. **Change in Entity Status** (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

☐ Applicant asserting small entity status. See 37 CFR 1.27

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

☐ Applicant changing to regular undiscounted fee status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

6. **Courtesy Ceremonial Copy**

☐ Applicant requests a courtesy ceremonial copy of the electronic patent grant. Applicant understands that the electronic patent grant is the official statutory patent grant.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date April 24, 2026

Typed or printed name Jonathan O. Scott Registration No. 39,364

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BMJ Publishing Group v. Evidium

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/092,400	**04/24/2026 02:30:27 PM Z ET**	**RCVRP002C1C5**

Title of Invention

TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	6474	FILED BY	Alyssa Beyer
PATENT CENTER #	75483854	FILING DATE	03/27/2025
CUSTOMER #	58766	FIRST NAMED INVENTOR	Carl BATE
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jonathan Scott

Documents

TOTAL DOCUMENTS: 1

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
RCVRP002C1C5_Issue Fee.pdf	1	Issue Fee Payment (PTO-85B)	132 KB

Warning: The attached file contains comments or annotations. Comments are not recommended and may cause processing problems with the document.

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
RCVRP002C1C5_Issue Fee.pdf	09166733768FCA533518EC463D8580188C1DD0C745B624749085986176F4B8C08DE237696353661E7332AE472C32E74D623B227010D6B2095F653954AFBEA905

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized

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by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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PATENT AND TRADEMARK OFFICE

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Alexandria, VA 22313 - 1450
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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/092,400	**04/24/2026 02:30:27 PM Z ET**	**RCVRP002C1C5**

Title of Invention

TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

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PATENT CENTER #	75483854	AUTHORIZED BY	Jonathan Scott
CUSTOMER #	58766	FILING DATE	03/27/2025
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Carl BATE

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
DA / 504481	**E20264NE32526234**	**Alyssa Beyer**

PRE-AUTHORIZED ACCOUNT	PRE-AUTHORIZED CATEGORY
504481	**37 CFR 1.16 (National application filing, search, and examination fees); 37 CFR 1.17 (Patent application and reexamination processing fees); 37 CFR 1.19 (Document supply fees); 37 CFR 1.20 (Post Issuance fees); 37 CFR 1.21 (Miscellaneous fees and charges)**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
2501	UTILITY ISSUE FEE	516.00	1	516.00
			TOTAL AMOUNT:	**$516.00**

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

58766 7590 04/16/2026

Beyer Law Group LLP
P. O. Box 51887
Palo Alto, CA 94303-1887

EXAMINER	
SAINT CYR, LEONARD	
ART UNIT	PAPER NUMBER
2658	

DATE MAILED: 04/16/2026

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
19/092,400	03/27/2025	Carl BATE	RCVRP002C1C5	6474

TITLE OF INVENTION: TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$516	$0.00	$0.00	$516	07/16/2026

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 40% the amount of undiscounted fees, and micro entity fees are 20% the amount of undiscounted fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

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BMJ Publishing Group v. Evidium

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via the USPTO patent electronic filing system.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 6 should be completed where appropriate. All further correspondence will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications. **Because electronic patent issuance may occur shortly after issue fee payment, any desired continuing application should preferably be filed prior to payment of this issue fee in order not to jeopardize copendency.**

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

58766 7590 04/16/2026

Beyer Law Group LLP
P. O. Box 51887
Palo Alto, CA 94303-1887

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via the USPTO patent electronic filing system or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
19/092,400	03/27/2025	Carl BATE	RCVRP002C1C5	6474

TITLE OF INVENTION: TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	$516	$0.00	$0.00	$516	07/16/2026

EXAMINER	ART UNIT	CLASS-SUBCLASS
SAINT CYR, LEONARD	2658	704-009000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

❑ Change of correspondence address (or Change of Correspondence Address form PTO/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 _____

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. Fees submitted: ❑Issue Fee ❑Publication Fee (if required)

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via the USPTO patent electronic filing system ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. **Change in Entity Status** (from status indicated above)

❑ Applicant certifying micro entity status. See 37 CFR 1.29

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

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6. **Courtesy Ceremonial Copy**

❑ Applicant requests a courtesy ceremonial copy of the electronic patent grant. Applicant understands that the electronic patent grant is the official statutory patent grant.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

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BMJ Publishing Group v. Evidium

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
19/092,400	03/27/2025	Carl BATE	RCVRP002C1C5	6474

58766 7590 04/16/2026

Beyer Law Group LLP
P. O. Box 51887
Palo Alto, CA 94303-1887

EXAMINER	
SAINT CYR, LEONARD	
ART UNIT	PAPER NUMBER
2658	

DATE MAILED: 04/16/2026

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

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OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. The United States Patent and Trademark Office (USPTO) collects the information in this record under authority of 35 U.S.C. 2. The USPTO's system of records is used to manage all applicant and owner information including name, citizenship, residence, post office address, and other information with respect to inventors and their legal representatives pertaining to the applicant's/ owner's activities in connection with the invention for which a patent is sought or has been granted. The applicable Privacy Act System of Records Notice for the information collected in this form is COMMERCE/PAT-TM-7 Patent Application Files, available in the Federal Register at 78 FR 19243 (March 29, 2013).
https://www.govinfo.gov/content/pkg/FR-2013-03-29/pdf/2013-07341.pdf

Routine uses of the information in this record may include disclosure to:

1) law enforcement, in the event that the system of records indicates a violation or potential violation of law;
2) a federal, state, local, or international agency, in response to its request;
3) a contractor of the USPTO having need for the information in order to perform a contract;
4) the Department of Justice for determination of whether the Freedom of Information Act (FOIA) requires disclosure of the record;
5) a Member of Congress submitting a request involving an individual to whom the record pertains, when the individual has requested the Member's assistance with respect to the subject matter of the record;
6) a court, magistrate, or administrative tribunal, in the course of presenting evidence, including disclosures to opposing counsel in the course of settlement negotiations;
7) the Administrator, General Services Administration (GSA), or their designee, during an inspection of records conducted by GSA under authority of 44 U.S.C. 2904 and 2906, in accordance with the GSA regulations and any other relevant (i.e., GSA or Commerce) directive, where such disclosure shall not be used to make determinations about individuals;
8) another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c));
9) the Office of Personnel Management (OPM) for personnel research purposes; and
10) the Office of Management and Budget (OMB) for legislative coordination and clearance.

If you do not furnish the information requested on this form, the USPTO may not be able to process and/or examine your submission, which may result in termination of proceedings, abandonment of the application, and/or expiration of the patent.

Notice of Allowability	Application No. 19/092,400	Applicant(s) BATE et al.	
	Examiner LEONARD SAINT-CYR	Art Unit 2658	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☑ This communication is responsive to 02/25/26.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are 1, 3, 4, 7 – 13, 16 – 30 . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

   Certified copies:

   a) ☐ All b) ☐ Some* c) ☐ None of the:

   1. ☐ Certified copies of the priority documents have been received.
   2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
   3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____ .

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____ .

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/LEONARD SAINT-CYR/
Primary Examiner, Art Unit 2658

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BMJ Publishing Group v. Evidium

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Response to Arguments

2. Applicant's arguments, see page 10, filed 02/25/26, with respect to claims 1, 3, 4, 7 – 13, 16 - 30 have been fully considered and are persuasive. The rejection of claims 1, 3, 4, 7 – 13, 16 – 30 under 35 U.S.C 101 has been withdrawn.

Allowable Subject Matter

3. Claims 1, 3, 4, 7 – 13, 16 – 30 are allowed over the prior art made of record. The following is an examiner's statement of reasons for allowance:

As to claims 1, 3, 4, 7 -11, the prior art made of record does not teach or suggest processing said text using a natural language processing (NLP) engine to produce a plurality of clinical concepts indicative of said medical condition; generating a plurality of nodes in a graph database, said plurality of nodes including said plurality of clinical concepts, wherein said medical condition and said symptom, which are associated with said same name in said one or more medical evidence sources, are represented in different nodes in said graph database in order to disambiguate one or more of said plurality of clinical concepts; storing said plurality of clinical concepts each as separate nodes in said graph database, said medical condition being linked to one or more of said plurality of clinical concepts in said graph database, wherein said graph database describes more than one hundred thousand relationships; establishing one or more

application programming interfaces (APIs) for said graph database, said one or more APIs allowing a software application to integrate with said graph database to access said plurality of nodes to generate a healthcare determination by traversing a portion of said plurality of nodes that disambiguate one or more of said plurality of clinical concepts. These limitations in conjunction with other limitations of the dependent and independent claims were not shown by, would not have been obvious over, nor would have been fairly suggested by the prior art of record.

As to claims 12, 13, the prior art made of record does not teach or suggest extracting, using a natural language processing (NLP) engine, from a medical evidence source a plurality of diagnostic factors each indicative of a medical condition and store each of said diagnostic factors and said medical condition as its own node in a graph database, said medical condition being linked to said diagnostic factors, wherein said medical evidence source uses a same name to describe both said medical condition and one of said diagnostic factors, wherein said medical condition and said one of said diagnostic factors are arranged in different hierarchies in one or more medical evidence sources, and wherein said medical condition and said one of said diagnostic factors are represented in different nodes in said graph database in order to disambiguate said medical condition from said one of said diagnostic factors, wherein said graph database describes more than one hundred thousand relationships; for at least one of said diagnostic factors, store demographics that indicate said medical condition on the basis of said at least one diagnostic factor between said medical condition node and a node representing said at least one diagnostic factor; establishing one or more application

programming interfaces (APIs) for said graph database, said one or more APIs allowing a software application to integrate with said graph database to access said nodes to generate a healthcare determination; matching patient data from a patient medical chart to at least one of said diagnostic factor nodes or said demographics by traversing a portion of said nodes of said graph database in order to display said healthcare determination that said patient has said medical condition. These limitations in conjunction with other limitations of the dependent and independent claims were not shown by, would not have been obvious over, nor would have been fairly suggested by the prior art of record.

As to claims 16 - 23, the prior art made of record does not teach or suggest matching said diagnostic factors to factor nodes in a knowledge graph that includes a plurality of medical condition nodes, each of said factor nodes being linked to at least one of said medical condition nodes, wherein at least one of said medical condition nodes and at least one of said factor nodes uses a same name to describe both said at least one of said medical condition nodes and said at least one of said factor nodes, and wherein said at least one of said medical condition nodes and said at least one of said factor nodes are represented in different nodes in said knowledge graph in order to disambiguate said at least one of said medical condition nodes from said at least one of said factor nodes, wherein said knowledge graph describes more than one hundred thousand relationships; establishing one or more application programming interfaces (APIs) for said knowledge graph, said one or more APIs allowing a software application to integrate with said knowledge graph to access said medical condition nodes and said

factor nodes to generate a healthcare determination; for each of a plurality of said medical condition nodes, collect a rank value from along a path between said each medical condition node and each matched factor node to which said each medical condition node is linked, said rank value indicating how likely it is that the diagnostic factor matched to said each matched factor node is indicative of a medical condition represented by said each medical condition node; summing all collected rank values for said each medical condition node to produce a final ranking value for said each medical condition node; outputting the medical condition representing said each medical condition node and said final ranking value of said each medical condition node in order to output said healthcare determination. These limitations in conjunction with other limitations of the dependent and independent claims were not shown by, would not have been obvious over, nor would have been fairly suggested by the prior art of record.

As to claims 24 - 30, the prior art made of record does not teach or suggest identifying all known factor nodes in a knowledge graph that each represent a diagnostic factor known to be present or absent in said patient, said diagnostic factors being determined using a natural language processing (NLP) engine, each known factor node being linked to a medical condition node in said knowledge graph representing said at least one medical condition, wherein said knowledge graph describes more than one hundred thousand relationships; identifying all unknown factor nodes in said knowledge graph that each represent an unknown diagnostic factor not known to be present or absent in said patient, each unknown factor node being linked to said medical condition node, wherein said medical condition node and at least one of said

known or unknown factor nodes uses a same name to describe both said medical condition node and said at least one of said known or unknown factor nodes, and wherein said medical condition node and said at least one of said known or unknown factor nodes are represented in different nodes in said knowledge graph in order to disambiguate said medical condition node from said at least one of said known or unknown factor nodes; establishing one or more application programming interfaces (APIs) for said knowledge graph, said one or more APIs allowing a software application to integrate with said knowledge graph to access said medical condition node and said known and unknown factor nodes to generate a healthcare determination; identifying a rank of each unknown factor node that indicates a likelihood that said represented unknown diagnostic factor indicates said at least one medical condition, said rank being stored between said unknown factor node and said medical condition node; outputting said unknown diagnostic factors corresponding to said unknown factor nodes in association with said at least one medical condition in order of said rank of said each unknown factor node in order to output said healthcare determination. These limitations in conjunction with other limitations of the dependent and independent claims were not shown by, would not have been obvious over, nor would have been fairly suggested by the prior art of record.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Conclusion

4. Any inquiry concerning this communication or earlier communications from the examiner should be directed to LEONARD SAINT-CYR whose telephone number is (571)272-4247. The examiner can normally be reached Monday- Friday.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Richemond Dorvil can be reached at (571)272-7602. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/LEONARD SAINT-CYR/
Primary Examiner, Art Unit 2658

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	19/092,400	BATE et al.
	Examiner	Art Unit
	LEONARD SAINT-CYR	2658

CPC - Searched*		
Symbol	**Date**	**Examiner**
G16H70/$$$$; G16H10/$$$$; G06F40/$$$$	05/22/2025	LS
Updated Search	09/11/2025	LS
Updated Search	03/10/2026	LS

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**
704	7 - 10, 257	05/22/2025	LS
Updated Search		09/11/2025	LS
Updated Search		03/10/2026	LS

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
See PE2E Search (attached)	05/22/2025	LS
See Google Scholar search (attached)	05/22/2025	LS
Updated Search	09/11/2025	LS
Updated Search	03/10/2026	LS
Similarity Search	03/10/2026	LS
lp.com	03/10/2026	LS

/LEONARD SAINT-CYR/ Primary Examiner, Art Unit 2658	

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	19/092,400	BATE et al.
	Examiner	Art Unit
	LEONARD SAINT-CYR	2658

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**
704	7 - 10, 257	03/10/2026	LS
G06F	40/$$$$	03/10/2026	LS
G16H	10/$$$$; 70/$$$$	03/10/2026	LS

/LEONARD SAINT-CYR/ Primary Examiner, Art Unit 2658	

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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	19/092,400	BATE et al.
	Examiner	Art Unit
	LEONARD SAINT-CYR	2658

CPC						
Symbol					Type	Version
G16H	/	70	/	20	F	2018-01-01
G16H	/	10	/	60	I	2018-01-01
G06F	/	40	/	40	I	2020-01-01

CPC Combination Sets								
Symbol					Type	Set	Ranking	Version
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	25	
/LEONARD SAINT-CYR/ Primary Examiner, Art Unit 2658	10 March 2026	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	19/092,400	BATE et al.
	Examiner	Art Unit
	LEONARD SAINT-CYR	2658

INTERNATIONAL CLASSIFICATION					
CLAIMED					
G16H	/	10	/	60	

NON-CLAIMED					
	/		/		

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS
704	9

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					
704	7	8	10	257		

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	25	
/LEONARD SAINT-CYR/ Primary Examiner, Art Unit 2658	10 March 2026	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office

Part of Paper No.: 20260309

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Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	19/092,400	BATE et al.
	Examiner	**Art Unit**
	LEONARD SAINT-CYR	2658

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	7	10	14	19	23	28								
	2	8	11	15	20	24	29								
2	3	9	12	16	21	25	30								
3	4	10	13	17	22										
	5		14	18	23										
	6		15	19	24										
4	7	11	16	20	25										
5	8	12	17	21	26										
6	9	13	18	22	27										

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	25	
/LEONARD SAINT-CYR/ Primary Examiner, Art Unit 2658	10 March 2026	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	1

U.S. Patent and Trademark Office

Part of Paper No.: 20260309

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PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L266	50	(Artificial Intelligence) Similar to: 19/092,400 with 0 CPC Selections and 0 Text Selections Text: (US-20250182912-A1 OR US-10593429-B2 OR US-20190189253-A1 OR US-11182550-B2 OR US-20200185103-A1 OR CN-110362690-A OR WO-2016172801-A1 OR US-11200968-B2 OR US-20230326610-A1 OR US-8301465-B2 OR CN-116130091-A OR US-20050060193-A1 OR US-20130226612-A1 OR US-20180089381-A1 OR CN-121191784-A OR US-20200051694-A1 OR US-20170068789-A1 OR WO-2022164724-A1 OR AU-2022212704-A1 OR US-11710574-B2 OR US-20220189590-A1 OR CN-110391021-A OR US-20220068482-A1 OR CA-3209118-A1 OR WO-2020180679-A1 OR KR-20130140848-A OR WO-2005114536-A2 OR CN-119207770-A OR US-10971254-B2 OR CA-2567291-A1 OR US-20160224760-A1 OR US-20100094648-A1 OR US-20050261941-A1 OR WO-2022084527-A1 OR CN-121439257-A OR US-20110119084-A1 OR WO-2015127096-A1 OR WO-2007124356-A2 OR US-8554580-B2 OR US-20180075194-A1	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2026/03/10 06:26 PM

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		OR US-20110119084-A1 OR WO-2015127096-A1 OR WO-2007124356-A2 OR US-8554580-B2 OR US-20180075194-A1 OR US-20030097279-A1 OR US-20090192826-A1 OR WO-2018092145-A1 OR US-20070143145-A1 OR CN-121054225-A OR WO-2016103036-A1 OR US-20210057098-A1 OR US-20190180874-A1 OR US-20250336531-A1 OR US-20210158914-A1).did.					
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		20150254408-A1 OR US-20100106529-A1 OR JP-2023504203-A OR JP-7667155-B2 OR KR-20240157539-A OR CN-117438073-A OR US-20040030584-A1 OR WO-2021119188-A1 OR US-8560582-B2 OR US-20040030669-A1 OR EP-1806162-A2 OR US-20050261941-A1 OR US-20250182862-A1 OR US-12243628-B2 OR US-20240242791-A1).did.					
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L271	1029	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) WITH (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/03/10 09:33 PM
L273	10330	(704/7-10,257).ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2026/03/10 09:34 PM
L275	62	270 AND 273	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL,	OR	ON	ON	2026/03/10 09:36 PM

			PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L276	763	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) near6 (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) WITH (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/03/10 09:37 PM
L277	355	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) near6 (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) near6 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/03/10 09:38 PM
L278	369	(medical near3 (condition$2 disease morbidity complaint$2	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY,	OR	ON	ON	2026/03/10 09:38 PM

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		infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) near6 (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) near6 (database$2 dictionar$3 dataset knowledge) WITH (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)	CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L279	611	L276 AND ((G16H50/70 OR G16H50/20 OR G16H10/60 OR G16H50/30 OR G16H70/20 OR G16H40/63 OR G16H20/30 OR G16H15/00 OR G16H10/20 OR G16H20/10 OR G16H80/00 OR G16H70/60 OR G16H40/20 OR G16H40/67 OR G16H50/50 OR G16H20/60 OR G16H20/70 OR G16H70/00 OR G16H10/40 OR G16H30/20 OR G16H20/17 OR G16H20/00 OR G16H30/40 OR G16H70/40 OR G16H30/00 OR G16H20/40 OR G16H50/80 OR G16H10/00 OR G16H40/60 OR G16H40/00 OR G16H40/40 OR G16H20/90 OR G16H50/00 OR G06F16/9535 OR G06F16/2282 OR	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2026/03/10 09:43 PM

		G06F16/00 OR G06F16/951 OR G06F16/9538 OR G06F16/24575 OR G06F16/24578 OR G06F16/285 OR G06F16/955 OR G06F16/3329 OR G06F16/367 OR G06F40/30 OR G06F16/288 OR G06F40/279 OR G06F16/2264 OR G06F40/40 OR G06F40/237 OR G06F16/35 OR G06F21/6245 OR G06F21/76 OR G06F3/0482 OR G06F40/295 OR G06F16/345 OR G06F21/31 OR G06F40/20 OR G06F8/34 OR G06F9/453 OR G06F16/36 OR G06F16/9024 OR G06F18/22 OR G06F16/33295 OR G06F3/04842 OR G06F40/169 OR G06F16/3344 OR G06F18/23 OR G06F18/24 OR G06F21/64 OR G06F40/211 OR G06F16/322 OR G06F16/9577 OR G06F16/27 OR G06F18/214 OR G06F18/24323 OR G06F40/284 OR G06F40/35 OR G06F16/2457 OR G06F16/353 OR G06F17/153 OR G06F17/175 OR G06F21/10 OR G06F3/0488 OR G06F3/0489 OR G06F16/182 OR G06F16/2455 OR G06F16/258 OR G06F16/29 OR G06F16/313 OR G06F16/34 OR G06F16/55 OR G06F18/10 OR					

		G06F18/213 OR G06F18/23213 OR G06F18/2415 OR G06F18/2433 OR G06F18/29 OR G06F21/602 OR G06F2123/02 OR G06F3/048 OR G06F9/543 OR G06F9/547 OR G06F11/3409 OR G06F16/164 OR G06F16/22 OR G06F16/2228 OR G06F16/2291 OR G06F16/24522 OR G06F16/2453 OR G06F16/24556 OR G06F16/2462 OR G06F16/2465 OR G06F16/248 OR G06F16/284 OR G06F16/3347 OR G06F16/335 OR G06F16/338 OR G06F16/907 OR G06F17/18 OR G06F18/2111 OR G06F18/2113 OR G06F18/2131 OR G06F18/2148 OR G06F18/217 OR G06F18/231 OR G06F18/2323 OR G06F18/2411 OR G06F18/27 OR G06F18/28 OR G06F18/295 OR G06F21/45 OR G06F2209/5017 OR G06F2209/502 OR G06F2221/2103 OR G06F3/012 OR G06F3/013 OR G06F3/04817 OR G06F3/1454 OR G06F40/174 OR G06F40/247 OR G06F40/289 OR G06F9/5072 OR G06F11/3668 OR G06F16/1767 OR G06F16/21 OR G06F16/24 OR G06F16/243 OR G06F16/2433 OR G06F16/2452 OR G06F16/25 OR					

		G06F16/254 OR G06F16/26 OR G06F16/325 OR G06F16/33 OR G06F16/334 OR G06F16/9027 OR G06F16/906 OR G06F16/908 OR G06F16/954 OR G06F16/9562 OR G06F18/15 OR G06F18/2115 OR G06F18/2193 OR G06F18/232 OR G06F18/241 OR G06F18/2414 OR G06F18/253 OR G06F21/32 OR G06F21/604 OR G06F21/62 OR G06F21/6218 OR G06F21/6254 OR G06F2221/2141 OR G06F3/14 OR G06F3/167 OR G06F30/27 OR G06F40/103 OR G06F40/186 OR G06F40/194 OR G06F40/216 OR G06F40/253 OR G06F40/58 OR G06F8/70 OR G06F9/445 OR G06F40/00).cpc.)					

PE2E SEARCH - Search History (Interference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
N24	131	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) near6 (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) near6 (database$2 dictionar$3 dataset knowledge) WITH	(US-PGPUB; USPAT)	OR	ON	ON	2026/03/10 09:39 PM

		(condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)					
N25	142	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) near6 (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) near6 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)	(US-PGPUB; USPAT)	OR	ON	ON	2026/03/10 09:39 PM
N26	337	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) near6 (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) WITH (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)	(US-PGPUB; USPAT)	OR	ON	ON	2026/03/10 09:39 PM
N27	418	(medical near3 (condition$2 disease	(US-PGPUB; USPAT)	OR	ON	ON	2026/03/10 09:39 PM

		morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) WITH (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)					
N28	11	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) WITH (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome) AND evidium	(US-PGPUB; USPAT)	OR	ON	ON	2026/03/10 09:40 PM
N29	14	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2	(US-PGPUB; USPAT)	OR	ON	ON	2026/03/10 09:40 PM

		participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) WITH (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome) AND carl near2 bate					
N31	14	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) WITH (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome) AND Wian near2 Stipp	(US-PGPUB; USPAT)	OR	ON	ON	2026/03/10 09:41 PM
N32	14	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) WITH	(US-PGPUB; USPAT)	OR	ON	ON	2026/03/10 09:41 PM

		(condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome) AND Thomas near2 unger					
N33	387	N27 AND ((G16H50/70 OR G16H50/30 OR G16H50/20 OR G16H70/20 OR G16H10/60 OR G16H20/30 OR G16H40/63 OR G16H10/20 OR G16H15/00 OR G16H20/10 OR G16H40/67 OR G16H70/60 OR G16H50/50 OR G16H80/00 OR G16H40/20 OR G16H30/40 OR G16H70/00 OR G16H20/70 OR G16H20/60 OR G16H30/20 OR G16H10/40 OR G16H20/17 OR G16H20/00 OR G16H20/40 OR G16H30/00 OR G16H70/40 OR G16H50/80 OR G16H20/13 OR G16H10/00 OR G06F16/24578 OR G06F16/00 OR G06F16/2282 OR G06F16/24575 OR G06F16/285 OR G06F16/951 OR G06F16/9535 OR G06F16/9538 OR G06F16/955 OR G06F40/30 OR G06F16/3329 OR G06F16/288 OR G06F40/279 OR G06F16/2264 OR G06F40/237 OR G06F40/40 OR G06F3/0482 OR G06F16/9024 OR G06F21/6245 OR G06F16/345 OR	(US-PGPUB; USPAT)	OR	ON	ON	2026/03/10 09:42 PM

		G06F21/31 OR G06F40/20 OR G06F8/34 OR G06F9/453 OR G06F16/36 OR G06F18/2148 OR G06F3/04842 OR G06F40/169 OR G06F40/295 OR G06F16/2468 OR G06F16/367 OR G06F21/64 OR G06F16/55 OR G06F21/604 OR G06F21/62 OR G06F2221/2113 OR G06F40/35 OR G06F16/258 OR G06F16/322 OR G06F16/9577 OR G06F18/214 OR G06F18/217 OR G06F18/23 OR G06F18/2323 OR G06F18/24 OR G06F21/76 OR G06F3/04817 OR G06F3/0488 OR G06F3/0489 OR G06F40/186 OR G06F40/211 OR G06F40/56 OR G06F9/543 OR G06F9/547 OR G06F11/3409 OR G06F16/164 OR G06F16/182 OR G06F16/22 OR G06F16/27 OR G06F16/28 OR G06F16/3328 OR G06F16/33295 OR G06F16/338 OR G06F16/353 OR G06F18/21 OR G06F18/2113 OR G06F18/23213 OR G06F18/241 OR G06F18/251 OR G06F18/295 OR G06F21/10 OR G06F21/45 OR G06F21/6218 OR G06F21/6254 OR G06F2221/2103 OR G06F3/048 OR G06F3/0483 OR G06F3/167 OR					

		G06F40/174 OR G06F40/247 OR G06F40/58 OR G06F40/00).cpc.)					

Main Concept Text
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extract, using a natural language processing (NLP) engine,from a medical evidence source a plurality of diagnostic factors each indicative of a medical condition and store each of said diagnostic factors and said medical condition as its own node in a graph database, said medical condition being linked to said diagnostic factors, wherein said medical evidence source uses a same name to describe both said medical condition and one of said diagnostic factors, wherein said medical condition and said one of said diagnostic factors are arranged in different hierarchies in one or more medical evidence sources, and wherein said medical condition and said one of said diagnostic factors are represented in different nodes in said graph database in order to disambiguate said medical condition from said one of said diagnostic factors, wherein said graph database describes more than one hundred thousand relationships; for at least one of said diagnostic factors, store demographics that indicate said medical condition on the basis of said at least one diagnostic factor between said medical condition node and a node representing said at least one diagnostic factor; establish one or more application programming interfaces (APIs) for said graph database, said one or more APIs allowing a software application to integrate with said graph database to access said nodes to generate a healthcare determination; and match patient data from a patient medical chart to at least one of said diagnostic factor nodes or said demographics by traversing a portion of said nodes of said graph database in order to display said healthcare determination that said patient has said medical condition.

(No Concept Modifiers)
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(No Filters)
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Options
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De-dup: None
Relevance Cut-off: None
Sort: Relevance

Content: Patent Publications (169)
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US Patents
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Portugal Applications
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Romania Applications
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San Marino Applications
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Serbia Applications
Slovakia Patents
Slovakia Applications
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Yugoslavia/Serbia and Montenegro Applications
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Indonesia Applications
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Jordan Applications
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Macao Applications
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Kazakhstan Applications
Russia Patents
Russia Applications
Turkey Patents
Turkey Applications

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Leveraging **medical knowledge graphs** into large language models for **diagnosis** prediction: Design and application study

Y Gao, R Li, E Croxford, J Caskey, BW Patterson… - Jmir Ai, 2025 - ai.jmir.org

… as a **medical knowledge** repository, **facilitating** the integration… impact of **knowledge** paths on LLM **diagnostic** predictions, … to **support** conclusions or provide evidence for a **diagnostic** …

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… of a TCM **knowledge graph** and application of potential **knowledge** discovery **in** diabetic kidney disease by integrating **diagnosis** and treatment guidelines …

X Zhao, Y Wang, P Li, J Xu, Y Sun, M Qiu… - Frontiers in …, 2023 - frontiersin.org

… of sufficient clinical **knowledge** to **support** the **diagnosis** and … , and **facilitate** the in-depth discovery of **knowledge** based on … by employing reverse validation based on expert **diagnostic** …

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Improving chronic disease management for children **with knowledge graphs** and artificial intelligence

G Yu, M Tabatabaei, J Mezei, Q Zhong, S Chen… - Expert Systems with …, 2022 - Elsevier

… combines artificial intelligence, **knowledge graph**, big data and … and analytic tools for decision **support** relying on AI-based … , we utilize real life **health** care data from a hospital in China …

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Toward a **knowledge graph** for **medical diagnosis**: **issues** and usage scenarios

A De Nicola, R Zgheib, F Taglino - Semantic Models in IoT and eHealth …, 2022 - Elsevier

… **Diagnostic** systems need a significant amount of background … of electronic **health** records, can **support** clinicians in their … -9 and ICD-10, which help **facilitate** semantic interoperability. …

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Real-world data **medical knowledge graph**: construction and applications

L Li, P Wang, J Yan, Y Wang, S Li, J Jiang… - … intelligence in medicine, 2020 - Elsevier

Objective **Medical knowledge graph** (KG) is attracting attention from both academic and healthcare industry due to its power in intelligent healthcare applications. In this paper, we …

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Learning a **health knowledge graph** from electronic **medical** records

M Rotmensch, Y Halpern, A Tlimat, S Horng… - Scientific reports, 2017 - nature.com

… decision **support** systems in **medicine** and self-**diagnostic** … up the development of such **diagnosis** tools. Moreover, such … A user interface was built to **facilitate** easy tagging. Physicians …

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Electronic **health** record–oriented **knowledge graph** system for collaborative clinical decision **support using** multicenter fragmented **medical** data: design and …

Y Shang, Y Tian, K Lyu, T Zhou, P Zhang… - Journal of Medical …, 2024 - jmir.org

… decision **support**, helping clinicians with prompt **diagnosis** and … **facilitating** data interoperability guided by **knowledge graphs** [… alone would not **support** the **diagnostic** criteria for CKD. In …

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Constructing a clinical **knowledge graph** from electronic **health** records for enhanced decision-making and disease **diagnosis**

D Civale, C De Maio, D Furno, S Senatore - Neurocomputing, 2025 - Elsevier

The increasing complexity of clinical data presents both challenges and opportunities for modern healthcare. This study proposes a robust framework for building a Clinical **Knowledge** …

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Doctor recommendation on healthcare consultation platforms: an integrated framework of **knowledge graph** and deep learning

H Yuan, W Deng - Internet Research, 2022 - emerald.com

… a **health knowledge graph** and propose interactive features based on the **knowledge graph** to … to 30 latest patients he/she has **diagnosed** before the year 2020 for constructing the **health** …

☆ Save 99 Cite Cited by 53 Related articles All 4 versions »

Embedding dynamic **graph** attention mechanism into Clinical **Knowledge Graph** for enhanced **diagnostic** accuracy

D Chen, W Zhang, Z Ding - Expert Systems with Applications, 2025 - Elsevier

… Errors in **diagnosis** can … **health** records, clinical notes, and genomic data—into a dynamic and interconnected framework, thereby **facilitating** a holistic understanding of patient **health**. …

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: BATE et al.	Attorney Docket No.: RCVRP002C1C5
Application No.: 19/092,400	Examiner: LEONARD SAINT CYR
Filed: March 27, 2025	Group: 2658 OK TO ENTER: /L.S/
Title: TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF	Confirmation No.: 6474

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Signed: _____/Andrea Dacanay/_____
Andrea Dacanay

Reply B After Final

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Final Office Action dated September 16th, 2025, please enter the following amendments and consider the following remarks.

Amendments to the Claims begin on page 2 of this paper.
Remarks begin on page 11 of this paper.

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

Retrieval-Augmented Large Language Model for Clinical Decision **Support with** a **Medical Knowledge Graph**

F Saidu, J Wall - Electronics, 2026 - mdpi.com

… **diagnostic support**, with an emphasis on the rare **condition** … between them, **facilitating** organised data management and … may **support** clinical reasoning in rare disease **diagnosis**. Rather …

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Interpretable Disease Prediction via Path Reasoning over **medical knowledge graphs** and admission history

Z Yang, Y Lin, Y Xu, J Hu, S Dong - Knowledge-Based Systems, 2023 - Elsevier

… formulated via a personalized **medical knowledge graph**, which is … of each **diagnosis**. Furthermore, the subgraph is updated via … This process also **facilitates** interpretability by extracting …

☆ Save 99 Cite Cited by 24 Related articles All 2 versions

Building a **knowledge graph** to enable precision **medicine**

P Chandak, K Huang, M Zitnik - Scientific data, 2023 - nature.com

… Developing personalized **diagnostic** strategies and targeted … Further, **knowledge graphs** **facilitated** research across … We provide evidence and statistical **support** for these claims …

☆ Save 99 Cite Cited by 623 Related articles All 9 versions »

DiagLink: A Dual-User **Diagnostic** Assistance System by Synergizing Experts **with** LLMs and **Knowledge Graphs**

Z Zhou, Y Liu, Y Xie, B Wang, X Yang… - arXiv preprint arXiv …, 2026 - arxiv.org

… **diagnostic** assistance system that synergizes large language models (LLMs), **knowledge graphs** (KGs), and **medical** experts to **support** … **diagnosis** module, and also **facilitating** direct …

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Reasoning-enhanced healthcare predictions **with knowledge graph** community retrieval

P Jiang, C Xiao, M Jiang, P Bhatia, T Kass-Hout… - arXiv preprint arXiv …, 2024 - arxiv.org

… We employ hierarchical **graph** community **detection** and … enabling more robust and versatile clinical decision **support** … of community summaries that **facilitate** precise **knowledge** retrieval. …

☆ Save 99 Cite Cited by 38 Related articles All 9 versions »

FPGDKG 1.0: An Integrated Facial Phenotype-Gene-Disease **Knowledge Graph** for Rare Disease **Diagnosis** and Explanation

M He, J Song, S Ren, Y Zhang, J Du… - … and Health …, 2026 - ieeexplore.ieee.org

… matching to **support** differential **diagnosis** for ultrarare diseases. To **facilitate** clinical **use** and research, … promising **diagnostic** performance and enhances explainability by providing multi-…

☆ Save 99 Cite Related articles All 2 versions

A **knowledge graph** based intelligent auxiliary **diagnosis** and treatment system for primary tinnitus **using** traditional Chinese **medicine**

Z Yin, L Wang, H Zhang, Z Kuang, H Yu, T Li… - Egyptian Informatics …, 2024 - Elsevier

… a new **diagnosis** and treatment method **using knowledge graphs**, and an … **support diagnosis**, a **knowledge graph** is created as a decision **support** tool **using** traditional Chinese **medicine** …

☆ Save 99 Cite Cited by 1 Related articles All 2 versions

Digital **health** transformation: leveraging a **knowledge graph** reasoning framework and conversational agents for enhanced **knowledge** management

AA Farsedi, M Ismail, S Gagnon, A Ghazanfar… - Systems, 2026 - mdpi.com

… are also **facilitated** by the system **using use** cases such as … such as "**Medical** Case Study" and "**Diagnostic** Techniques", which … of a **knowledge graph**-driven framework that **supports** CAs, …

☆ Save 99 Cite Cited by 3 Related articles All 6 versions »

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

Maps of **medical** reason: Applying **knowledge graphs** and artificial intelligence **in medical** education and practice

B Cope, M Kalantzis, CX Zhai, A Krussel… - … postdigital knowledge …, 2022 - Springer

… developing **knowledge graph** software to **support medical** … , the **Diagnostic** and Statistical Manual of Mental **Disorders**. … To **facilitate** better integration, the project added their own …

☆ Save 99 Cite Cited by 21 Related articles All 3 versions »

Enhancing ophthalmology **medical** record management **with** multi-modal **knowledge graphs**

W Gao, F Rong, L Shao, Z Deng, D Xiao, R Zhang… - Scientific Reports, 2024 - nature.com

… In the meantime, to ensure continued **support**, we are … of benefits, from **facilitating** assisted **diagnosis** and addressing similar … We propose an auxiliary **diagnostic** method based on **graph** …

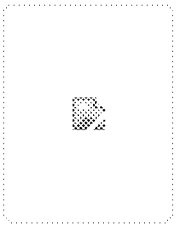
☆ Save 99 Cite Cited by 10 Related articles All 8 versions

ranslation of medical evidence into computational evidence and applications thereof

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and investigations do not include information specific to their associat...

EVIDIUM INC

US20250182912US Applications2025-06-055

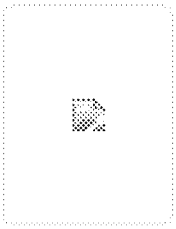


2. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

US20250191783US Applications2025-06-125

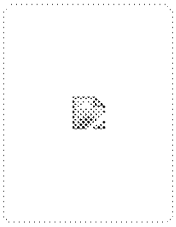


3. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

US20230335299US Applications2023-10-195

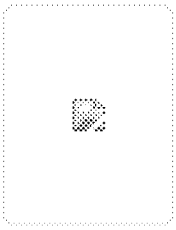


4. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

US12542217US Patents2026-02-035



5. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

WO2023201075A1WIPO Applications2023-10-195

6. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

US12518883US Patents2026-01-065

7. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

US20250182911US Applications2025-06-055

8. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

AU2023253653A1Australia Applications2024-11-285

9. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

US12518882US Patents2026-01-065

10. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

US11869674US Patents2024-01-095

11. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

US20250253061US Applications2025-08-075

12. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

EP4479986A1EPO Applications2024-12-255

13. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

CA3256254A1Canada Applications2023-10-195

14. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

US20230386681US Applications2023-11-305

15. **Determining a next-best action across medical conditions**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

US20250253062US Applications2025-08-075

16. **Determining a next-best action across medical conditions**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

US12525362US Patents2026-01-135

17. **Determining a next-best action across medical conditions**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking Elemental factors and...

EVIDIUM INC

US12300392US Patents2025-05-135

18. **Determination of patient state**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking Elemental factors and...

EVIDIUM INC

US20240153648US Applications2024-05-095

19. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

WO2023201075A4WIPO Applications2023-11-094

20. **Transformation of medical evidence into computational evidence and its applications**

[Solution] A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of links of basic diagnostic factors and basic tests to diseases. Input from the person groups, modifies, and adds rankings of factors and tests. Basic factors and tests do not contain information...

EVIDIUM INC

JP2025512348AJapan Applications2025-04-174

21. **Translation of medical evidence into computational evidence and applications thereof**

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and...

EVIDIUM INC

GB2634462AGreat Britain Applications2025-04-094

22. **System and method for defining a user experience of medical data systems through a knowledge graph**

A method for controlling distribution of information pertaining to a medical condition is disclosed. The method may include receiving, at a server, an electronic medical record including notes pertaining to a patient. The method may also include processing the notes to obtain indicia. The method may also include identifyin...

HEALTHPOINTE SOLUTIONS INC

US12412670US Patents2025-09-094

23. **System and method for defining a user experience of medical data systems through a knowledge graph**

A method for controlling distribution of information pertaining to a medical condition is disclosed. The method may include receiving, at a server, an electronic medical record including notes pertaining to a patient. The method may also include processing the notes to obtain indicia. The method may also include identifyin...

HEALTHPOINTE SOLUTIONS INC

WO2021041241A1WIPO Applications2021-03-044

24. **System and method for defining a user experience of medical data systems through a knowledge graph**

A method for controlling distribution of information pertaining to a medical condition is disclosed. The method may include receiving, at a server, an electronic medical record including notes pertaining to a patient. The method may also include processing the notes to obtain indicia. The method may also include identifyin...

HEALTHPOINTE SOLUTIONS INC

US20220375622US Applications2022-11-244

25. **Machine learning for collaborative medical data metrics**

A medical knowledge database including medical knowledge information, medical diagnoses, and medical treatments, is used for machine learning for collaborative medical data metrics. Medical data is collected from a plurality of clinicians serving a first plurality of patients and assembling a medical knowledge database that...

HEALTHPALS INC

US20180342323US Applications2018-11-294

26. **Machine learning for collaborative medical data metrics**

A medical knowledge database including medical knowledge information, medical diagnoses, and medical treatments, is used for machine learning for collaborative medical data metrics. Medical data is collected from a plurality of clinicians serving a first plurality of patients and assembling a medical knowledge database that...

HEALTHPALS INC

US11488714US Patents2022-11-014

27. **Self-learning clinical intelligence system based on biological information and medical data metrics**

Biological information and medical knowledge information are used for self-learning clinical intelligence. Medical knowledge information is assembled. Medical rules are generated based on the medical knowledge. The medical rules can be generated probabilistically. A plurality of risk models can be learned. The plurality o...

HEALTHPALS INC

US20170277841US Applications2017-09-284

28. **System and method for diagnosing disease through cognification of unstructured data**

A method for diagnosing a medical condition through cognification of unstructured data is disclosed. The method may include receiving, at a server, an electronic medical record including notes pertaining to a patient. The method may also include generating cognified data using the notes, where the cognified data includes a...

HEALTHPOINTE SOLUTIONS INC

US20220300713US Applications2022-09-224

29. **System and method for diagnosing disease through cognification of unstructured data**

A method for diagnosing a medical condition through cognification of unstructured data is disclosed. The method may include receiving, at a server, an electronic medical record including notes pertaining to a patient. The method may also include generating cognified data using the notes, where the cognified data includes a...

HEALTHPOINTE SOLUTIONS INC

WO2021041243A1WIPO Applications2021-03-044

30. **System and method for diagnosing disease through cognification of unstructured data**

A method for diagnosing a medical condition through cognification of unstructured data is disclosed. The method may include receiving, at a server, an electronic medical record including notes pertaining to a patient. The method may also include generating cognified data using the notes, where the cognified data includes a...

HEALTHPOINTE SOLUTIONS INC

US12159113US Patents2024-12-034

31. **Healthcare network**

A system operable to transmit healthcare data to a user device configured to analyze medical information. A directed graph representing at least one medical guideline is maintained in a database. The directed graph includes a plurality of nodes connected by a plurality of directed edges. In some examples, the directed grap...

SIEMENS HEALTHCARE GMBH

CN112840406AChina Applications2021-05-254

32. **Tracking infectious disease using a comprehensive clinical risk profile and performing actions in real-time via a clinic portal**

A method for determining a risk for an infectious disease for a patient using a cognitive intelligence platform is disclosed. The method includes receiving, from an authoritative source, factors indicative of a person being infected by the infectious disease, wherein the factors include medical information pertaining to the infectiou...

HEALTHPOINTE SOLUTIONS INC

US20230343460US Applications2023-10-264

33. **Health related data management of a population**

A method is disclosed for managing risk associated with a medical condition diagnosed for a plurality of patients in a population, the method including creating, using an artificial-intelligence engine of a cognitive intelligence platform, a population profile including a plurality of patient graphs associated with the medical...

BETTER CARE TECH LLC

US20250378955US Applications2025-12-114

34. **Digital healthcare systems and methods**

Digital Healthcare Systems and Methods A digital healthcare system comprises: a clinician-facing application, a patient-facing application, and a server-based application. The patient-facing application is configured to: receive in a first user input, first patient data, and send the first patient data to the server-based application....

NEOM CO

WO2026047595A1WIPO Applications2026-03-054

35. **Tracking infectious disease using a comprehensive clinical risk profile and performing actions in real-time via a clinic portal**

A method for determining a risk for an infectious disease for a patient using a cognitive intelligence platform is disclosed. The method includes receiving, from an authoritative source, factors indicative of a person being infected by the infectious disease, wherein the factors include medical information pertaining to the infectiou...

HEALTHPOINTE SOLUTIONS INC

WO2021211804A1WIPO Applications2021-10-214

36. **Health related data management of a population**

A method is disclosed for managing risk associated with a medical condition diagnosed for a plurality of patients in a population, the method including creating, using an artificial-intelligence engine of a cognitive intelligence platform, a population profile including a plurality of patient graphs associated with the medical...

HEALTHPOINTE SOLUTIONS INC

WO2021087316A1WIPO Applications2021-05-064

37. **Health related data management of a population**

A method is disclosed for managing risk associated with a medical condition diagnosed for a plurality of patients in a population, the method including creating, using an artificial-intelligence engine of a cognitive intelligence platform, a population profile including a plurality of patient graphs associated with the medical...

HEALTHPOINTE SOLUTIONS INC

US20220367054US Applications2022-11-174

38. **Tracking infectious disease using a comprehensive clinical risk profile and performing actions in real-time via a clinic portal**

A method for determining a risk for an infectious disease for a patient using a cognitive intelligence platform is disclosed. The method includes receiving, from an authoritative source, factors indicative of a person being infected by the infectious disease, wherein the factors include medical information pertaining to the infectiou...

HEALTHPOINTE SOLUTIONS INC

US12198814US Patents2025-01-144

39. **Healthcare network**

A system operable to transmit healthcare data to a user device configured for use in analysing medical information. A directed graph representing at least one medical guideline is maintained in a database. The directed graph includes a plurality of nodes connected by a plurality of directed edges. In some examples a...

SIEMENS HEALTHCARE GMBH

US20210407694US Applications2021-12-304

40. **Healthcare network**

A system operable to transmit healthcare data to a user device configured for use in analysing medical information. A directed graph representing at least one medical guideline is maintained in a database. The directed graph comprising a plurality of nodes connected by a plurality of directed edges. In some examples ...

SIEMENS HEALTHCARE GMBH

EP3637424A1EPO Applications2020-04-154

41. **Data structures for use in clinical decision making systems**

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

Data Structures for use in Clinical Decision Making Systems A computer implemented method for converting medical data into a graph structure for improved diagnostic querying comprises: converting first information on a first health condition into a first sub-knowledge-graph, sub-KG, the first sub-KG having the following...

NEOM CO

WO2026047592A1WIPO Applications2026-03-054

42. **System and method for determining and presenting clinical answers**

A method includes causing at least a portion of a knowledge graph representing ontological health related information to be presented on a display of a client device. The method further includes receiving, at an artificial intelligence engine, a medical query, wherein the medical query includes a plurality of strings of...

HEALTHPOINTE SOLUTIONS INC

WO2021138013A1WIPO Applications2021-07-084

43. **System and method for determining and presenting clinical answers**

A method includes causing at least a portion of a knowledge graph representing ontological health related information to be presented on a display of a client device. The method further includes receiving, at an artificial intelligence engine, a medical query, wherein the medical query includes a plurality of strings of...

HEALTHPOINTE SOLUTIONS INC

US20230043543US Applications2023-02-094

44. **Healthcare network**

A system operable to transmit healthcare data to a user device configured for use in analysing medical information. A directed graph representing at least one medical guideline is maintained in a database. The directed graph comprising a plurality of nodes connected by a plurality of directed edges. In some examples ...

SIEMENS HEALTHCARE GMBH

WO2020074191A1WIPO Applications2020-04-164

45. **Computer medical planning method and system using mass medical analysis**

OLEYNIK MARK

JP6709166B2Japan Patents2020-06-104

46. **Hybrid knowledge graph for healthcare applications**

A healthcare system, platform and methods for providing enhanced medical diagnostics and treatment are herein provided. The platform includes a healthcare knowledge graph database for storing a medical hybrid knowledge graph, the hybrid knowledge graph including healthcare data from one or more ontology-based...

KAHUN MEDICAL LTD

US11636949US Patents2023-04-254

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

47. **Healthcare network**

A system operable to transmit healthcare data to a user device configured for use in analysing medical information. A directed graph representing at least one medical guideline is maintained in a database. The directed graph comprising a plurality of nodes connected by a plurality of directed edges. In some examples ...

SIEMENS HEALTHCARE GMBH

EP3837693A1EPO Applications2021-06-234

48. *System and method for cognifying unstructured data*

A method includes receiving, at an artificial intelligence engine, a corpus of data for a patient, where the corpus of data includes a set of strings of characters. The method also includes identifying, in the set of strings of characters, indicia including a phrase, a predicate, a keyword, a subject, an object, a cardinal, a number, a...

HEALTHPOINTE SOLUTIONS INC

WO2021041239A1WIPO Applications2021-03-044

49. **Performing mapping operations to perform an intervention**

A method may include receiving a set of codes pertaining to an event performed for a patient, mapping the plurality of codes to a taxonomy of data to determine a utilization unit, mapping the utilization unit to ontological data of a medical condition, mapping the ontological data to a knowledge fragment pertaining t...

HEALTHPOINTE SOLUTIONS INC

WO2021087317A1WIPO Applications2021-05-064

50. **System and method for cognifying unstructured data**

A method includes receiving, at an artificial intelligence engine, a corpus of data for a patient, where the corpus of data includes a set of strings of characters. The method also includes identifying, in the set of strings of characters, indicia including a phrase, a predicate, a keyword, a subject, an object, a cardinal, a number, a...

HEALTHPOINTE SOLUTIONS INC

US20220300832US Applications2022-09-224

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: BATE et al.	Attorney Docket No.: RCVRP002C1C5
Application No.: 19/092,400	Examiner: LEONARD SAINT CYR
Filed: March 27, 2025	Group: 2658
Title: TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF	Confirmation No.: 6474

Certificate of Transmission via USPTO Patent Electronic Filing System
I hereby certify that this correspondence is being transmitted via the U.S. Patent and Trademark Office (USPTO) patent electronic filing system to the USPTO on February 25, 2026.

Signed: _____/Andrea Dacanay/_____
Andrea Dacanay

REPLY B TRANSMITTAL

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Commissioner:

Transmitted herewith is an Amendment in the above-identified application.

The fee has been calculated as shown below.

	Claims After Amendment		Highest Previously Paid For	Present Extra	Small Entity Rate Fee	Large Entity Rate Fee
Total Claims	25	MINUS	30	0	x $80 = $0.00	x 200 = $0.00
Independent Claims	4	MINUS	4	0	x $240 = $0.00	x 600 = $0.00
Multiple Dependent Claim Present and Fee Not Previously Paid						
				Total	$0.00	$0.00

☒ Applicant(s) hereby petitions for a 3 month extension(s) of time to respond to the aforementioned Office Action.

☒ Applicant(s) believe that no (additional) Extension of Time is required; however, if it is determined that such an extension is required, Applicant(s) hereby petition that such an extension be granted and authorize the Commissioner to charge the required fees for an Extension of Time under 37 CFR 1.136 to Deposit Account No. 50-4481.

☒ Please charge the required fees, or any additional fees required to facilitate filing the enclosed response, to Deposit Account No. 50-4481 (Order No. RCVRP002C1C5).

Respectfully submitted,
BEYER LAW GROUP LLP
/Jonathan O. Scott/
Jonathan O. Scott
Reg. No. 39,364

P. O. Box 51887
Palo Alto, CA 94303-1887
650-842-1300

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: BATE et al.	Attorney Docket No.: RCVRP002C1C5
Application No.: 19/092,400	Examiner: LEONARD SAINT CYR
Filed: March 27, 2025	Group: 2658
Title: TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF	Confirmation No.: 6474

CERTIFICATE OF EFS-WEB TRANSMISSION
I hereby certify that this correspondence is being transmitted electronically through EFS-WEB to the Commissioner for Patents, P.O. Box 1450 Alexandria, VA 22313-1450 on February 25, 2026.

Signed: _____/Andrea Dacanay/_____
Andrea Dacanay

Reply B After Final

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Final Office Action dated September 16th, 2025, please enter the following amendments and consider the following remarks.

Amendments to the Claims begin on page 2 of this paper.
Remarks begin on page 11 of this paper.

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

IN THE CLAIMS

1. (Currently Amended) A computer system for transforming narrative medical evidence into a computational form, said computer system comprising:

one or more processors; and

memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to:

receive text from a plurality of medical evidence sources, said text pertaining to a medical condition, wherein one or more of said medical evidence sources use a same name to describe both said medical condition and a symptom, and wherein said medical condition and said symptom are arranged in different hierarchies in one or more medical evidence sources;

process said text **using a natural language processing (NLP) engine** to produce a plurality of clinical concepts indicative of said medical condition;

generate a plurality of nodes in a graph database, said plurality of nodes including said plurality of clinical concepts, wherein said medical condition and said symptom, which are associated with said same name in said one or more medical evidence sources, are represented in different nodes in said graph database in order to disambiguate one or more of said plurality of clinical concepts;

store said plurality of clinical concepts each as separate nodes in said graph database, said medical condition being linked to one or more of said plurality of clinical concepts in said graph database**, wherein said graph database describes more than one hundred thousand relationships**; and

establish one or more application programming interfaces (APIs) for said graph database, said one or more APIs allowing a software application to integrate with said graph database to access said plurality of nodes to generate a healthcare determination by traversing a portion of said plurality of nodes that disambiguate one or more of said plurality of clinical concepts.

2. (Cancelled)

3. (Previously Presented) A computer system as recited in claim 1 wherein said graph database is a knowledge graph and said each separate node is a node of said knowledge graph.

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

4. (Previously Presented) A computer system as recited in claim 1 wherein each clinical concept is a diagnostic factor and each diagnostic factor node includes a unique identifier which links to an entry in a medical ontology representing said each diagnostic factor.

5. (Cancelled)

6. (Cancelled)

7. (Previously Presented) A computer system as recited in claim 1, wherein the instructions, when executed, further cause the one or more processors to:

receive a rank associated with said clinical concepts, said rank indicating how likely it is that said clinical concepts are indicative of said medical condition; and

store said rank in a graph database node between said medical condition node and said clinical concepts nodes.

8. (Original) A computer system as recited in claim 1 wherein said clinical concepts are diagnostic factors caused by said medical condition, are risk factors that contribute to said medical condition, are laboratory tests that indicate said medical condition, are examinations that indicate said medical condition, or are drugs that contribute to said medical condition.

9. (Previously Presented) A computer system as recited in claim 1, wherein the instructions, when executed, further cause the one or more processors to:

receive input indicating a group that subsumes said clinical concepts; and

store said group as a separate node in said graph database, said group including at least one condition-dependent attribute that depends upon said medical condition, said medical condition node being linked to said group node and said group node being linked to each of said clinical factors nodes.

10. (Previously Presented) A computer system as recited in claim 1 wherein said one of said clinical concepts is a diagnostic factor, and wherein a diagnostic factor node includes a temporality attribute indicating whether or not a patient is currently exhibiting said diagnostic factor, a negation attribute indicating whether not said diagnostic factor is present in said patient, or an experience attribute indicating whether not said patient experiences said diagnostic factor personally.

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

11. (Previously Presented) A computer system as recited in claim 1, wherein the instructions, when executed, further cause the one or more processors to:

extract from said text a rank indicating how likely it is that one of said clinical concepts is indicative of said medical condition; and

add said rank to a location in said graph database between said medical condition node and said clinical concepts nodes.

12. (Currently Amended) A computer system for determining a state of a patient, said computer system comprising:

one or more processors; and

memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to:

extract**, using a natural language processing (NLP) engine,** from a medical evidence source a plurality of diagnostic factors each indicative of a medical condition and store each of said diagnostic factors and said medical condition as its own node in a graph database, said medical condition being linked to said diagnostic factors, wherein said medical evidence source uses a same name to describe both said medical condition and one of said diagnostic factors, wherein said medical condition and said one of said diagnostic factors are arranged in different hierarchies in one or more medical evidence sources, and wherein said medical condition and said one of said diagnostic factors are represented in different nodes in said graph database in order to disambiguate said medical condition from said one of said diagnostic factors**, wherein said graph database describes more than one hundred thousand relationships**;

for at least one of said diagnostic factors, store demographics that indicate said medical condition on the basis of said at least one diagnostic factor between said medical condition node and a node representing said at least one diagnostic factor;

establish one or more application programming interfaces (APIs) for said graph database, said one or more APIs allowing a software application to integrate with said graph database to access said nodes to generate a healthcare determination; and

match patient data from a patient medical chart to at least one of said diagnostic factor nodes or said demographics by traversing a portion of said nodes of said graph database in order to display said healthcare determination that said patient has said medical condition.

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13. (Original) A computer system as recited in claim 12, wherein the instructions, when executed, further cause the one or more processors to:

determine a rank of said likelihood that said patient has said medical condition by reference to a node intermediate between said medical condition node and said diagnostic factor nodes that holds said rank of said diagnostic factors.

14. (Cancelled)

15. (Cancelled)

16. (Currently Amended) A computer system for determining a state of a patient, said computer system comprising:

one or more processors; and

memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to:

receive a plurality of diagnostic factors known to be present or absent in a patient **using a natural language processing (NLP) engine**;

match said diagnostic factors to factor nodes in a knowledge graph that includes a plurality of medical condition nodes, each of said factor nodes being linked to at least one of said medical condition nodes, wherein at least one of said medical condition nodes and at least one of said factor nodes uses a same name to describe both said at least one of said medical condition nodes and said at least one of said factor nodes, and wherein said at least one of said medical condition nodes and said at least one of said factor nodes are represented in different nodes in said knowledge graph in order to disambiguate said at least one of said medical condition nodes from said at least one of said factor nodes**, wherein said knowledge graph describes more than one hundred thousand relationships**;

establish one or more application programming interfaces (APIs) for said knowledge graph, said one or more APIs allowing a software application to integrate with said knowledge graph to access said medical condition nodes and said factor nodes to generate a healthcare determination;

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for each of a plurality of said medical condition nodes, collect a rank value from along a path between said each medical condition node and each matched factor node to which said each medical condition node is linked, said rank value indicating how likely it is that the diagnostic factor matched to said each matched factor node is indicative of a medical condition represented by said each medical condition node;

sum all collected rank values for said each medical condition node to produce a final ranking value for said each medical condition node; and

output the medical condition representing said each medical condition node and said final ranking value of said each medical condition node in order to output said healthcare determination.

17. (Original) A computer system as recited in claim 16, wherein the instructions, when executed, further cause the one or more processors to:

display in association with each of said output medical conditions its corresponding final ranking value.

18. (Previously Presented) A computer system as recited in claim 16 wherein each of said medical conditions is a disease, an orthopedic anomaly, an adverse drug reaction, or a drug-to-drug interaction.

19. (Original) A computer system as recited in claim 16 wherein the instructions, when executed, further cause the one or more processors to:

display said output medical conditions in order of final ranking value.

20. (Previously Presented) A computer system as recited in claim 16 wherein the instructions, when executed, further cause the one or more processors to:

receive said plurality of diagnostic factors at said knowledge graph via an one of said application programming interfaces (APIs); and

output said medical conditions and said final ranking values via one of said APIs to said software application.

21. (Original) A computer system as recited in claim 16 wherein the instructions, when executed, further cause the one or more processors to:

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for at least one of said diagnostic factors known to be present, traversing upward in a medical ontology link found in one of said matched factor nodes corresponding to said at least one of said diagnostic factors known to be present in order to infer at least one other diagnostic factor present in said patient and matching this other diagnostic factor to a factor node in said knowledge graph.

22. (Original) A computer system as recited in claim 16 wherein a demographics node of said knowledge graph located between one of said matched factor nodes and its corresponding linked medical condition node includes demographics of people who exhibit said matched diagnostic factor in the context of said linked medical condition, and wherein the instructions, when executed, further cause the one or more processors to:

only collect a rank value from along a path between said matched factor node and said at least one linked medical condition node when information of said patient matches said demographics in said demographics node.

23. (Original) A computer system as recited in claim 16 wherein each of said factor nodes does not include information specific to a medical condition represented by said at least one medical condition node.

24. (Currently Amended) A computer system for determining next-best actions for a medical condition, said system comprising:

one or more processors; and

memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to perform the following for at least one medical condition of a patient:

identify all known factor nodes in a knowledge graph that each represent a diagnostic factor known to be present or absent in said patient, **said diagnostic factors being determined using a natural language processing (NLP) engine,** each known factor node being linked to a medical condition node in said knowledge graph representing said at least one medical condition**, wherein said knowledge graph describes more than one hundred thousand relationships**;

identify all unknown factor nodes in said knowledge graph that each represent an unknown diagnostic factor not known to be present or absent in said patient, each unknown factor node being linked to said medical condition node, wherein said medical condition node

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and at least one of said known or unknown factor nodes uses a same name to describe both said medical condition node and said at least one of said known or unknown factor nodes, and wherein said medical condition node and said at least one of said known or unknown factor nodes are represented in different nodes in said knowledge graph in order to disambiguate said medical condition node from said at least one of said known or unknown factor nodes;

establish one or more application programming interfaces (APIs) for said knowledge graph, said one or more APIs allowing a software application to integrate with said knowledge graph to access said medical condition node and said known and unknown factor nodes to generate a healthcare determination;

identify a rank of each unknown factor node that indicates a likelihood that said represented unknown diagnostic factor indicates said at least one medical condition, said rank being stored between said unknown factor node and said medical condition node; and

output said unknown diagnostic factors corresponding to said unknown factor nodes in association with said at least one medical condition in order of said rank of said each unknown factor node in order to output said healthcare determination.

25. (Original) A computer system as recited in claim 24, wherein the instructions, when executed, further cause the one or more processors to:

identify said unknown factor nodes by traversing down through said knowledge graph from said at least one medical condition node and disregarding said known factor nodes.

26. (Original) A computer system as recited in claim 24 wherein said rank of said each unknown factor node is located between said at least one medical condition node and said each unknown factor node.

27. (Original) A computer system as recited in claim 24, wherein the instructions, when executed, further cause the one or more processors to:

for each known factor node, traverse upward in a medical ontology link found in said each known factor node in order to infer other diagnostic factors present in said patient.

28. (Original) A computer system as recited in claim 24 wherein traversing said knowledge graph from one of said unknown factor nodes to said at least one medical condition produces a first rank for said one of said unknown factor nodes in the context of said at least one medical

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condition which is different from a second rank produced by traversing from said one of said unknown factor nodes to a second medical condition.

29. (Original) A computer system as recited in claim 24 wherein the instructions, when executed, further cause the one or more processors to:

input said diagnostic factors known to be present or absent in said patient to said knowledge graph via an applications programming interface (API); and

provide said unknown diagnostic factors in association with said at least one medical condition via said API to a software application.

30. (Original) A computer system as recited in claim 24 wherein said each known factor node does not include information specific to said at least one medical condition.

31. (Cancelled)

32. (Cancelled)

33. (Cancelled)

34. (Cancelled)

35. (Cancelled)

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REMARKS

Claims 1, 3-4, 7-13, 16-30 are now pending in this application. Reconsideration of the application is earnestly requested. The examiner has indicated that the above amendments will place the application in condition for allowance.

Reconsideration of this application and issuance of a Notice of Allowance at an early date are respectfully requested. If the examiner believes a telephone conference would in any way expedite prosecution, please do not hesitate to telephone the undersigned at (612) 924-6494.

Respectfully submitted,
BEYER LAW GROUP LLP

/Jonathan O. Scott/

Jonathan O. Scott
Registration No. 39,364

P.O. Box 51887
Palo Alto, CA 94303-1887

Telephone: (612) 924-6494
Facsimile: (612) 924-6499

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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/092,400	**02/25/2026 01:12:56 PM Z ET**	**RCVRP002C1C5**

Title of Invention

TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	6474	FILED BY	ANDREASARAH DACANAY
PATENT CENTER #	74609717	AUTHORIZED BY	Jonathan Scott
CUSTOMER #	58766	FILING DATE	03/27/2025
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Carl BATE

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
DA / 504481	**E20262OD13146639**	**ANDREASARAH DACANAY**

PRE-AUTHORIZED ACCOUNT	PRE-AUTHORIZED CATEGORY
504481	**37 CFR 1.21 (Miscellaneous fees and charges)**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
2253	EXTENSION FOR RESPONSE WITHIN THIRD MONTH, EXCEPT PROVISIONAL APPLICATIONS	636.00	1	636.00
			TOTAL AMOUNT:	**$636.00**

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement

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Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/092,400	**02/25/2026 01:12:56 PM Z ET**	**RCVRP002C1C5**

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CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jonathan Scott

Documents

TOTAL DOCUMENTS: 4

DOCUMENT		PAGES	DESCRIPTION	SIZE (KB)
RCVRP002C1C5_Reply_B_Transmittal.pdf		1	Transmittal Letter	21 KB
RCVRP002C1C5 Reply B after final.pdf		10	-	54 KB
RCVRP002C1C5 Reply B after final-A.NE.pdf	(1-1)	1	Response After Final Action	18 KB
RCVRP002C1C5 Reply B after final-CLM.pdf	(2-9)	8	Claims	43 KB
RCVRP002C1C5 Reply B after final-REM.pdf	(10-10)	1	Applicant Arguments/Remarks Made in an Amendment	10 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
RCVRP002C1C5_Reply_B_Transmittal.pdf	A5B45B1514A36ECDC35570B028FB4D0D31E224F14B8E96BF16E3E3E1E60DD34A7C204FE3DAF54A3C2380CA978407E6B25E411262DFF7FE1AD076ED644FBBE3A2
RCVRP002C1C5 Reply B after final.pdf	B0F702922BDF4CF81121F2033A1AEB2080FEB510392248EE300082487762BF597CBD766E819E6EC1999DA10A78B8576AF2EC6954600B6EDABA7098EB2A252520
RCVRP002C1C5 Reply B after final-A.NE.pdf	2E6E7710462B16AF2A85CE4819E13F0B8135916FA5AF8BCF34CF2B44FB517C4AA7708F209A6C3E625A91638D0E216FCF7F49FBF0D4F9527B1DE158BFE953F8A9
RCVRP002C1C5 Reply B after final-CLM.pdf	DA5B94668C84A300F52D1E8DA52C9DA48158F90629930653C5BC445C4EBD6E9DCD6D2EF62600DE77EE9EF8B553BDF1CABCC22E21C156BD5E08AC032A09EEC546
RCVRP002C1C5 Reply B after final-REM.pdf	3DACAF2F7499607DEB9B3315AFA0AD54D4225456F55962889409B9E47CF2A2B5B7239C4E1FA607B3A98B46B6F2A3226178BA33A0F0D8132A38608172903300EB

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New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (09-11)
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 19/092,400	Filing Date 03/27/2025	☐ To be Mailed

ENTITY: ☐ LARGE ☑ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $80 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $240 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	02/25/2026	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 20	Minus	** 30	= 0		x $80 =	0
	Independent (37 CFR 1.16(h))	* 4	Minus	*** 4	= 0		x $240 =	0
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	0

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.	LIE
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".	/KIMBERLY N PANNELL/
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".	
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.	

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
19/092,400	03/27/2025	Carl BATE	RCVRP002C1C5	6474

58766 7590 09/16/2025

Beyer Law Group LLP
P. O. Box 51887
Palo Alto, CA 94303-1887

EXAMINER
SAINT CYR, LEONARD

ART UNIT	PAPER NUMBER
2658	

NOTIFICATION DATE	DELIVERY MODE
09/16/2025	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

USPTOmail@beyerlaw.com

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Office Action Summary	Application No. 19/092,400	Applicant(s) BATE et al.	
	Examiner LEONARD SAINT-CYR	Art Unit 2658	AIA (First Inventor to File) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☑ Responsive to communication(s) filed on 08/27/25.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☑ This action is **FINAL.** 2b) ☐ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1, 3, 4, 7 -13, 16 – 35 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1, 3, 4, 7 -13, 16 – 35 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 03/27/25 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

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DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Response to Arguments

2. Applicant's arguments, see pages 12 - 19, filed 08/27/25, with respect to claims 1, 3, 4, 7 -13, 16 – 30 have been fully considered and are persuasive. The rejections of claims 1, 3, 4, 7 -13, 16 – 30 under 35 U.S.C 102 & 103 have been withdrawn.

3. Applicant's arguments filed 08/27/25 have been fully considered but they are not persuasive.

Applicant argues that not only is an API a software construct that a human cannot practically perform in his or her mind, but also that the API allows the software application to integrate with the graph database to access the nodes for traversal. Practically speaking, a human cannot implement a software application in his or her mind in order to integrate it with a graph database via an API. The system then allows external applications to access and traverse these disambiguated nodes through APIs to generate accurate healthcare recommendations. This approach improves how computer systems process and structure medical evidence by enabling these computer systems to integrate and use medical evidence from multiple sources in a way that eliminates ambiguity and produces more reliable results (Amendment, pages 12 – 19).

The examiner disagrees, and points out that the Application programming interface (API) recited in the claims is a generic computer component that use as a tool in performing generic computer functions of accessing the graph database to generate healthcare determination. it is also held that the Application programming interface (API) is directed to an existing technology with its available basic functions that does not create patent eligibility or render the claims eligible under 35 USC 101.

Claim Rejections - 35 USC § 101

4. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

5. Claims 1, 3, 4, 7 -13, 16 – 35 are rejected under 35 U.S.C. 101 because the claimed invention is directed to an abstract without significantly more.

When considering subject matter eligibility under 35 USC 101, it must be determined whether the claim is directed to one of the four statutory categories of invention, i.e., process, machine, manufacture, or composition of matter.

6. Claims 1, 3, 4, 7 -11, 31, 35 are directed to a system. They hereby fall under one of the four statutory classes of invention.

If the claim does not fall within one of the statutory categories, it must then be determined whether the claim is directed to a judicial exception (i.e., law of nature, natural phenomenon, and abstract idea).

Claims 1, 3, 4, 7 -11, 31, 35 recite steps that can be practically performed by a human, either mentally or with the use of pen and paper.

The limitations of "generate a plurality of nodes in a graph database, said plurality of nodes including said plurality of clinical concepts, wherein said medical condition and said symptom, which are associated with said same name in said one or more medical evidence sources, are represented in different nodes in said graph database in order to disambiguate one or more of said plurality of clinical concepts are relevant to said medical condition; and store said plurality of clinical concepts each as separate nodes in said graph database, said medical condition being linked to one or more of said plurality of clinical concepts in said graph database" in claims 1, 3, 4, 7 -11, 31, 35, is a machine that, under its broadest reasonable interpretation, covers performance of the limitation in the mind, but for the recitation of generic computer components. That is, other than reciting "a computer system comprising one or more processors and memory", nothing in the claim element precludes the steps from practically being performed in a human mind or using a pen and a piece of paper.

The mere nominal recitation of a generic processor and computing device do not take the claim limitations out of the mental processes grouping.

If a claim limitation, under its broadest reasonable interpretation, covers mental processes but for the recitation of generic computer components, then it falls within the "Mental Processes" grouping of abstract ideas (concepts performed in the human mind including an observation, evaluation, judgement, and opinion). Accordingly, the claims recite an abstract idea.

This judicial exception is not integrated into a practical application. In particular, the claims recite the additional elements "receive text from a plurality of medical evidence sources, said text pertaining to a medical condition, wherein one or more of

said medical evidence sources use a same name to describe both said medical condition and a symptom, and wherein said medical condition and said symptom are arranged in different hierarchies in one or more medical evidence sources; establish one or more application programming interfaces (APIs) for said graph database, said one or more APIs allowing a software application to integrate with said graph database to access said plurality of nodes to generate a healthcare determination by traversing a portion of said plurality of nodes that disambiguate one or more of said plurality of clinical concepts.".

The limitation "receive text from a plurality of medical evidence sources, said text pertaining to a medical condition, wherein one or more of said medical evidence sources use a same name to describe both said medical condition and a symptom, and wherein said medical condition and said symptom are arranged in different hierarchies in one or more medical evidence sources', amount to data-gathering steps which is considered to be insignificant extra solution activity, (See MPEP 2106.05(g)).

The limitation "establish one or more application programming interfaces (APIs) for said graph database, said one or more APIs allowing a software application to integrate with said graph database to access said plurality of nodes to generate a healthcare determination by traversing a portion of said plurality of nodes that disambiguate one or more of said plurality of clinical concepts.", represents an extra-solution activity because it is a mere nominal or tangential addition to the claim, a mere generic transmission and presentation of collected and analyzed data. (See MPEP 2106.05 (g)).

Accordingly, these additional elements do not integrate the abstract idea into a

practical application because they do not impose any meaningful limits on practicing the abstract idea, thus fail to integrate the abstract idea into a practical application. See MPEP 2106.05(g).

The insignificant extra-solution activities identified above, which include the data gathering (receiving, and inputting), and establishing steps, are recognized by the courts as well-understood, routine, and conventional activities when they are claimed in a merely generic manner (e.g., at a high level of generality) or as insignificant extra solution activity (See MPEP 2106.05(d)(II) (i) Receiving or transmitting data over a network, e.g., using the Internet to gather data, buySAPE, Inc. v. Google, Inc., 765 F.3d 1350, 1355, 112 USPO2d 1093, 1096 (Fed. Cir. 2014) (computer receives and sends information over a network); (v) Presenting (displaying) offers and gathering statistics, OIP Techs., 788 F.3d at 1362-63, 115 USPO2d at 1092- 93). The claims are not patent eligible.

Claims 1, 3, 4, 7 -11, 31, 35 do not include additional elements that are sufficient to amount to significantly more than the judicial exception. As discussed above with respect to integration of the abstract idea into a practical application, the additional element of receive text from a plurality of medical evidence sources, said text pertaining to a medical condition, wherein one or more of said medical evidence sources use a same name to describe both said medical condition and a symptom; establish one or more application programming interfaces (APIs) for said graph database steps amounts to no more than mere instructions to apply the exception using a generic computer component. Mere instructions to apply an exception using a generic computer component cannot provide an inventive concept.

Claims 1, 3, 4, 7 -11, 31, 35 as a whole, do not amount to significantly more than the abstract idea itself. This is because the claims do not affect an improvement to the functioning of a computer itself; and the claims do not move beyond a general link of the use of an abstract idea to a particular technological environment.

7. Claims 12, 13, 16 – 23, 32, 33 are directed to a system. They hereby fall under one of the four statutory classes of invention.

If the claim does not fall within one of the statutory categories, it must then be determined whether the claim is directed to a judicial exception (i.e., law of nature, natural phenomenon, and abstract idea).

Claims 12, 13, 16 – 23, 32, 33 recite steps that can be practically performed by a human, either mentally or with the use of pen and paper.

The limitations of "extract from a medical evidence source a plurality of diagnostic factors each indicative of a medical condition and store each of said diagnostic factors and said medical condition as its own node in a graph database, said medical condition being linked to said diagnostic factors, wherein said medical evidence source uses a same name to describe both said medical condition and one of said diagnostic factors, wherein said medical condition and said one of said diagnostic factors are arranged in different hierarchies in one or more medical evidence sources, and wherein said medical condition and said one of said diagnostic factors are represented in different nodes in said graph database in order to disambiguate said medical condition from said one of said diagnostic factors each of said diagnostic factor nodes do not include information specific to said medical condition; for at least one of

said diagnostic factors, store demographics that indicate said medical condition on the basis of said at least one diagnostic factor between said medical condition node and a node representing said at least one diagnostic factor" in claims 12, 13, 16 – 23, 32, 33, is a machine that, under its broadest reasonable interpretation, covers performance of the limitation in the mind, but for the recitation of generic computer components. That is, other than reciting "a computer system comprising one or more processors and memory", nothing in the claim element precludes the steps from practically being performed in a human mind or using a pen and a piece of paper.

The mere nominal recitation of a generic processor and computing device do not take the claim limitations out of the mental processes grouping.

If a claim limitation, under its broadest reasonable interpretation, covers mental processes but for the recitation of generic computer components, then it falls within the "Mental Processes" grouping of abstract ideas (concepts performed in the human mind including an observation, evaluation, judgement, and opinion). Accordingly, the claims recite an abstract idea.

This judicial exception is not integrated into a practical application. In particular, the claims recite the additional elements "extract from a medical evidence source a plurality of diagnostic factors; establish one or more application programming interfaces (APIs) for said graph database, said one or more APIs allowing a software application to integrate with said graph database to access said nodes to generate a healthcare determination; and match patient data from a patient medical chart to at least one of said diagnostic factor nodes; or said demographics, by traversing a portion of said

nodes of said graph database in order to display said healthcare determination that said patient has said medical condition".

The limitation "extract from a medical evidence source a plurality of diagnostic factors; establish one or more application programming interfaces (APIs) for said graph database, said one or more APIs allowing a software application to integrate with said graph database to access said nodes to generate a healthcare determination; and match patient data from a patient medical chart to at least one of said diagnostic factor nodes; or said demographics, by traversing a portion of said nodes of said graph database in order to display said healthcare determination that said patient has said medical condition", represents an extra-solution activity because it is a mere nominal or tangential addition to the claim, a mere generic transmission and presentation of collected and analyzed data. (See MPEP 2106.05 (g)).

Accordingly, these additional elements do not integrate the abstract idea into a practical application because they do not impose any meaningful limits on practicing the abstract idea, thus fail to integrate the abstract idea into a practical application. See MPEP 2106.05(g).

The insignificant extra-solution activities identified above, which include the data gathering extracting, and establishing steps, are recognized by the courts as well understood, routine, and conventional activities when they are claimed in a merely generic manner (e.g., at a high level of generality) or as insignificant extra-solution activity (See MPEP 2106.05(d)(II) (i) Receiving or transmitting data over a network, e.g., using the Internet to gather data, buySAPE, Inc. v. Google, Inc., 765 F.3d 1350, 1355, 112 USPO2d 1093, 1096 (Fed. Cir. 2014) (computer receives and sends information

over a network); (v) Presenting (displaying) offers and gathering statistics, OIP Techs., 788 F.3d at 1362-63, 115 USPO2d at 1092- 93). The claims are not patent eligible.

Claims 12, 13, 16 – 23, 32, 33 do not include additional elements that are sufficient to amount to significantly more than the judicial exception. As discussed above with respect to integration of the abstract idea into a practical application, the additional element of establish one or more application programming interfaces (APIs) for said graph database, said one or more APIs allowing a software application to integrate with said graph database to access said nodes to generate a healthcare determination, and matching steps amounts to no more than mere instructions to apply the exception using a generic computer component. Mere instructions to apply an exception using a generic computer component cannot provide an inventive concept.

Claims 12, 13, 16 – 23, 32, 33 as a whole, do not amount to significantly more than the abstract idea itself. This is because the claims do not affect an improvement to the functioning of a computer itself; and the claims do not move beyond a general link of the use of an abstract idea to a particular technological environment.

8. Claims 24 — 30, 34 are directed to a system. They hereby fall under one of the four statutory classes of invention.

If the claim does not fall within one of the statutory categories, it must then be determined whether the claim is directed to a judicial exception (i.e., law of nature, natural phenomenon, and abstract idea).

Claims 24 — 30, 34 recite steps that can be practically performed by a human, either mentally or with the use of pen and paper.

The limitations of "identify all known factor nodes in a knowledge graph that each represent a diagnostic factor known to be present or absent in said patient, each known factor node being linked to a medical condition node in said knowledge graph representing said at least one medical condition;

identify all unknown factor nodes in said knowledge graph that each represent an unknown diagnostic factor not known to be present or absent in said patient, each unknown factor node being linked to said medical condition node, wherein said medical condition node and at least one of said Known or unknown factor nodes uses a same name to describe both said medical condition node and said at least one of said known or unknown factor nodes, and wherein said medical condition node and said at least one of said known or unknown factor nodes are represented in different nodes in said knowledge graph in order to disambiguate said medical condition node from said at least one of said known or unknown factor nodes; identify a rank of each unknown factor node that indicates a likelihood that said represented unknown diagnostic factor indicates said at least one medical condition, said rank being stored between said unknown factor node and said medical condition node" in claims 24 - 30, 34, is a machine that, under its broadest reasonable interpretation, covers performance of the limitation in the mind, but for the recitation of generic computer components. That is, other than reciting "a computer system comprising one or more processors and memory", nothing in the claim element precludes the steps from practically being performed in a human mind or using a pen and a piece of paper.

The mere nominal recitation of a generic processor and computing device do not take the claim limitations out of the mental processes grouping.

If a claim limitation, under its broadest reasonable interpretation, covers mental processes but for the recitation of generic computer components, then it falls within the "Mental Processes" grouping of abstract ideas (concepts performed in the human mind including an observation, evaluation, judgement, and opinion). Accordingly, the claims recite an abstract idea.

This judicial exception is not integrated into a practical application. In particular, the claims recite the additional elements "establish one or more application programming interfaces (APIs) for said knowledge graph, said one or more APIs allowing a software application to integrate with said knowledge graph to access said medical condition node and said known and unknown factor nodes to generate a healthcare determination; output said unknown diagnostic factors corresponding to said unknown factor nodes in association with said at least one medical condition in order of said rank of said each unknown factor node in order to output said healthcare determination.".

The limitation "establish one or more application programming interfaces (APIs) for said knowledge graph, said one or more APIs allowing a software application to integrate with said knowledge graph to access said medical condition node and said known and unknown factor nodes to generate a healthcare determination; output said unknown diagnostic factors corresponding to said unknown factor nodes in association with said at least one medical condition in order of said rank of said each unknown factor node in order to output said healthcare determination.", represents an extra-

solution activity because it is a mere nominal or tangential addition to the claim, a mere generic transmission and presentation of collected and analyzed data. (See MPEP 2106.05 (g)).

Accordingly, these additional elements do not integrate the abstract idea into a practical application because they do not impose any meaningful limits on practicing the abstract idea, thus fail to integrate the abstract idea into a practical application. See MPEP 2106.05(g).

The insignificant extra-solution activities identified above, which include the data gathering establishing, and outputting steps, are recognized by the courts as well understood, routine, and conventional activities when they are claimed in a merely generic manner (e.g., at a high level of generality) or as insignificant extra-solution activity (See MPEP 2106.05(d)(II) (i) Receiving or transmitting data over a network, e.g., using the Internet to gather data, buySAPE, Inc. v. Google, Inc., 765 F.3d 1350, 1355, 112 USPO2d 1093, 1096 (Fed. Cir. 2014) (computer receives and sends information over a network); (v) Presenting (displaying) offers and gathering statistics, OIP Techs., 788 F.3d at 1362-63, 115 USPO2d at 1092- 93). The claims are not patent eligible.

Claims 24 – 30, 34 do not include additional elements that are sufficient to amount to significantly more than the judicial exception. As discussed above with respect to integration of the abstract idea into a practical application, the additional element of output said unknown diagnostic factors corresponding to said unknown factor nodes in association with said at least one medical condition in order of said rank of said each unknown factor node step amounts to no more than mere instructions to

apply the exception using a generic computer component. Mere instructions to apply an exception using a generic computer component cannot provide an inventive concept.

Claims 24 – 30, 34 as a whole, do not amount to significantly more than the abstract idea itself. This is because the claims do not affect an improvement to the functioning of a computer itself; and the claims do not move beyond a general link of the use of an abstract idea to a particular technological environment.

Conclusion

9. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any nonprovisional extension fee (37 CFR 1.17(a)) pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

10.Any inquiry concerning this communication or earlier communications from the examiner should be directed to LEONARD SAINT-CYR whose telephone number is (571)272-4247. The examiner can normally be reached Monday- Friday.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Richemond Dorvil can be reached at (571)272-7602. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/LEONARD SAINT-CYR/
Primary Examiner, Art Unit 2658

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	19/092,400	BATE et al.
	Examiner	Art Unit
	LEONARD SAINT-CYR	2658

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	05/22/2025	09/11/2025							
	1	✓	✓							
	2	✓	-							
	3	✓	✓							
	4	✓	✓							
	5	✓	-							
	6	✓	-							
	7	✓	✓							
	8	✓	✓							
	9	✓	✓							
	10	✓	✓							
	11	✓	✓							
	12	✓	✓							
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	16	✓	✓							
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	27	✓	✓							
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	32		✓							
	33		✓							
	34		✓							
	35		✓							

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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	19/092,400	BATE et al.
	Examiner	Art Unit
	LEONARD SAINT-CYR	2658

CPC - Searched*		
Symbol	**Date**	**Examiner**
G16H70/$$$$; G16H10/$$$$; G06F40/$$$$	05/22/2025	LS
Updated Search	09/11/2025	LS

CPC Combination Sets - Searched*		
Symbol	**Date**	**Examiner**

US Classification - Searched*			
Class	**Subclass**	**Date**	**Examiner**
704	7 - 10, 257	05/22/2025	LS
Updated Search		09/11/2025	LS

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	**Date**	**Examiner**
See PE2E Search (attached)	05/22/2025	LS
See Google Scholar search (attached)	05/22/2025	LS
Updated Search	09/11/2025	LS

Interference Search			
US Class/CPC Symbol	**US Subclass/CPC Group**	**Date**	**Examiner**

/LEONARD SAINT-CYR/ Primary Examiner, Art Unit 2658	

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Form 1449 (Modified) Information Disclosure Statement By Applicant (Use Several Sheets if Necessary)	Atty Docket No.	RCVRP002C1C5
	Application No.:	19/092,400
	Applicant	Evidium, Inc.
	Filing Date	March 27, 2025
	Group	2658
		Page 1 of 2
	Date Submitted	August 27, 2025

U.S. Patent Documents

Examiner Initial	No.	Patent No.	Date	Patentee	Class	Sub-class	Filing Date
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/L.S/	2.	2020/0211692	07/02/20	Kalafut et al.			12/31/18
/L.S/	3.	2014/201627	07/17/14	Coll			01/09/14
/L.S/	4.	2009/0192800	07/30/09	Brandt			01/23/09
/L.S/	5.	2021/0192365	06/24/21	Zhang			09/25/20
/L.S/	6.	2025/0191783	06/12/25	Bate et al.			02/11/25
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/L.S/	10.	2011/0119212	05/19/11	De Bruin et al.			01/31/11
/L.S/	11.	2023/0115939	04/13/23	Gnanasambandam et al.			10/14/22
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/L.S/	16.	10,446,273	10/15/19	McNair et al.			01/06/14
/L.S/	17.	10,733,566	08/04/20	Chan et al.			11/11/16
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/L.S/	23.	12,300,392	05/13/25	Bate et al.			01/08/24
/L.S/	24.	2024/0153648	05/09/24	Bate et al.			01/08/24

Examiner /LEONARD SAINT-CYR/	Date Considered 09/10/2025

Examiner: Initial citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Form 1449 (Modified) **Information Disclosure Statement By Applicant** (Use Several Sheets if Necessary)	**Atty Docket No.**	RCVRP002C1C5
	Application No.:	19/092,400
	Applicant	Evidium, Inc.
	Filing Date	March 27, 2025
	Group	2658
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/L.S/	25.	2025/0059224	02/24/22	Tulley et al.			08/19/21
/L.S/	26.	2025/0182911	06/05/25	Bate et al.			02/04/25
/L.S/	27.	2025/0253062	08/07/25	Bate et al.			04/24/25
/L.S/	28.	2003/0065535	04/03/03	Karlov et al.			05/01/02
/L.S/	29.	2025/0253061	08/07/25	Bate et al.			03/27/25

Foreign Patent or Published Foreign Patent Application

Examiner Initial	No.	Document No.	Publication Date	Country or Patent Office	Class	Sub-Class	Translation Yes	Translation No
	30.							
	31.							
	32.							
	33.							

Other Documents

Examiner Initial	No.	Author, Title, Place (e.g. Journal) of Publication, Date
	34.	
	35.	
	36.	
	37.	

Examiner	/LEONARD SAINT-CYR/	Date Considered	09/10/2025

Examiner: Initial citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Improving chronic disease management for children **with** knowledge graphs and artificial intelligence

G Yu, M Tabatabaei, J Mezei, Q Zhong, S Chen… - Expert Systems with …, 2022 - Elsevier

… clients, data storage and analytic tools for decision **support** relying on AI-based services. We … To assess the feasibility of the AI component, we utilize real life **health** care data from a …

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Modeling paradigms for **medical diagnostic** decision **support**: a survey and future directions

KB Wagholikar, V Sundararajan… - Journal of medical …, 2012 - Springer

… be **facilitated** by public release of de-identified **medical** datasets… modeling techniques for **diagnostic** decision **support**, with a … a range of **medical** decisions including **diagnosis**, prognosis …

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Embedding dynamic **graph** attention mechanism into Clinical Knowledge **Graph** for enhanced **diagnostic** accuracy

D Chen, W Zhang, Z Ding - Expert Systems with Applications, 2025 - Elsevier

… Errors in **diagnosis** can … **health** records, clinical notes, and genomic data—into a dynamic and interconnected framework, thereby **facilitating** a holistic understanding of patient **health**. …

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Knowledge **graph**-based clinical decision **support** system reasoning: a survey

X Xiang, Z Wang, Y Jia, B Fang - … on Data Science in …, 2019 - ieeexplore.ieee.org

… knowledge and improve **diagnostic** accuracy without the … is to deploy knowledge **graph** to **facilitate** a faster and precise … Unfortunately, querying the **graph database** is relatively slow …

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Enhancing **medical** decision making: A semantic technology-based framework for efficient **diagnosis** inference

D Belmiri, S Albagli-Kim - Mathematics, 2024 - mdpi.com

… , virtualizing, and **facilitating** new healthcare processes such … in new **diagnostic** and **support** systems for **medical** decision making, … The KG was constructed **using** Neo4j **Graph Database**, …

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Systems bioinformatics: increasing precision of computational **diagnostics** and therapeutics through network-based approaches

A Oulas, G Minadakis, M Zachariou… - Briefings in …, 2019 - academic.oup.com

… results, thus, **facilitating** systems **medicine** (**medicine** that is in … Furthermore, it is **supported** that each system has a 'buffering … one **node** to other **nodes**), which indicates important **nodes** …

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Leveraging **medical** knowledge graphs into large language models for **diagnosis** prediction: Design and application study

Y Gao, R Li, E Croxford, J Caskey, BW Patterson… - Jmir Ai, 2025 - ai.jmir.org

… as a **medical** knowledge repository, **facilitating** the integration… influences the **diagnostic** output of LLMs **using** human … **node** in this **graph** represents a CUI; therefore, we **use** "**node**…

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Building a knowledge **graph** to enable precision **medicine**

P Chandak, K Huang, M Zitnik - Scientific Data, 2023 - nature.com

… Developing personalized **diagnostic** strategies and targeted … graphs **facilitated** research across various **problems** faced by … features for diseases **nodes** in the knowledge **graph** from the …

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Artificial neural networks **in medical diagnosis**

F Amato, A López, EM Peña-Méndez, P Vaňhara… - Journal of applied …, 2013 - Elsevier

… during the **diagnostic** process. To streamline the **diagnostic** process in daily routine and avoid misdiagnosis, artificial intelligence methods (especially computer aided **diagnosis** and …

☆ Save 99 Cite Cited by 1300 Related articles All 16 versions

Combining a neural network **with** case-based reasoning **in** a **diagnostic** system

EB Reategui, JA Campbell, BF Leao - Artificial Intelligence in Medicine, 1997 - Elsevier

… library, which **facilitates** its maintenance and allows for the **use** of … other information that **supports** the **diagnostic** hypothesis. … in the strongest **node** for one **diagnosis** (ie the **node** with the …

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BMJ Publishing Group v. Evidium

Representing social network patient data as evidence-based knowledge to **support** decision making **in** disease progression for comorbidities

M Krishnamurthy, P Marcinek, KM Malik, M Afzal - IEEE Access, 2018 - ieeexplore.ieee.org

… disease **conditions** and their progression, hence **facilitating** … we consider that two **nodes/conditions** can have only one path … considered only the **diagnostic** aspect of **conditions**; the same …

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An interpretable approach **using** hybrid **graph** networks and explainable AI for intelligent **diagnosis** recommendations **in** chronic disease care

M Huang, XS Zhang, UA Bhatti, YY Wu, Y Zhang… - … Signal Processing and …, 2024 - Elsevier

With the rapid advancement of modern **medical** technology and the increasing demand for a higher quality of life there is an emergent requirement for personalized healthcare services. …

☆ Save 99 Cite Cited by 37 Related articles All 2 versions

Medical diagnostic decision **support** systems—past, present, and future: a threaded bibliography and brief commentary

RA Miller - Journal of the American Medical Informatics …, 1994 - academic.oup.com

… In order to **facilitate** data exchange among local and remote … ory to **diagnosis** of **medical conditions** such as rheumatologic … directed, acyclic **graph** containing **nodes** whose link strengths …

☆ Save 99 Cite Cited by 716 Related articles All 9 versions

Graph-based tag recommendations **using** clusters of patients **in** clinical decision **support** system

M Hafidi, EH Abdelwahed… - … and Computation: Practice …, 2021 - Wiley Online Library

… Tagging will **facilitate diagnosis** of diseases by reducing … connected **nodes** and weakly related to other **nodes** of the **graph**. … We aim to make a great **use** of the extracted **diagnostic** labels (…

☆ Save 99 Cite Cited by 8 Related articles »

Establishment of a mindmap for **medical** e-**Diagnosis** as a service for **graph**-based learning and analytics

S Mohammed, J Fiaidhi - Neural Computing and Applications, 2023 - Springer

… Central to all these challenges is to **facilitate diagnosis** and … to emphasize that such **medical diagnostic** services cannot … data are stored in **graph databases** according to recent survey by …

☆ Save 99 Cite Cited by 9 Related articles All 4 versions

NESTOR: A Computer-Based **Medical Diagnostic** Aid That Integrates Causal and Probabilistic Knowledge.

GF Cooper - 1984 - apps.dtic.mil

… are used to aid in **diagnosing** the cause of a patient's **condition**. … the underlying **diagnostic** techniques that **support** those features… mechanism between **nodes** in the **graph** are necessarily …

☆ Save 99 Cite Cited by 305 Related articles All 2 versions »

A decision **support** system to follow up and **diagnose** primary headache patients **using** semantically enriched data

G Vandewiele, F De Backere, K Lannoye… - BMC medical informatics …, 2018 - Springer

… Third, we present an automated **diagnosis support** module to … to two **nodes** and a connecting edge in the knowledge **graph**. The … We could **facilitate** trigger management by extending our …

☆ Save 99 Cite Cited by 36 Related articles All 17 versions

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

An ontology-driven clinical decision **support** system (IDDAP) for infectious disease **diagnosis** and antibiotic prescription

Y Shen, K Yuan, D Chen, J Colloc, M Yang, Y Li… - … intelligence in medicine, 2018 - Elsevier

… of the sensitivity and specificity of a decision **support** system named IDDAP, which is based on ontologies for infectious disease **diagnosis** and antibiotic therapy. The ontology for this …

☆ Save 99 Cite Cited by 115 Related articles All 5 versions

Online disease **diagnosis with** inductive heterogeneous **graph** convolutional networks

Z Wang, R Wen, X Chen, S Cao, SL Huang… - Proceedings of the web …, 2021 - dl.acm.org

… **diagnosis** as a **node** classification task, we formulate the disease **diagnosis** process as link prediction between user **nodes** … from the raw dialog, which **supports** more accurate **diagnosis**. …

☆ Save 99 Cite Cited by 47 Related articles All 3 versions »

Detailed **diagnosis in** enterprise networks

S Kandula, R Mahajan, P Verkaik, S Agarwal… - Proceedings of the …, 2009 - dl.acm.org

… at is, the **diagnostic** system should be able to **diagnose** not … enough in practice to **facilitate** effective **diagnosis**. Further, we do … , most of the **nodes** in the **graph** correspond to processes. …

☆ Save 99 Cite Cited by 275 Related articles All 20 versions »

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BMJ Publishing Group v. Evidium

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L167	50	(Artificial Intelligence) Similar to: 19/092,400 with 0 CPC Selections and 0 Text Selections Text: (US-12300392-B2 OR US-20060282286-A1 OR CN-110362690-A OR US-20120173285-A1 OR US-20190189253-A1 OR US-20180089568-A1 OR US-11182550-B2 OR WO-2016172801-A1 OR US-20170068789-A1 OR AU-2022212704-A1 OR WO-2022164724-A1 OR US-20220238237-A1 OR CN-110391021-A OR US-11710574-B2 OR US-11200968-B2 OR CA-3209118-A1 OR CN-119207770-A OR US-20220189590-A1 OR KR-20130140848-A OR US-10818394-B2 OR US-20220068482-A1 OR WO-2015127096-A1 OR US-20160224760-A1 OR US-20180089381-A1 OR US-20210057098-A1 OR WO-2016103036-A1 OR US-20130173293-A1 OR WO-2005114536-A2 OR US-20190392924-A1 OR WO-2020180679-A1 OR US-20200098477-A1 OR EP-3238111-B1 OR US-20200265955-A1 OR US-11721438-B2 OR CA-2567291-A1 OR US-20100094648-A1 OR US-20190198178-A1 OR WO-2018092145-A1 OR US-8554580-B2 OR	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2025/09/11 07:39 PM

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L168	96	(US-12300392-B2 OR US-20060282286-A1 OR CN-110362690-A OR US-20120173285-A1 OR US-20190189253-A1 OR US-20180089568-A1 OR US-11182550-B2 OR WO-2016172801-A1 OR US-20170068789-A1 OR AU-2022212704-A1 OR WO-2022164724-A1 OR US-20220238237-A1 OR CN-110391021-A OR US-11710574-B2 OR US-11200968-B2 OR CA-3209118-A1 OR CN-119207770-A OR US-20220189590-A1 OR KR-20130140848-A OR US-10818394-B2 OR US-20220068482-A1 OR WO-2015127096-A1 OR US-20160224760-A1 OR US-20180089381-A1 OR US-20210057098-A1 OR WO-2016103036-A1 OR US-20130173293-A1 OR WO-2005114536-A2 OR US-20190392924-A1 OR WO-2020180679-A1 OR US-20200098477-A1 OR EP-3238111-B1 OR US-20200265955-A1 OR US-11721438-B2 OR CA-2567291-A1 OR US-20100094648-A1 OR US-20190198178-	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2025/09/11 07:39 PM

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L169	190	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) SAME (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) SAME (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome) AND (rank$3 order$3 sort$3) SAME (medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome))	(US-PGPUB; USPAT)	OR	ON	ON	2025/09/11 07:40 PM
L170	180	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus	(US-PGPUB; USPAT)	OR	ON	ON	2025/09/11 07:40 PM

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		syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) SAME (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome) AND (rank$3 order$3 sort$3) SAME (medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome))					
L171	387	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) WITH (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome) AND (rank$3 order$3 sort$3)	(US-PGPUB; USPAT)	OR	ON	ON	2025/09/11 07:40 PM
L172	671	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness	(US-PGPUB; USPAT)	OR	ON	ON	2025/09/11 07:41 PM

		infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) SAME (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome) AND (rank$3 order$3 sort$3)					
L173	471	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) SAME (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) WITH (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)	(US-PGPUB; USPAT)	OR	ON	ON	2025/09/11 07:41 PM
L174	9977	(704/8-10,257).ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2025/09/11 07:41 PM
L176	5	174 AND (medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH	(US-PGPUB; USPAT)	OR	ON	ON	2025/09/11 07:42 PM

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		(display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) SAME (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)					
L178	23	174 AND (medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) SAME (display$3 graphical)	(US-PGPUB; USPAT)	OR	ON	ON	2025/09/11 07:42 PM
L179	604	L172 AND ((G16H50/20 OR G16H50/70 OR G16H50/30 OR G16H10/60 OR G16H70/20 OR G16H40/63 OR G16H20/30 OR G16H10/20 OR G16H15/00 OR G16H70/60 OR G16H20/10 OR G16H40/67 OR G16H80/00 OR G16H40/20 OR G16H50/50 OR G16H20/00 OR G16H70/00 OR G16H30/40 OR G16H20/70 OR G16H30/20 OR G16H20/60 OR G16H10/40 OR G16H20/17 OR G16H20/40 OR G16H70/40 OR G16H30/00 OR G16H50/80 OR G16H20/13 OR G16H10/00 OR G16H20/90 OR G06F16/951 OR	(US-PGPUB; USPAT)	OR	ON	ON	2025/09/11 07:44 PM

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		G06F16/24578 OR G06F16/00 OR G06F16/2282 OR G06F16/24575 OR G06F16/285 OR G06F16/9535 OR G06F16/9538 OR G06F16/955 OR G06F40/30 OR G06F16/2246 OR G06F16/3329 OR G06F16/2455 OR G06F40/211 OR G06F16/182 OR G06F16/27 OR G06F16/24537 OR G06F16/24544 OR G06F16/24552 OR G06F16/2456 OR G06F16/2462 OR G06F16/2471 OR G06F16/278 OR G06F16/288 OR G06F16/2264 OR G06F40/279 OR G06F40/169 OR G06F40/20 OR G06F40/205 OR G06F3/0482 OR G06F18/23 OR G06F40/289 OR G06F40/40 OR G06F18/2111 OR G06F18/2411 OR G06F18/24323 OR G06F18/28 OR G06F18/29 OR G06F40/237 OR G06F9/4881 OR G06F16/31 OR G06F16/9024 OR G06F16/93 OR G06F40/295 OR G06F16/2428 OR G06F16/334 OR G06F16/345 OR G06F21/31 OR G06F3/048 OR G06F8/34 OR G06F9/453 OR G06F9/5044 OR G06F9/5055 OR G06F16/24522 OR G06F16/532 OR G06F16/90335 OR G06F21/6245 OR G06F40/134 OR G06F3/04842 OR					

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		G06F21/6218 OR G06F21/6254 OR G06F3/0484 OR G06F3/04883 OR G06F3/167 OR G06F40/157 OR G06F40/174 OR G06F40/274 OR G06F9/451 OR G06F40/00).cpc.)					
L180	427	L173 AND ((G16H50/70 OR G16H50/30 OR G16H50/20 OR G16H70/20 OR G16H10/60 OR G16H40/63 OR G16H20/30 OR G16H10/20 OR G16H15/00 OR G16H20/10 OR G16H40/67 OR G16H70/60 OR G16H50/50 OR G16H80/00 OR G16H40/20 OR G16H20/70 OR G16H30/40 OR G16H70/00 OR G16H30/20 OR G16H20/60 OR G16H10/40 OR G16H20/17 OR G16H20/00 OR G16H20/40 OR G16H30/00 OR G16H70/40 OR G16H50/80 OR G16H20/13 OR G06F16/24578 OR G06F16/9535 OR G06F16/00 OR G06F16/2282 OR G06F16/24575 OR G06F16/285 OR G06F16/951 OR G06F16/9538 OR G06F16/955 OR G06F40/30 OR G06F16/3329 OR G06F16/288 OR G06F3/0482 OR G06F16/2264 OR G06F40/279 OR G06F16/9024 OR G06F40/237 OR G06F40/40 OR	(US-PGPUB; USPAT)	OR	ON	ON	2025/09/11 07:45 PM

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		G06F3/04842 OR G06F16/345 OR G06F21/31 OR G06F3/0488 OR G06F40/20 OR G06F8/34 OR G06F9/453 OR G06F18/217 OR G06F21/6245 OR G06F18/214 OR G06F2200/1637 OR G06F16/36 OR G06F16/367 OR G06F18/211 OR G06F18/2148 OR G06F18/285 OR G06F3/011 OR G06F3/017 OR G06F3/0346 OR G06F40/169 OR G06F40/295 OR G06F1/163 OR G06F1/1632 OR G06F1/1694 OR G06F16/2468 OR G06F40/35 OR G06F16/2365 OR G06F16/55 OR G06F16/258 OR G06F16/322 OR G06F16/9577 OR G06F18/23 OR G06F18/24 OR G06F21/604 OR G06F21/62 OR G06F21/64 OR G06F21/76 OR G06F2221/2113 OR G06F3/04817 OR G06F3/0489 OR G06F40/186 OR G06F40/211 OR G06F40/247 OR G06F40/56 OR G06F9/543 OR G06F9/547 OR G06F11/3409 OR G06F16/11 OR G06F16/164 OR G06F16/182 OR G06F16/214 OR G06F16/22 OR G06F16/2379 OR G06F16/24522 OR G06F16/27 OR G06F16/28 OR G06F16/3328 OR G06F16/338 OR					

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PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

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PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/092,400	**08/27/2025 06:55:35 PM Z ET**	**RCVRP002C1C5**

Title of Invention

TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	6474	FILED BY	ANDREASARAH DACANAY
PATENT CENTER #	72043716	FILING DATE	03/27/2025
CUSTOMER #	58766	FIRST NAMED INVENTOR	Carl BATE
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jonathan Scott

Documents

TOTAL DOCUMENTS: 7

DOCUMENT		PAGES	DESCRIPTION	SIZE (KB)
RCVRP002C1C5 Amendment Transmittal.pdf		1	Transmittal Letter	21 KB
RCVRP002C1C5 Reply A.pdf		20	-	103 KB
RCVRP002C1C5 Reply A-A....pdf	(1-1)	1	Amendment/Request for Reconsideration-After Non-Final Rejection	19 KB
RCVRP002C1C5 Reply A-CLM.pdf	(2-10)	9	Claims	51 KB
RCVRP002C1C5 Reply A-REM.pdf	(11-20)	10	Applicant Arguments/Remarks Made in an Amendment	60 KB
RCVRP002C1C5_IDS_Size_		2	Assertion regarding	228 KB

Fee_Assertation.pdf		Information Disclosure Statement (IDS) Size Fee (SB/08C)	
RCVRP002C1C5_IDS.pdf	2	Transmittal Letter	23 KB
RCVRP002C1C5_1449.pdf	2	Information Disclosure Statement (IDS) Form (SB08)	30 KB

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DOCUMENT	MESSAGE DIGEST(SHA-512)
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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: BATE et al.	Attorney Docket No.: RCVRP002C1C5
Application No.: 19/092,400	Examiner: LEONARD SAINT CYR
Filed: March 27, 2025	Group: 2658
Title: TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF	Confirmation No.: 6474

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Signed: _____/Andrea Dacanay/_____
Andrea Dacanay

Reply A

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

In response to the Office action dated May 27, 2025, please enter the following amendments and consider the following remarks.

Amendments to the Claims begin on page 2 of this paper.
Remarks begin on page 11 of this paper.

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

IN THE CLAIMS

1. (Currently Amended) A computer system for **transforming narrative medical evidence into a computational form,** ~~**translating medical evidence into computational elements,**~~ said computer system comprising:

one or more processors; and

memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to:

~~**input a portion of electronic**~~ **receive** text **from a plurality of medical evidence sources, said text** pertaining to a medical condition**, wherein one or more of said medical evidence sources use a same name to describe both said medical condition and a symptom, and wherein said medical condition and said symptom are arranged in different hierarchies in one or more medical evidence sources** ~~**from a medical evidence source**~~;

process said ~~**electronic**~~ text to produce a plurality of clinical concepts indicative of said medical condition;

~~**display said clinical concepts on a computing device;**~~

~~**receive input from said computing device indicating that**~~ **generate a plurality of nodes in a graph database, said plurality of nodes including** said **plurality of** clinical concepts**, wherein said medical condition and said symptom, which are associated with said same name in said one or more medical evidence sources, are represented in different nodes in said graph database in order to disambiguate one or more of said plurality of clinical concepts** ~~**are relevant to said medical condition**~~; ~~**and**~~

store ~~**said medical condition and**~~ said **plurality of** clinical concepts each as ~~**a**~~ separate **nodes in said graph database** ~~**entry in a database**~~, said medical condition being linked to ~~**each**~~ **one or more** of said **plurality of** clinical concepts **in said graph database; and** ~~**wherein said entry of each of said clinical concepts in said database does not include information specific to said medical condition.**~~

establish one or more application programming interfaces (APIs) for said graph database, said one or more APIs allowing a software application to integrate with said graph database to access said plurality of nodes to generate a healthcare determination by traversing a portion of said plurality of nodes that disambiguate one or more of said plurality of clinical concepts.

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2. (Cancelled)

3. (Currently Amended) A computer system as recited in claim 1 wherein said **graph** database is a knowledge graph and said each separate **node** ~~**entry**~~ is a node of said knowledge graph.

4. (Currently Amended) A computer system as recited in claim 1 wherein each clinical concept is a diagnostic factor and each diagnostic factor **node** ~~**entry**~~ includes a unique identifier which links to an entry in a medical ontology representing said each diagnostic factor.

5. (Cancelled)

6. (Cancelled)

7. (Currently Amended) A computer system as recited in claim 1, wherein the instructions, when executed, further cause the one or more processors to:

receive a rank associated with said clinical concepts, said rank indicating how likely it is that said clinical concepts are indicative of said medical condition; and

store said rank in a **graph** database **node** ~~**entry**~~ between said medical condition **node** ~~**entry**~~ and said clinical concepts **nodes** ~~**entries**~~.

8. (Original) A computer system as recited in claim 1 wherein said clinical concepts are diagnostic factors caused by said medical condition, are risk factors that contribute to said medical condition, are laboratory tests that indicate said medical condition, are examinations that indicate said medical condition, or are drugs that contribute to said medical condition.

9. (Currently Amended) A computer system as recited in claim 1, wherein the instructions, when executed, further cause the one or more processors to:

receive input indicating a group that subsumes said clinical concepts; and

store said group as a separate **node** ~~**entry**~~ in said **graph** database, said group including at least one condition-dependent attribute that depends upon said medical condition, said medical condition **node** ~~**entry**~~ being linked to said group **node** ~~**entry**~~ and said group **node** ~~**entry**~~ being linked to each of said clinical factors **nodes** ~~**entries**~~.

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10. (Currently Amended) A computer system as recited in claim 1 wherein said one of said clinical concepts is a diagnostic factor, and wherein ~~said~~ **a** diagnostic factor **node** ~~entry~~ includes a temporality attribute indicating whether or not a patient is currently exhibiting said diagnostic factor, a negation attribute indicating whether not said diagnostic factor is present in said patient, or an experience attribute indicating whether not said patient experiences said diagnostic factor personally.

11. (Currently Amended) A computer system as recited in claim 1, wherein the instructions, when executed, further cause the one or more processors to:

extract from said ~~electronic~~ text a rank indicating how likely it is that one of said clinical concepts is indicative of said medical condition; and

add said rank to a location in said **graph** database between said medical condition **node** ~~entry~~ and said clinical concepts **nodes** ~~entries~~.

12. (Currently Amended) A computer system for determining a state of a patient, said computer system comprising:

one or more processors; and

memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to:

extract from a medical evidence source a plurality of diagnostic factors each indicative of a medical condition and store each of said diagnostic factors and said medical condition as its own node in a **graph** database, said medical condition being linked to said diagnostic factors, wherein **said medical evidence source uses a same name to describe both said medical condition and one of said diagnostic factors, wherein said medical condition and said one of said diagnostic factors are arranged in different hierarchies in one or more medical evidence sources, and wherein said medical condition and said one of said diagnostic factors are represented in different nodes in said graph database in order to disambiguate said medical condition from said one of said diagnostic factors** ~~each of said diagnostic factor nodes do not include information specific to said medical condition~~;

for at least one of said diagnostic factors, store demographics that indicate said medical condition on the basis of said at least one diagnostic factor between said medical condition node and a node representing said at least one diagnostic factor;

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~~extract from a medical evidence source a plurality of laboratory tests each indicative of said medical condition and store each of said laboratory tests in said database;~~

~~for at least one of said laboratory tests, store a test result in said database;~~ ~~and~~

establish one or more application programming interfaces (APIs) for said graph database, said one or more APIs allowing a software application to integrate with said graph database to access said nodes to generate a healthcare determination; and

match patient data from a patient medical chart to at least one of said diagnostic factor nodes~~,~~ **or** said demographics~~, or said test result~~ **by traversing a portion of said nodes of said graph database** in order to display **said healthcare determination** ~~a result indicating a likelihood~~ that said patient has said medical condition.

13. (Original) A computer system as recited in claim 12, wherein the instructions, when executed, further cause the one or more processors to:

determine a rank of said likelihood that said patient has said medical condition by reference to a node intermediate between said medical condition node and said diagnostic factor nodes that holds said rank of said diagnostic factors.

14. (Cancelled)

15. (Cancelled)

16. (Currently Amended) A computer system for determining a state of a patient, said computer system comprising:

one or more processors; and

memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to:

receive a plurality of diagnostic factors known to be present or absent in a patient;

match said diagnostic factors to factor nodes in a knowledge graph that includes a plurality of medical condition nodes, each of said factor nodes being linked to at least one of said medical condition nodes**, wherein at least one of said medical condition nodes and at least one of said factor nodes uses a same name to describe both said at least one of said medical**

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condition nodes and said at least one of said factor nodes, and wherein said at least one of said medical condition nodes and said at least one of said factor nodes are represented in different nodes in said knowledge graph in order to disambiguate said at least one of said medical condition nodes from said at least one of said factor nodes;

establish one or more application programming interfaces (APIs) for said knowledge graph, said one or more APIs allowing a software application to integrate with said knowledge graph to access said medical condition nodes and said factor nodes to generate a healthcare determination;

for each of a plurality of said medical condition nodes, collect a rank value from along a path between said each medical condition node and each matched factor node to which said each medical condition node is linked, said rank value indicating how likely it is that the diagnostic factor matched to said each matched factor node is indicative of a medical condition represented by said each medical condition node;

sum all collected rank values for said each medical condition node to produce a final ranking value for said each medical condition node; and

output the medical condition representing said each medical condition node and said final ranking value of said each medical condition node **in order to output said healthcare determination**.

17. (Original) A computer system as recited in claim 16, wherein the instructions, when executed, further cause the one or more processors to:

display in association with each of said output medical conditions its corresponding final ranking value.

18. (Currently Amended) A computer system as recited in claim 16 wherein **each of** said medical condition**s** is a disease, an orthopedic anomaly, an adverse drug reaction, or a drug-to-drug interaction.

19. (Original) A computer system as recited in claim 16 wherein the instructions, when executed, further cause the one or more processors to:

display said output medical conditions in order of final ranking value.

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20. (Currently Amended) A computer system as recited in claim 16 wherein the instructions, when executed, further cause the one or more processors to:

receive said plurality of diagnostic factors at said knowledge graph via an **one of said** application~~s~~ programming interface**s** (API**s**); and

output said medical conditions and said final ranking values via **one of** said API**s** to ~~a~~ **said** software application.

21. (Original) A computer system as recited in claim 16 wherein the instructions, when executed, further cause the one or more processors to:

for at least one of said diagnostic factors known to be present, traversing upward in a medical ontology link found in one of said matched factor nodes corresponding to said at least one of said diagnostic factors known to be present in order to infer at least one other diagnostic factor present in said patient and matching this other diagnostic factor to a factor node in said knowledge graph.

22. (Original) A computer system as recited in claim 16 wherein a demographics node of said knowledge graph located between one of said matched factor nodes and its corresponding linked medical condition node includes demographics of people who exhibit said matched diagnostic factor in the context of said linked medical condition, and wherein the instructions, when executed, further cause the one or more processors to:

only collect a rank value from along a path between said matched factor node and said at least one linked medical condition node when information of said patient matches said demographics in said demographics node.

23. (Original) A computer system as recited in claim 16 wherein each of said factor nodes does not include information specific to a medical condition represented by said at least one medical condition node.

24. (Currently Amended) A computer system for determining next-best actions for a medical condition, said system comprising:

one or more processors; and

memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to perform the following for at least one medical condition of a patient:

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identify all known factor nodes in a knowledge graph that each represent a diagnostic factor known to be present or absent in said patient, each known factor node being linked to a medical condition node in said knowledge graph representing said at least one medical condition;

identify all unknown factor nodes in said knowledge graph that each represent an unknown diagnostic factor not known to be present or absent in said patient, each unknown factor node being linked to said medical condition node**, wherein said medical condition node and at least one of said known or unknown factor nodes uses a same name to describe both said medical condition node and said at least one of said known or unknown factor nodes, and wherein said medical condition node and said at least one of said known or unknown factor nodes are represented in different nodes in said knowledge graph in order to disambiguate said medical condition node from said at least one of said known or unknown factor nodes**;

establish one or more application programming interfaces (APIs) for said knowledge graph, said one or more APIs allowing a software application to integrate with said knowledge graph to access said medical condition node and said known and unknown factor nodes to generate a healthcare determination;

identify a rank of each unknown factor node that indicates a likelihood that said represented unknown diagnostic factor indicates said at least one medical condition, said rank being stored between said unknown factor node and said medical condition node; and

output said unknown diagnostic factors corresponding to said unknown factor nodes in association with said at least one medical condition in order of said rank of said each unknown factor node **in order to output said healthcare determination**.

25. (Original) A computer system as recited in claim 24, wherein the instructions, when executed, further cause the one or more processors to:

identify said unknown factor nodes by traversing down through said knowledge graph from said at least one medical condition node and disregarding said known factor nodes.

26. (Original) A computer system as recited in claim 24 wherein said rank of said each unknown factor node is located between said at least one medical condition node and said each unknown factor node.

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27. (Original) A computer system as recited in claim 24, wherein the instructions, when executed, further cause the one or more processors to:

for each known factor node, traverse upward in a medical ontology link found in said each known factor node in order to infer other diagnostic factors present in said patient.

28. (Original) A computer system as recited in claim 24 wherein traversing said knowledge graph from one of said unknown factor nodes to said at least one medical condition produces a first rank for said one of said unknown factor nodes in the context of said at least one medical condition which is different from a second rank produced by traversing from said one of said unknown factor nodes to a second medical condition.

29. (Original) A computer system as recited in claim 24 wherein the instructions, when executed, further cause the one or more processors to:

input said diagnostic factors known to be present or absent in said patient to said knowledge graph via an applications programming interface (API); and

provide said unknown diagnostic factors in association with said at least one medical condition via said API to a software application.

30. (Original) A computer system as recited in claim 24 wherein said each known factor node does not include information specific to said at least one medical condition.

31. (New) A computer system as recited in claim 1 wherein said graph database includes more than one hundred thousand nodes.

32. (New) A computer system as recited in claim 12 wherein said graph database includes more than one hundred thousand nodes.

33. (New) A computer system as recited in claim 16 wherein said knowledge graph includes more than one hundred thousand nodes.

34. (New) A computer system as recited in claim 24 wherein said knowledge graph includes more than one hundred thousand nodes.

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35. (New) A computer system as recited in claim 1 wherein said graph database includes more than twenty thousand nodes.

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REMARKS

Claims 2, 5-6, and 14-15 have been canceled. New claims 31-35 have been added. Claims 1, 3-4, 7-13, 16-32 are now pending in this application. Reconsideration of the application is earnestly requested.

Support for Amendments

Support for the amendments to claim 1 may be found in paragraphs 0004-05 ("conventional medical evidence is in narrative form and is not computable"), 0135 ("one or more of said medical evidence sources use a same name to describe both said medical condition and a symptom"), Figure 1 at 40 ("establish one or more application programming interfaces for said graph database"), Figure 10 (transform evidence to computational form), and elsewhere in the specification and drawings. Amendments to claims 12, 16 and 24 are similarly supported.

Claim 1—Section 101 Rejection

The Office action alleges that claims 1-11 "can be practically performed by a human, either mentally or with the use of pen and paper." Applicant disagrees.

Claim 1 addresses a specific technical problem articulated in the background: conventional medical evidence is in narrative form and is not computable. The claim provides a technical solution by removing ambiguity when the conventional narrative medical evidence uses the same name to refer to two different things, such as the disease "a cold" and the symptom "cold." The system resolves this ambiguity by creating separate nodes for each meaning in a graph database and then linking them within that graph, thus ensuring that the concepts are disambiguated. Claim 1 specifically requires "wherein said medical condition and said symptom, which are associated with said same name in said one or more medical evidence sources, are represented in different nodes in said graph database in order to disambiguate one or more of said plurality of clinical concepts." The system then allows external applications to access and traverse these disambiguated nodes through APIs to generate accurate healthcare recommendations. This approach improves how computer systems process and structure medical evidence by enabling these computer systems to integrate and use medical evidence from multiple sources in a way that eliminates ambiguity and produces more reliable results.

Claim 1 also specifically requires "establish one or more application programming interfaces (APIs) for said graph database, said one or more APIs allowing a software application

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to integrate with said graph database to access said plurality of nodes . . . ." Applicant submits that not only is an API a software construct that a human cannot practically perform in his or her mind, but also that the API allows the software application to integrate with the graph database to access the nodes for traversal. Practically speaking, a human cannot implement a software application in his or her mind in order to integrate it with a graph database via an API.

Even though Applicant believes it is clear that the section 101 rejection should be withdrawn, Applicant further notes that recent guidance from the U.S. PTO ("Reminders on evaluating subject matter eligibility of claims under 35 U.S.C. 101," dated August 4), states that "Examiners are reminded that if it is a 'close call' as to whether a claim is eligible, they should only make a rejection when it is more likely than not (i.e., more than 50%) that the claim is ineligible under 35 U.S.C. 101. A rejection of a claim should not be made simply because an examiner is uncertain as to the claim's eligibility."

Claim 1—Section 102 Rejection, *Iliff '444*

Claim 1 specifically requires "wherein one or more of said medical evidence sources use a same name to describe both said medical condition and a symptom, and wherein said medical condition and said symptom are arranged in different hierarchies in one or more of said medical evidence sources," as well as "wherein said medical condition and said symptom, which are associated with said same name in said one or more medical evidence sources, are represented in different nodes in said graph database in order to disambiguate one or more of said plurality of clinical concepts."

Iliff '444 does not disclose these limitations. The EMR of paragraph 0019 cannot disclose the first limitation above because there is no disclosure of the same name being used for both nor is there any disclosure of the medical condition and symptom being arranged in different hierarchies in the medical evidence sources. Nor does the reference disclose a medical condition and a symptom having the same name being represented in different nodes in a graph database. The matrix representation of Figure 6 is not a graph database, does not have any nodes, and uses a tabular representation for chief complaints and for medical conditions (current disease list E).

Claim 1 also specifically requires "receive text from a plurality of medical evidence sources," "process said text to produce a plurality of clinical concepts indicative of said medical

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condition," "generate a plurality of nodes in a graph database" and then "store said plurality of clinical concepts each as separate nodes in said graph database." Thus, text is received from a first location ("medical evidence sources"), processed to produce the clinical concepts, and then these clinical concepts are stored into a different location which are the separate nodes in the graph database. The advantage is that clinical concepts that might be ambiguous in the medical evidence source (e.g., a condition and a symptom having the same name) are stored into a different location, the graph database, where they represented in different nodes in order to disambiguate their concepts. The clinical concepts from the medical evidence source are not stored back into the same medical evidence source; that would make no sense.

The Office action, though, cites paragraphs in *Iliff* that require taking a concept such as the "cause of a disease" from the EMR of the patient and then storing it back into the EMR of the patient. The Office cites paragraphs 0019-21 as receiving the text and producing the clinical concepts, such as the "cause of the disease" from the EMR of the patient. Paragraph 0115 is then cited for the limitation of "store said plurality of clinical concepts each as separate nodes in the graph database," but this paragraph states that "the EMR can be updated with or store the cause of the disease, the anatomic system, etc." Because the claim language requires receiving text from medical evidence sources and then storing the clinical concepts from this text as separate nodes in a graph database, but *Iliff* discloses taking a medical concept from the patient EMR and then later storing that same concept back into the patient EMR, it is respectfully requested that the rejection be withdrawn.

Dependent Claim 4

Claim 4 requires "wherein each clinical concept is a diagnostic factor and each diagnostic factor node includes a unique identifier which links to an entry in a medical ontology representing said each diagnostic factor." The Office cites paragraphs 0021-25 and specifically paragraph 0024. But, this paragraph only mentions attributes of the medical condition such as a cause of the condition and an anatomic system of the patient; none of these are diagnostic factors. Further, there is no disclosure in these paragraphs or in *Iliff* of a unique identifier of a diagnostic factor node that links to an entry in a medical ontology.

Claim 12—Section 101 Rejection

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Claim 12 includes similar limitations as in claim 1 and is believed eligible under Section 101 for the same reasons. Claim 12 specifically requires "wherein said medical condition and said one of said diagnostic factors are represented in different nodes in said graph database in order to disambiguate said medical condition from said one of said diagnostic factors" and "establish one or more application programming interfaces (APIs) for said graph database, said one or more APIs allowing a software application to integrate with said graph database to access said nodes to generate a healthcare determination."

Claim 12—Section 102 Rejection, *Iliff '444*

Claim 12 specifically requires "wherein said medical evidence source uses a same name to describe both said medical condition and one of said diagnostic factors, wherein said medical condition and said one of said diagnostic factors are arranged in different hierarchies in said medical evidence source," as well as "wherein said medical condition and said one of said diagnostic factors are represented in different nodes in said graph database in order to disambiguate said medical condition from said one of said diagnostic factors." *Iliff* does not disclose these limitations for the reasons discussed above with respect to claim 1.

Claim 12 further requires "extract from a medical evidence source a plurality of diagnostic factors each indicative of a medical condition." The cited paragraphs 0021-25 only discloses "identified attribute values representative of the medical condition of the patient" which are defined in paragraphs 0023 and 0024 as only being "a cause of disease" or "an anatomic system of the patient," neither of which are required "diagnostic factors each indicative of a medical condition." A diagnostic factor does not cause a disease; it is a sign or symptom of the disease.

Claim 12 also requires "store each of said diagnostic factors and said medical condition as its own node in a graph database." There is no disclosure in *Iliff* of storing diagnostic factors and medical conditions each of their own node in the graph database. The matrices of Figures-6-8 are tables and store causes of diseases B, anatomic systems A and a disease list E.

Further, claim 12 requires "extract from a medical evidence source a plurality of diagnostic factors" and then "store each of said diagnostic factors and said medical condition as

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its own node in a graph database," thus, the diagnostic factors are extracted and then stored. By contrast, *Iliff* at paragraph 0021 discloses receiving attribute values and then accessing a data structure based on these attribute values. Paragraph 0022 discloses that medical diagnoses for the patient have already been stored into the data structure. Thus, storing into the data structure must occur before receiving attribute values, which is backwards from what is required by claim 12.

Even further, claim 12 requires "for at least one of said diagnostic factors, store demographics that indicate said medical condition on the basis of said at least one diagnostic factor between said medical condition node and a node representing said at least one diagnostic factor." Although the cited paragraph 0017 discloses that criteria such as gender is received from a user, there is no disclosure of storing demographics between a medical condition node and a node representing a diagnostic factor as claimed.

Claim 12 further requires "extract from a medical evidence source a plurality of diagnostic factors each indicative of a medical condition," a medical evidence source being a published journal, for example, but the Office action cites paragraphs 0021-25 which disclose that identified attribute values are received from a user via the user interface.

Claim 16—Section 101 Rejection

Claim 16 includes similar limitations as in claim 1 and is believed eligible under Section 101 for the same reasons. Claim 16 specifically requires "wherein said at least one of said medical condition nodes and said at least one of said factor nodes are represented in different nodes in said knowledge graph in order to disambiguate said at least one of said medical condition nodes from said at least one of said factor nodes" and "establish one or more application programming interfaces (APIs) for said knowledge graph, said one or more APIs allowing a software application to integrate with said knowledge graph to access said medical condition nodes and said factor nodes to generate a healthcare determination."

Claim 16—Section 102 Rejection, *Iliff '444*

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Claim 16 specifically requires "wherein at least one of said medical condition nodes and at least one of said factor nodes uses a same name to describe both said at least one of said medical condition nodes and said at least one of said factor nodes," as well as "wherein said at least one of said medical condition nodes and said at least one of said factor nodes are represented in different nodes in said knowledge graph in order to disambiguate said at least one of said medical condition nodes from said at least one of said factor nodes." *Iliff* does not disclose these limitations for the reasons discussed above with respect to claim 1.

Claim 16 specifically requires "match said diagnostic factors to factor nodes in a knowledge graph that includes a plurality of medical condition nodes." *Iliff* cannot disclose this limitation because it does not disclose a knowledge graph that includes factor nodes and medical condition nodes.

Further, claim 16 specifically requires "for each of a plurality of said medical condition nodes, collect a rank value from along a path between said each medical condition node and each matched factor node to which said each medical condition node is linked." *Iliff* cannot disclose this limitation because there is no disclosure of a matched factor node linked to a medical condition node, nor a path between two such nodes. The cited paragraph 0092 simply discloses the matrix of Figures 6-8. Further, even though the "symptoms, signs, etc. are actually weighted," there is no disclosure of a rank value along a path between a medical condition node and a matched factor node.

Dependent Claim 23

Claim 23 requires "wherein each of said factor nodes does not include information specific to a medical condition represented by said at least one medical condition node." The cited paragraphs do not disclose this limitation. A "Chief Complaint" is disclosed in paragraph 0115, but the limitation of claim 23 is not disclosed. Further, the Chief Complaint of Figure 12 includes a cause code and a gender, all of which can be specific to a medical condition.

Claim 24—Section 101 Rejection

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Claim 24 includes similar limitations as in claim 1 and is believed eligible under Section 101 for the same reasons. Claim 24 specifically requires "wherein said medical condition node and said at least one of said known or unknown factor nodes are represented in different nodes in said knowledge graph in order to disambiguate said medical condition node from said at least one of said known or unknown factor nodes" and "establish one or more application programming interfaces (APIs) for said knowledge graph, said one or more APIs allowing a software application to integrate with said knowledge graph to access said medical condition node and said known and unknown factor nodes to generate a healthcare determination."

Claim 24—Section 102 Rejection, *Iliff '299*

Claim 24 specifically requires "wherein said medical condition node and at least one of said known or unknown factor nodes uses a same name to describe both said medical condition node and said at least one of said known or unknown factor nodes," as well as "wherein said medical condition node and said at least one of said known or unknown factor nodes are represented in different nodes in said knowledge graph in order to disambiguate said medical condition node from said at least one of said known or unknown factor nodes."

Iliff '299 does not disclose these limitations. There is no disclosure of a medical condition node and a known or unknown factor nodes using a same name. Figures 18-19 (paragraphs 0410-450) disclose inputting conditions and symptoms, but there is nothing regarding a same name being used, let alone the nodes being "represented in different nodes in said knowledge graph in order to disambiguate said medical condition node from said at least one of said known or unknown factor nodes."

Claim 24 also requires "identify all known factor nodes in a knowledge graph." The cited paragraphs 0030-32 only discloses an unspecified data structure that only includes a medical condition of the patient, not known factor nodes each representing a diagnostic factor. There is no knowledge graph nor nodes in a knowledge graph. Paragraph 0125 and 0137 make clear that the "nodes" are simply questions in an algorithm.

Claim 24 also requires "identify all unknown factor nodes in said knowledge graph that each represent an unknown diagnostic factor not known to be present or absent in said patient."

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There is no disclosure of these "unknown" factor nodes. Paragraphs 0291-301 disclose known factors, that are known to be present or to be absent in said patient. Paragraphs 0289, 0290, 0294 and 0295 ask the patient "Yes" or "No" questions; there is no provision made for an answer of "I don't know if I have nausea or vomiting associated with my headache." Further, there is no disclosure of nodes in a knowledge graph in these paragraphs.

Claim 24 further requires "identify a rank of each unknown factor node." As above, there are no unknown factor nodes disclosed. The cited paragraph 0301 discloses a score, but this is a score of the condition, not a rank of an unknown factor node.

Claim 24 even further requires "output said unknown diagnostic factors." The cited paragraph 0552 discloses outputting system questions, diagnoses, advice and treatments, but nowhere is disclosed outputting "unknown diagnostic factors that each represent an unknown diagnostic factor not known to be present or absent in said patient."

Dependent Claims 27 and 28

Claim 27 requires "for each known factor node, traverse upward in a medical ontology link found in said each known factor node in order to infer other diagnostic factors present in said patient." Paragraphs 0030-32 do not disclose anything related to an ontology, traversing, or inferring other factors.

Claim 28 has not been rejected based upon substantive prior art and it is requested that the claim be indicated as allowable.

Dependent Claims 31-35

Claims 31-34 require "wherein said graph database [or "knowledge graph"] includes more than one hundred thousand nodes." Claim 35 requires "wherein said graph database includes more than twenty thousand nodes."

The application discloses a wide range in the number of nodes, for example, paragraphs 61, 71, 72, 79, 109 and 174 disclose any "number of" condition or factor nodes may be present in the knowledge graph. Paragraph 45 discloses "extract medical evidence from any of a variety of

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sources for representation within graph database 50." The following paragraphs go on to explain how this evidence becomes nodes within the graph database 50. The Office is requested to take Official Notice that these sources may disclose from a few thousand clinical concepts up to a hundred thousand or more. Further, page 6 of the provisional application (No. 63/331,526) discloses that the computational data of the knowledge graph applies "to ~100,000 points of evidence across BMJ Best Practice." The figures of the instant application also show a range in the number of nodes (e.g., Figure 1 shows 48 nodes in the graph database 50, Figure 4A shows 23 nodes, etc.). Paragraph 155 discloses "many hundreds of thousands of nodes or more."

The Office is also requested to take Official Notice that a trained clinician (e.g., a doctor or physician) is only able to retain and reason with about 5,000–15,000 distinct medical concepts, depending on his or her area of specialty. Such information is readily available from experts or in relevant literature. The reason for this limit of about 15,000 medical concepts is that doctors do not memorize everything—they use frameworks for diagnosis and they can look up details in electronic references when needed. Further, concepts not used regularly are forgotten and humans can only mentally process so much data, otherwise there is cognitive overload. Therefore, because the human mind can only practically retain, reason with and be conversant in about 15,000 medical concepts, Applicant submits that a knowledge graph that has at least 20,000 or 100,000 medical concept nodes is not a knowledge graph that can be processed by the human mind. Therefore, even though Applicant submits that claims 1, 12, 16 and 24 are eligible under §101, Applicant further submits that claims 31-35 are also patent eligible because they do not recite a mental process that can be processed in the human mind.

In conclusion, Applicant submits that each of the rejections should be withdrawn for any of the differences noted above.

Double Patenting

The Office action has provisionally rejected all claims under the judicially-created doctrine of obviousness-type double patenting in view of U.S. application No. 19/045,329. To obviate the double patenting rejection, Applicant hereby submits a terminal disclaimer pursuant to 37 C.F.R. §1.321 and Applicant respectfully requests that the double patenting rejection be withdrawn.

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Reconsideration of this application and issuance of a Notice of Allowance at an early date are respectfully requested. If the examiner believes a telephone conference would in any way expedite prosecution, please do not hesitate to telephone the undersigned at (612) 924-6494.

Respectfully submitted,
BEYER LAW GROUP LLP

/Jonathan O. Scott/

Jonathan O. Scott
Registration No. 39,364

P.O. Box 51887
Palo Alto, CA 94303-1887

Telephone: (612) 924-6494
Facsimile: (612) 924-6499

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: BATE et al.	Attorney Docket No.: RCVRP002C1C5
Application No.: 19/092,400	Examiner: LEONARD SAINT CYR
Filed: March 27, 2025	Group: 2658
Title: TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF	Confirmation No.: 6474

Certificate of Transmission via USPTO Patent Electronic Filing System
I hereby certify that this correspondence is being transmitted via the U.S. Patent and Trademark Office (USPTO) patent electronic filing system to the USPTO on August 27, 2025.

Signed: _____/Andrea Dacanay/_____
Andrea Dacanay

REPLY A TRANSMITTAL

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Commissioner:

Transmitted herewith is an Amendment in the above-identified application.

The fee has been calculated as shown below.

	Claims After Amendment		Highest Previously Paid For	Present Extra	Small Entity Rate Fee	Large Entity Rate Fee
Total Claims	30	MINUS	30	0	x $80 = $0.00	x 200 = $0.00
Independent Claims	4	MINUS	4	0	x $240 = $0.00	x 600 = $0.00
Multiple Dependent Claim Present and Fee Not Previously Paid						
				Total	$0.00	$0.00

☒ Applicant(s) believe that no (additional) Extension of Time is required; however, if it is determined that such an extension is required, Applicant(s) hereby petition that such an extension be granted and authorize the Commissioner to charge the required fees for an Extension of Time under 37 CFR 1.136 to Deposit Account No. 50-4481.

☒ Please charge the required fees, or any additional fees required to facilitate filing the enclosed response, to Deposit Account No. 50-4481 (Order No. RCVRP002C1C5).

Respectfully submitted,
BEYER LAW GROUP LLP

/Jonathan O. Scott/

Jonathan O. Scott
Reg. No. 39,364

P. O. Box 51887
Palo Alto, CA 94303-1887
650-842-1300

Form 1449 (Modified) **Information Disclosure Statement By Applicant** (Use Several Sheets if Necessary)	**Atty Docket No.**	RCVRP002C1C5
	Application No.:	19/092,400
	Applicant	Evidium, Inc.
	Filing Date	March 27, 2025
	Group	2658
		Page 1 of 2
	Date Submitted	August 27, 2025

U.S. Patent Documents

Examiner Initial	No.	Patent No.	Date	Patentee	Class	Sub-class	Filing Date
	1.	2023/0335299	10/19/23	Tulley et al.			04/14/23
	2.	2020/0211692	07/02/20	Kalafut et al.			12/31/18
	3.	2014/201627	07/17/14	Coll			01/09/14
	4.	2009/0192800	07/30/09	Brandt			01/23/09
	5.	2021/0192365	06/24/21	Zhang			09/25/20
	6.	2025/0191783	06/12/25	Bate et al.			02/11/25
	7.	2025/0182912	06/05/25	Bate et al.			02/11/25
	8.	2010/145720	06/10/10	Reiner			12/07/09
	9.	2021/0142904	05/13/21	Michuda et al.			01/15/21
	10.	2011/0119212	05/19/11	De Bruin et al.			01/31/11
	11.	2023/0115939	04/13/23	Gnanasambandam et al.			10/14/22
	12.	2024/0087700	03/14/24	Gnanasambandam et al.			10/11/19
	13.	2024/0086366	03/14/24	Gnanasambandam et al.			10/11/19
	14.	2023/0048252	02/16/23	Sasidharan et al.			08/11/22
	15.	2021/0004714	01/07/21	Neumann			07/03/19
	16.	10,446,273	10/15/19	McNair et al.			01/06/14
	17.	10,733,566	08/04/20	Chan et al.			11/11/16
	18.	11,037,070	06/15/21	Salganicoff et al.			06/15/21
	19.	11,437,145	09/06/22	Tulley et al.			08/19/21
	20.	11,551,813	01/10/23	Tulley et al.			08/03/22
	21.	11,636,949	04/25/23	Goldberg et al.			08/12/19
	22.	11,705,230	07/18/23	Jain et al.			11/30/21
	23.	12,300,392	05/13/25	Bate et al.			01/08/24
	24.	2024/0153648	05/09/24	Bate et al.			01/08/24

Examiner	**Date Considered**

Examiner: Initial citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Form 1449 (Modified) **Information Disclosure Statement By Applicant** (Use Several Sheets if Necessary)	**Atty Docket No.**	RCVRP002C1C5
	Application No.:	19/092,400
	Applicant	Evidium, Inc.
	Filing Date	March 27, 2025
	Group	2658
		Page 2 of 2
	Date Submitted	August 27, 2025

	25.	2025/0059224	02/24/22	Tulley et al.			08/19/21
	26.	2025/0182911	06/05/25	Bate et al.			02/04/25
	27.	2025/0253062	08/07/25	Bate et al.			04/24/25
	28.	2003/0065535	04/03/03	Karlov et al.			05/01/02
	29.	2025/0253061	08/07/25	Bate et al.			03/27/25

Foreign Patent or Published Foreign Patent Application

Examiner Initial	No.	Document No.	Publication Date	Country or Patent Office	Class	Sub-Class	Translation Yes	Translation No
	30.							
	31.							
	32.							
	33.							

Other Documents

Examiner Initial	No.	Author, Title, Place (e.g. Journal) of Publication, Date
	34.	
	35.	
	36.	
	37.	

Examiner	Date Considered

Examiner: Initial citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: BATE et al.	Attorney Docket No.: RCVRP002C1C5
Application No.: 19/092,400	Examiner: LEONARD SAINT CYR
Filed: March 27, 2025	Group: 2658
Title: TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF	Confirmation No.: 6474

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Signed: _____/Andrea Dacanay/_____
Andrea Dacanay

INFORMATION DISCLOSURE STATEMENT BEFORE FINAL ACTION OR NOTICE OF ALLOWANCE (37 CFR §§ 1.56 AND 1.97(c))

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

The reference(s) identified in the attached PTO Form 1449, (copies of non-U.S. references are attached), may be material to examination of the above-identified patent application. Applicants identify the reference(s) in compliance with their duty of disclosure pursuant to 37 CFR §§1.56 and 1.97. The Examiner is requested to make the identified reference(s) of official record in this application.

This Information Disclosure Statement is not to be construed as a representation that a search has been made, that additional information material to the examination of this application does not exist, or that the reference(s) indeed constitutes prior art.

This Information Disclosure Statement is being filed after the mailing date of the first Office Action on the merits, or after three months from the filing date of this application, whichever event occurred last, but it is believed before the mailing date of either: (i) a final action under §1.113 or (ii) a notice of allowance under §1.311, whichever occurs first.

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

Accompanying this Information Disclosure Statement is the fee set forth in 37 CFR 1.17(p).

The Commissioner is hereby authorized to charge Deposit Account 50-4481 (Order No. RCVRP002C1C5) for $112.00 in payment of the Information Disclosure Statement Fee. If it is determined that any additional fees are due, the Commissioner is hereby authorized to charge such fees to Deposit Account 50-4481 (Order No. RCVRP002C1C5).

Respectfully submitted,
BEYER LAW GROUP LLP

/Jonathan O. Scott/

Jonathan O. Scott
Registration No. 39,364

P. O. Box 51887
Palo Alto, CA 94303-1887
650-842-1300

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

Doc Code: IDS.SIZEFEE
Document Description: Assertion of whether IDS Size Fee Due

PTO/SB/08C (01-25)
Approved for use through 01/31/2028. OMB 0651-0070
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995 no persons are required to respond to a collection of information unless it displays a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT SIZE FEE – WRITTEN ASSERTION UNDER 37 CFR 1.98

Complete if Known

Application or Patent No.: 19/092,400	First Named Inventor: Carl BATE	Art Unit: 2658
Filing Date: March 27, 2025	Attorney Docket Number: RCVRP002C1C5	Examiner: LEONARD SAINT CYR

Please see 37 CFR 1.17(v) and attached Instructions for completing this form to make the appropriate selection of an assertion under 37 CFR 1.98. For the information disclosure statement (IDS) submitted herewith, the applicant or patent owner certifies the following with respect to the cumulative number of applicant-provided or patent-owner provided items of information submitted to date including those in the accompanying IDS (select only one):

☑ No IDS size fee is required under 37 CFR 1.17(v) at this time.

☐ The IDS is accompanied by the IDS size fee under 37 CFR 1.17(v)(1).

☐ The IDS is accompanied by the IDS size fee under 37 CFR 1.17(v)(2).

☐ The IDS is accompanied by the IDS size fee under 37 CFR 1.17(v)(3).

NOTE: This form must be accompanied by PTO/SB/08a and/or PTO/SB/08b or equivalent.

DEPOSIT ACCOUNT

The Director is authorized to charge the fee indicated above in the amount of $ _____ for the IDS submitted herewith to deposit account _____.

SIGNATURE

This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications.

If applicant or patent owner is a juristic entity (e.g., an LLC or corporation), this form must be signed by a registered practitioner. See 37 CFR 1.31.

If applicant or patent owner is a person or persons, this form may be signed by either a registered practitioner, or the applicant or patentee. Note that if multiple people together are the applicant or patentee (e.g., there are joint inventors who together are the applicant), then a signature is required from each person who is an applicant or patentee. *Submit multiple forms if more than one signature is required, see below*.*

Signature /Jonathan O. Scott/	Date August 27, 2025
Name (Print/Typed) Jonathan O. Scott	Practitioner Registration Number (if applicable) 39,364

☐ * Total of _____ forms are submitted.

A Federal agency may not conduct or sponsor, and a person is not required to respond to, nor shall a person be subject to a penalty for failure to comply with an information collection subject to the requirements of the Paperwork Reduction Act of 1995, unless the information collection has a currently valid OMB Control Number. The OMB Control Number for this information collection is 0651-0070. Public burden for this form is estimated to average 2 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the information collection. Send comments regarding this burden estimate or any other aspect of this information collection, including suggestions for reducing this burden to the Office of the Chief Administrative Officer, United States Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450 or email InformationCollection@uspto.gov. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

Routine uses of the information in this record may include disclosure to:

1) law enforcement, in the event that the system of records indicates a violation or potential violation of law;

2) a federal, state, local, or international agency, in response to its request;

3) a contractor of the USPTO having need for the information in order to perform a contract;

4) the Department of Justice for determination of whether the Freedom of Information Act (FOIA) requires disclosure of the record;

5) a Member of Congress submitting a request involving an individual to whom the record pertains, when the individual has requested the Member's assistance with respect to the subject matter of the record;

6) a court, magistrate, or administrative tribunal, in the course of presenting evidence, including disclosures to opposing counsel in the course of settlement negotiations;

7) the Administrator, General Services Administration (GSA), or their designee, during an inspection of records conducted by GSA under authority of 44 U.S.C. 2904 and 2906, in accordance with the GSA regulations and any other relevant (i.e., GSA or Commerce) directive, where such disclosure shall not be used to make determinations about individuals;

8) another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c));

9) the Office of Personnel Management (OPM) for personnel research purposes; and

10) the Office of Management and Budget (OMB) for legislative coordination and clearance.

If you do not furnish the information requested on this form, the USPTO may not be able to process and/or examine your submission, which may result in termination of proceedings, abandonment of the application, and/or expiration of the patent.

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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/092,400	**08/27/2025 06:55:35 PM Z ET**	**RCVRP002C1C5**

Title of Invention

TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	6474	FILED BY	ANDREASARAH DACANAY
PATENT CENTER #	72043716	AUTHORIZED BY	Jonathan Scott
CUSTOMER #	58766	FILING DATE	03/27/2025
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Carl BATE

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
DA / 504481	**E20258QI56025515**	**ANDREASARAH DACANAY**

PRE-AUTHORIZED ACCOUNT	PRE-AUTHORIZED CATEGORY
504481	**37 CFR 1.21 (Miscellaneous fees and charges)**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
2806	SUBMISSION OF AN INFORMATION DISCLOSURE STATEMENT	112.00	1	112.00
			TOTAL AMOUNT:	**$112.00**

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

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Commissioner for Patents
United States Patent and Trademark Office
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APPROVAL LETTER

APPLICATION #	FILING DATE	APPLICANT/PATENT UNDER REEXAMINATION
19/092,400	03/27/2025	Carl BATE

Title of Invention

TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

Electronic terminal disclaimer filed on 08/27/2025

☑ Approved

This patent is subject to a Terminal Disclaimer

Approved / Disapproved by: Electronic Terminal Disclaimer automatically approved

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/092,400	**08/27/2025 06:49:06 PM Z ET**	**RCVRP002C1C5**

Title of Invention

TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	6474	FILED BY	Jonathan Scott
PATENT CENTER #	72047760	FILING DATE	03/27/2025
CUSTOMER #	58766	FIRST NAMED INVENTOR	Carl BATE
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jonathan Scott

Documents

TOTAL DOCUMENTS: 2

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
petition-request.pdf	3	Terminal Disclaimer-Filed (Electronic)	44 KB
grantLetter.pdf	1	Terminal Disclaimer-Electronic-Approved	18 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
petition-request.pdf	12A1DDA3F863482BEB57C590B05CFD25F5E0244FDD7F4EAE385B71F7ACD4F5B4C353EC6186F1DA695D0C1F8083AC98E95D7A82BAF1DD14EEB12F33B5FA4C68EC

grantLetter.pdf

11ED1032501AE6981EF772041956D18BEFF923969B743E138B
DE91FCFEB69BC52EB7E3AA00D06997249E21C198ED334643
FE1C9F512768DB720AF5A945CD5732

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

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TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A PRIOR PATENT

APPLICATION #	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET #
19092400	03/27/2025	Carl BATE	RCVRP002C1C5

Title of Invention

TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

☑ Filing of terminal disclaimer does not obviate requirement for response under 37 CFR 1.111 to outstanding Office Action

☑ This electronic Terminal Disclaimer is not being used for a Joint Research Agreement.

Owner	Percent interest
Evidium, Inc.	100%
Total	**100%**

The owner(s) of percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of any patent granted on pending reference Application Number(s)

Application #	Filing Date

as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and any patent granted on the reference application are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.
In making the above disclaimer, the owner does not disclaim the terminal part of any patent granted on the instant application that would extend to the expiration date of the full statutory term of any patent granted on said reference application, "as the term of any patent granted on said reference application may be shortened by any terminal disclaimer filed prior to the grant of any patent on the pending reference application," in the event that any such patent granted on the pending reference application: expires for failure to pay a maintenance fee, is held unenforceable, is found invalid by a court of competent jurisdiction, is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321, has all claims canceled by a reexamination certificate, is reissued, or is in any manner terminated prior to the expiration of its full statutory term as shortened by any terminal disclaimer filed prior to its grant.

The owner(s) of percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s)

Patent #

as the term of said prior patent is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the prior patent are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.
In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term of the prior patent, "as the term of said prior patent is presently shortened by any terminal disclaimer," in the event that said prior patent later:
- expires for failure to pay a maintenance fee;
- is held unenforceable;
- is found invalid by a court of competent jurisdiction;
- is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
- has all claims canceled by a reexamination certificate;
- is reissued; or
- is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

Terminal disclaimer fee under 37 CFR 1.20(d) included with Electronic Terminal Disclaimer request.

Applicant claims the following entity status:
Small

I hereby declare that all statements made herein of my own knowledge are true and that all statemnts made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

I certify, in accordance with 37 CFR 1.4(d)(4) that I am: An attorney or agent registered to practice before the Patent and Trademark Office who is of record in this application

Signature	Name	Registration #
/Jonathan Scott/	Jonathan Scott	39364

* Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner). Form PTO/SB/96 may be used for making this certification. See MPEP 324.

UNITED STATES
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ELECTRONIC PAYMENT RECEIPT

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CUSTOMER #	58766	FILING DATE	03/27/2025
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Carl BATE

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
DA / 504481	**E20258QI49595409**	**Jonathan Scott**

PRE-AUTHORIZED ACCOUNT	PRE-AUTHORIZED CATEGORY
504481	**37 CFR 1.21 (Miscellaneous fees and charges)**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
2814	STATUTORY DISCLAIMER, INCLUDING TERMINAL DISCLAIMER	183.00	1	183.00
			TOTAL AMOUNT:	**$183.00**

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
19/092,400	03/27/2025	Carl BATE	RCVRP002C1C5

CONFIRMATION NO. 6474

58766
Beyer Law Group LLP
P. O. Box 51887
Palo Alto, CA 94303-1887

PUBLICATION NOTICE

OC000000092682634

Date Mailed: 08/07/2025

Title:TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

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BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
19/092,400	03/27/2025	Carl BATE	RCVRP002C1C5	6474

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Beyer Law Group LLP
P. O. Box 51887
Palo Alto, CA 94303-1887

EXAMINER
SAINT CYR, LEONARD

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

Office Action Summary	Application No. 19/092,400	Applicant(s) BATE et al.	
	Examiner LEONARD SAINT-CYR	Art Unit 2658	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2a)☐ This action is **FINAL.** 2b) ☑ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5) ☑ Claim(s) 1-30 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 1-30 is/are rejected.

8) ☐ Claim(s) _____ is/are objected to.

9) ☐ Claim(s) _____ are subject to restriction and/or election requirement

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

10)☐ The specification is objected to by the Examiner.

11)☑ The drawing(s) filed on 03/27/25 is/are: a)☑ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☑ Notice of References Cited (PTO-892)

2) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

DETAILED ACTION

Notice of Pre-AIA or AIA Status

1. The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Claim Rejections - 35 USC § 101

2. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

3. Claims 1 — 30 are rejected under 35 U.S.C. 101 because the claimed invention is directed to an abstract without significantly more.

When considering subject matter eligibility under 35 USC 101, it must be determined whether the claim is directed to one of the four statutory categories of invention, i.e., process, machine, manufacture, or composition of matter.

4. Claims 1 — 11 are directed to a system. It hereby falls under one of the four statutory classes of invention.

If the claim does not fall within one of the statutory categories, it must then be determined whether the claim is directed to a judicial exception (i.e., law of nature, natural phenomenon, and abstract idea).

Claims 1 - 11 recite steps that can be practically performed by a human, either mentally or with the use of pen and paper.

The limitations of “input a portion of electronic text pertaining to a medical condition from a medical evidence source; process said electronic text to produce a plurality of clinical concepts indicative of said medical condition;

display said clinical concepts on a computing device;

receive input from said computing device indicating that said clinical concepts are relevant to said medical condition; and store said medical condition and said clinical concepts each as a separate entry in a database, said medical condition being linked to each of said clinical concepts, wherein said entry of each of said clinical concepts in said database does not include information specific to said medical condition." in claims 1 - 11, is a machine that, under its broadest reasonable interpretation, covers performance of the limitation in the mind, but for the recitation of generic computer components. That is, other than reciting "a computer system comprising one or more processors and memory", nothing in the claim element precludes the steps from practically being performed in a human mind or using a pen and a piece of paper.

The mere nominal recitation of a generic processor and computing device do not take the claim limitations out of the mental processes grouping.

If a claim limitation, under its broadest reasonable interpretation, covers mental processes but for the recitation of generic computer components, then it falls within the "Mental Processes" grouping of abstract ideas (concepts performed in the human mind including an observation, evaluation, judgement, and opinion). Accordingly, the claims recite an abstract idea.

This judicial exception is not integrated into a practical application. In particular, the claims recite the additional elements "display said clinical concepts on a computing device; receive input from said computing device indicating that said clinical concepts are relevant to said medical condition".

The limitation "receive input from said computing device indicating that said clinical concepts are relevant to said medical condition', amount to data-gathering steps which is considered to be insignificant extra solution activity, (See MPEP 2106.05(g)).

The limitation "display said clinical concepts on a computing device", represents an extra-solution activity because it is a mere nominal or tangential addition to the claim, a mere generic transmission and presentation of collected and analyzed data. (See MPEP 2106.05 (g)).

Accordingly, these additional elements do not integrate the abstract idea into a practical application because they do not impose any meaningful limits on practicing the abstract idea, thus fail to integrate the abstract idea into a practical application. See MPEP 2106.05(g).

The insignificant extra-solution activities identified above, which include the data gathering (receiving, and inputting), and displaying steps, are recognized by the courts as well-understood, routine, and conventional activities when they are claimed in a merely generic manner (e.g., at a high level of generality) or as insignificant extra solution activity (See MPEP 2106.05(d)(II) (i) Receiving or transmitting data over a network, e.g., using the Internet to gather data, buySAPE, Inc. v. Google, Inc., 765 F.3d 1350, 1355, 112 USPO2d 1093, 1096 (Fed. Cir. 2014) (computer receives and sends information over a network); (v) Presenting (displaying) offers and gathering statistics, OIP Techs., 788 F.3d at 1362-63, 115 USPO2d at 1092- 93). The claims are not patent eligible.

Claims 1 - 11 do not include additional elements that are sufficient to amount to significantly more than the judicial exception. As discussed above with respect to

integration of the abstract idea into a practical application, the additional element of receive input from said computing device indicating that said clinical concepts are relevant to said medical condition; and display said clinical concepts on a computing device steps amounts to no more than mere instructions to apply the exception using a generic computer component. Mere instructions to apply an exception using a generic computer component cannot provide an inventive concept.

Claims 1 - 11 as a whole, do not amount to significantly more than the abstract idea itself. This is because the claims do not affect an improvement to the functioning of a computer itself; and the claims do not move beyond a general link of the use of an abstract idea to a particular technological environment.

5. Claims 12 — 23 are directed to a system. It hereby falls under one of the four statutory classes of invention.

If the claim does not fall within one of the statutory categories, it must then be determined whether the claim is directed to a judicial exception (i.e., law of nature, natural phenomenon, and abstract idea).

Claims 12 - 23 recite steps that can be practically performed by a human, either mentally or with the use of pen and paper.

The limitations of “extract from a medical evidence source a plurality of diagnostic factors each indicative of a medical condition and store each of said diagnostic factors and said medical condition as its own node in a database, said medical condition being linked to said diagnostic factors, wherein each of said diagnostic factor nodes do not include information specific to said medical condition; for

at least one of said diagnostic factors, store demographics that indicate said medical condition on the basis of said at least one diagnostic factor between said medical condition node and a node representing said at least one diagnostic factor; extract from a medical evidence source a plurality of laboratory tests each indicative of said medical condition and store each of said laboratory tests in said database; for at least one of said laboratory tests, store a test result in said database; and match patient data from a patient medical chart to at least one of said diagnostic factor nodes, said demographics, or said test result in order to display a result indicating a likelihood that said patient has said medical condition" in claims 12 - 23, is a machine that, under its broadest reasonable interpretation, covers performance of the limitation in the mind, but for the recitation of generic computer components. That is, other than reciting "a computer system comprising one or more processors and memory", nothing in the claim element precludes the steps from practically being performed in a human mind or using a pen and a piece of paper.

The mere nominal recitation of a generic processor and computing device do not take the claim limitations out of the mental processes grouping.

If a claim limitation, under its broadest reasonable interpretation, covers mental processes but for the recitation of generic computer components, then it falls within the "Mental Processes" grouping of abstract ideas (concepts performed in the human mind including an observation, evaluation, judgement, and opinion). Accordingly, the claims recite an abstract idea.

This judicial exception is not integrated into a practical application. In particular,

the claims recite the additional elements "extract from a medical evidence source a plurality of diagnostic factors; display a result indicating a likelihood that said patient has said medical condition.".

The limitation "display a result indicating a likelihood that said patient has said medical condition.", represents an extra-solution activity because it is a mere nominal or tangential addition to the claim, a mere generic transmission and presentation of collected and analyzed data. (See MPEP 2106.05 (g)).

Accordingly, these additional elements do not integrate the abstract idea into a practical application because they do not impose any meaningful limits on practicing the abstract idea, thus fail to integrate the abstract idea into a practical application. See MPEP 2106.05(g).

The insignificant extra-solution activities identified above, which include the data gathering extracting, and displaying steps, are recognized by the courts as well understood, routine, and conventional activities when they are claimed in a merely generic manner (e.g., at a high level of generality) or as insignificant extra-solution activity (See MPEP 2106.05(d)(II) (i) Receiving or transmitting data over a network, e.g., using the Internet to gather data, buySAPE, Inc. v. Google, Inc., 765 F.3d 1350, 1355, 112 USPO2d 1093, 1096 (Fed. Cir. 2014) (computer receives and sends information over a network); (v) Presenting (displaying) offers and gathering statistics, OIP Techs., 788 F.3d at 1362-63, 115 USPO2d at 1092- 93). The claims are not patent eligible.

Claims 12 - 23 do not include additional elements that are sufficient to amount to significantly more than the judicial exception. As discussed above with respect to integration of the abstract idea into a practical application, the additional element of

display said diagnostic factors on a computing a result indicating a likelihood that said patient has said medical condition, and extracting steps amounts to no more than mere instructions to apply the exception using a generic computer component. Mere instructions to apply an exception using a generic computer component cannot provide an inventive concept.

Claims 12 - 23 as a whole, do not amount to significantly more than the abstract idea itself. This is because the claims do not affect an improvement to the functioning of a computer itself; and the claims do not move beyond a general link of the use of an abstract idea to a particular technological environment.

6. Claims 24 — 30 are directed to a system. It hereby falls under one of the four statutory classes of invention.

If the claim does not fall within one of the statutory categories, it must then be determined whether the claim is directed to a judicial exception (i.e., law of nature, natural phenomenon, and abstract idea).

Claims 24 — 30 recite steps that can be practically performed by a human, either mentally or with the use of pen and paper.

The limitations of "identify all known factor nodes in a knowledge graph that each represent a diagnostic factor known to be present or absent in said patient, each known factor node being linked to a medical condition node in said knowledge graph representing said at least one medical condition; identify all unknown factor nodes in said knowledge graph that each represent an unknown diagnostic factor not known to be present or absent in said patient, each unknown factor node being linked to said

medical condition node; identify a rank of each unknown factor node that indicates a likelihood that said represented unknown diagnostic factor indicates said at least one medical condition, said rank being stored between said unknown factor node and said medical condition node" in claims 24 - 30, is a machine that, under its broadest reasonable interpretation, covers performance of the limitation in the mind, but for the recitation of generic computer components. That is, other than reciting "a computer system comprising one or more processors and memory", nothing in the claim element precludes the steps from practically being performed in a human mind or using a pen and a piece of paper.

The mere nominal recitation of a generic processor and computing device do not take the claim limitations out of the mental processes grouping.

If a claim limitation, under its broadest reasonable interpretation, covers mental processes but for the recitation of generic computer components, then it falls within the "Mental Processes" grouping of abstract ideas (concepts performed in the human mind including an observation, evaluation, judgement, and opinion). Accordingly, the claims recite an abstract idea.

This judicial exception is not integrated into a practical application. In particular, the claims recite the additional elements "display said diagnostic factors on a computing a result indicating a likelihood that said patient has said medical condition".

The limitation "output said unknown diagnostic factors corresponding to said unknown factor nodes in association with said at least one medical condition in order of said rank of said each unknown factor node.", represents an extra-solution activity because it is a mere nominal or tangential addition to the claim, a mere generic

transmission and presentation of collected and analyzed data. (See MPEP 2106.05 (g)).

Accordingly, these additional elements do not integrate the abstract idea into a practical application because they do not impose any meaningful limits on practicing the abstract idea, thus fail to integrate the abstract idea into a practical application. See MPEP 2106.05(g).

The insignificant extra-solution activities identified above, which include the data gathering extracting, and displaying steps, are recognized by the courts as well understood, routine, and conventional activities when they are claimed in a merely generic manner (e.g., at a high level of generality) or as insignificant extra-solution activity (See MPEP 2106.05(d)(II) (i) Receiving or transmitting data over a network, e.g., using the Internet to gather data, buySAPE, Inc. v. Google, Inc., 765 F.3d 1350, 1355, 112 USPO2d 1093, 1096 (Fed. Cir. 2014) (computer receives and sends information over a network); (v) Presenting (displaying) offers and gathering statistics, OIP Techs., 788 F.3d at 1362-63, 115 USPO2d at 1092- 93). The claims are not patent eligible.

Claims 24 - 30 do not include additional elements that are sufficient to amount to significantly more than the judicial exception. As discussed above with respect to integration of the abstract idea into a practical application, the additional element of output said unknown diagnostic factors corresponding to said unknown factor nodes in association with said at least one medical condition in order of said rank of said each unknown factor node step amounts to no more than mere instructions to apply the exception using a generic computer component. Mere instructions to apply an exception using a generic computer component cannot provide an inventive concept.

Claims 24 - 30 as a whole, do not amount to significantly more than the abstract

idea itself. This is because the claims do not affect an improvement to the functioning of a computer itself; and the claims do not move beyond a general link of the use of an abstract idea to a particular technological environment.

Double Patenting

7. The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file

provisions of the AIA as explained in MPEP § 2159. See MPEP § 2146 *et seq.* for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The filing of a terminal disclaimer by itself is not a complete reply to a nonstatutory double patenting (NSDP) rejection. A complete reply requires that the terminal disclaimer be accompanied by a reply requesting reconsideration of the prior Office action. Even where the NSDP rejection is provisional the reply must be complete. See MPEP § 804, subsection I.B.1. For a reply to a non-final Office action, see 37 CFR 1.111(a). For a reply to final Office action, see 37 CFR 1.113(c). A request for reconsideration while not provided for in 37 CFR 1.113(c) may be filed after final for consideration. See MPEP §§ 706.07(e) and 714.13.

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The actual filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/apply/applying-online/eterminal-disclaimer.

8. Claims 1 – 30 are provisionally rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1 - 30 of copending Application No. 19/045,329 (reference application). Although the claims at issue are not identical, they are not patentably distinct from each other because claims 1 – 30 of the instant

application are similar in scope and content of claims 1 – 30 of the copending Application.

This is a provisional nonstatutory double patenting rejection because the patentably indistinct claims have not in fact been patented.

Here is comparison between claims 1, 12, 24 of the instant application and claims 1, 12, 24 of the copending application respectively.

Instant Application 19/092,400	Copending Application 19/045,329	Comparison
1. A computer system for translating medical evidence into computational elements, said computer system comprising:	1. A system for translating medical evidence into computational elements, said system comprising	Similar
one or more processors; and memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to:	a computer system comprising one or more processors and memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to:	Same

input a portion of electronic text pertaining to a medical condition from a medical evidence source;	input a portion of electronic text pertaining to a medical condition from a medical evidence source;	Same
process said electronic text to produce a plurality of clinical concepts indicative of said medical condition;	process said electronic text using natural language processing (NLP) to produce a plurality of diagnostic factors indicative of said medical condition;	Similar
display said clinical concepts on a computing device;	display said diagnostic factors on a computing device to a person;	Similar
receive input from said computing device indicating that said clinical concepts are relevant to said medical condition; and	receive input from said person via said computing device indicating a factor group that subsumes said diagnostic factors and a rank for said factor group; and	Similar
store said medical condition and said clinical	store said medical condition, said factor group	Similar

concepts each as a separate entry in a database, said medical condition being linked to each of said clinical concepts, wherein said entry of each of said clinical concepts in said database does not include information specific to said medical condition.	and each of said diagnostic factors each as a separate entry in a database, said medical condition linked to said factor group and said factor group linked to each of said diagnostic factors, wherein an entry of each of said diagnostic factors in said database does not include information specific to said medical condition.	

Instant Application 19/092,400	Copending Application 19/045,329	Comparison
12. A computer system for determining a state of a patient, said computer system comprising:	12. A system for determining a state of a patient, said system comprising:	Same
one or more processors; and memory that stores instructions, wherein the	a computer system comprising one or more processors and memory	Similar

instructions, when executed by the one or more processors, cause the one or more processors to:	that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to:	
extract from a medical evidence source a plurality of diagnostic factors each indicative of a medical condition and store each of said diagnostic factors and said medical condition as its own node in a database, said medical condition being linked to said diagnostic factors, wherein each of said diagnostic factor nodes do not include information specific to said medical condition;	extract, using natural language processing (NLP), from a medical evidence source a plurality of diagnostic factors indicative of a medical condition and storing each of said diagnostic factors and said medical condition as its own node in a database, said medical condition being linked to said diagnostic factors, wherein each of said diagnostic factor nodes do not include information	Similar

	specific to said medical condition;	
for at least one of said diagnostic factors, store demographics that indicate said medical condition on the basis of said at least one diagnostic factor between said medical condition node and a node representing said at least one diagnostic factor;	for at least one of said diagnostic factors, store demographics required to indicate said medical condition on the basis of said at least one diagnostic factor in a demographics node located between said medical condition node and a node representing said at least one diagnostic factor;	Similar
extract from a medical evidence source a plurality of laboratory tests each indicative of said medical condition and store each of said laboratory tests in said database;	extract from a medical evidence source a plurality of laboratory tests indicative of said medical condition and storing each of said laboratory tests as its own node in said database, said medical condition being linked to	Similar

	said laboratory tests, wherein each of said laboratory test nodes does not include information specific to said medical condition;	
for at least one of said laboratory tests, store a test result in said database; and	for at least one of said laboratory tests, store test results required to indicate said medical condition on the basis of said at least one laboratory test in a results node located between said medical condition node and a node representing said at least one laboratory test; and	Similar
match patient data from a patient medical chart to at least one of said diagnostic factor nodes, said demographics, or said test result in order to display a	match patient data from a patient medical chart to at least one of said diagnostic factor nodes, said demographics node, at least one of said laboratory	Similar

result indicating a likelihood that said patient has said medical condition.	test nodes, and said results node in order to display a result indicating a likelihood that said patient has said medical condition.	

Instant Application 19/092,400	Copending Application 19/045,329	Comparison
24. A computer system for determining next-best actions for a medical condition, said system comprising:	24. A system for determining next-best actions for a medical condition, said system comprising:	Same
one or more processors; and memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to perform the following for at least one	a computer system comprising one or more processors and memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to:	Similar

medical condition of a patient:		
identify all known factor nodes in a knowledge graph that each represent a diagnostic factor known to be present or absent in said patient, each known factor node being linked to a medical condition node in said knowledge graph representing said at least one medical condition;	for each medical condition of a patient having a probability greater than a threshold of being present in said patient, perform the following identify all known diagnostic factor entries in a database that each represent a diagnostic factor known to be present or absent in said patient, each known diagnostic factor entry being linked to a medical condition entry in said database representing said each medical condition but not including information specific to said each medical condition;	Similar

identify all unknown factor nodes in said knowledge graph that each represent an unknown diagnostic factor not known to be present or absent in said patient, each unknown factor node being linked to said medical condition node;	identify all unknown diagnostic factor entries in said database that each represent an unknown diagnostic factor not known to be present or absent in said patient, each unknown diagnostic factor entry being linked to said medical condition entry;	Similar
identify a rank of each unknown factor node that indicates a likelihood that said represented unknown diagnostic factor indicates said at least one medical condition, said rank being stored between said unknown factor node and said medical condition node; and	identify a rank of each unknown diagnostic factor entry that indicates a likelihood that said represented unknown diagnostic factor indicates said each medical condition, said rank being stored in a database entry link between said unknown diagnostic factor entry and	Similar

	said medical condition entry; and	
output said unknown diagnostic factors corresponding to said unknown factor nodes in association with said at least one medical condition in order of said rank of said each unknown factor node.	display said unknown diagnostic factors represented by said unknown diagnostic factor entries in association with said each medical condition in order of said rank of said each unknown diagnostic factor.	Similar

Claim Rejections - 35 USC § 102

9. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a)(2) the claimed invention was described in a patent issued under section 151, or in an application for patent published or deemed published under section 122(b), in which the patent or application, as the case may be, names another inventor and was effectively filed before the effective filing date of the claimed invention.

10. Claims 1 – 23 are rejected under 35 U.S.C. 102(a)(2) as being anticipated by Iliff (US PAP 2005/0010444).

As per claim 1, Iliff teaches a computer system for translating medical evidence into computational elements, said computer system comprising:

one or more processors; and memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to ("a data structure stored in a memory in data communication with a processor in the computing device"; paragraph 12):

input a portion of electronic text pertaining to a medical condition from a medical evidence source ("an electronic medical record for the patient", paragraph 19);

process said electronic text to produce a plurality of clinical concepts indicative of said medical condition ("the electronic medical record storing the cause of disease, the anatomic system and at least one of the one or more selected medical diagnoses."; paragraphs 19 —21);

display said clinical concepts on a computing device ("displaying a user interface on a computing device to a user, corresponding a first attribute of a medical condition to a cause of disease and a second attribute of the medical condition to an anatomic system of a patient"; paragraphs 21 — 25);

receive input from said computing device indicating that said clinical concepts are relevant to said medical condition ("the user selected subset of the list of possible chief complaints. The system may additionally comprise an electronic medical record for the patient, the electronic medical record storing the cause of disease, the anatomic system, at least one of the one or more selected medical diagnoses, and the user-selected subset of the list of possible chief complaints... The list of one or more selected medical diagnoses for the patient may include a confidence level associated with each diagnosis, and may comprise a rank ordered differential diagnosis."; paragraphs 15, 19 — 21); and

store said medical condition and said clinical concepts each as a separate entry in a database, said medical condition being linked to each of said clinical concepts, wherein said entry of each of said clinical concepts in said database does not include information specific to said medical condition ("receive a plurality of identified attribute values representative of a medical condition of a patient, and a data structure stored in a memory in data communication with a processor in the computing device, the data structure being configured, such that when accessed by the plurality of attribute values, to provide a list of one or more selected medical diagnoses of the patient for display via the user interface, wherein the plurality of attributes includes at least a first attribute corresponding to a cause of disease and a second attribute corresponding to an anatomic system of the patient...the EMR can be updated with or store the cause of disease, the anatomic system, at least one of the most likely candidate medical diseases or diagnoses, and/or the user-selected subset of the list of possible Chief Complaints."; paragraph 115, see also paragraphs 12, 19 -26).

As per claim 2, Iliff further discloses displaying on said computing device a portion of said database which includes said medical condition entry, each of said diagnostic factor entries and the links between said medical condition entry and each of said diagnostic factor entries ("provide a list of one or more selected medical diagnoses of the patient for display via the user interface, wherein the plurality of attributes includes at least a first attribute corresponding to a cause of disease and a second attribute corresponding to an anatomic system of the patient."; paragraph 12).

As per claim 3, Iliff further discloses said database is a knowledge graph and said each separate entry is a node of said knowledge graph ("a data structure based on the plurality of attribute values, and providing a list of one or more selected medical diagnoses associated with a diagnosis of the patient to the user interface based on the accessing... Each disease has a field in the database having a relative value for how dangerous the disease is"; paragraphs 21 — 25, 96).

As per claim 4, Iliff further discloses each clinical concept is a diagnostic factor and each diagnostic factor entry includes a unique identifier which links to an entry in a medical ontology representing said each diagnostic factor ("receiving a plurality of identified attribute values representative of a medical condition of a patient via the interface, wherein a first attribute of the medical condition corresponds to a cause of disease and a second attribute of the medical condition corresponds to an anatomic system of the patient"; paragraphs 21 — 25).

As per claim 5, Iliff further discloses receiving input indicating demographics corresponding said diagnostic factor, said demographics indicating a type of person to which said diagnostic factor occurs in the context of said medical condition; and store said demographics in a demographics entry linked between said medical condition entry and a diagnostic factor entry representing said diagnostic factor ("The list of one or more selected medical diagnoses for the patient may be identified based on a user-selected subset of the list of possible chief complaints for the patient and one or more criteria when an input signal is received from the user. One of the criteria may comprise

the gender of the patient. Another of the criteria may comprise the country or region of the country in which the patient resides"; paragraph 17).

As per claim 6, Iliff further discloses said clinical concepts are displayed on said computing device to a person, and wherein said input is received from said person via said computing device ("the user selected subset of the list of possible chief complaints. The system may additionally comprise an electronic medical record for the patient, the electronic medical record storing the cause of disease, the anatomic system, at least one of the one or more selected medical diagnoses, and the user-selected subset of the list of possible chief complaints... The list of one or more selected medical diagnoses for the patient may include a confidence level associated with each diagnosis, and may comprise a rank ordered differential diagnosis."; paragraphs 15, 19 — 21).

As per claim 7, Iliff further discloses receiving a rank associated with said clinical concepts, said rank indicating how likely it is that said clinical concepts are indicative of said medical condition; and storing said rank in a database entry between said medical condition entry and said clinical concepts entries (The list of one or more selected medical diagnoses for the patient may include a confidence level associated with each diagnosis, and may comprise a rank ordered differential diagnosis."; paragraphs 15, 19 — 21).

As per claim 8, Iliff further discloses said clinical concepts are diagnostic factors caused by said medical condition, are risk factors that contribute to said medical

condition, are laboratory tests that indicate said medical condition, are examinations that indicate said medical condition, or are drugs that contribute to said medical condition ("the database includes several tables, such as a chief complaint table and a disease table. A web site may optionally provide updates on new disease information or about new laboratory tests, special studies, imaging modality of choice and treatment of choice."; paragraphs 20, 54, 102).

As per claim 9, Iliff further discloses receiving input indicating a group that subsumes said clinical concepts; and storing said group as a separate entry in said database, said group including at least one condition-dependent attribute that depends upon said medical condition, said medical condition entry being linked to said group entry and said group entry being linked to each of said clinical factors entries ("receive a plurality of identified attribute values representative of a medical condition of a patient, and a data structure stored in a memory in data communication with a processor in the computing device, the data structure being configured, such that when accessed by the plurality of attribute values, to provide a list of one or more selected medical diagnoses of the patient for display via the user interface, wherein the plurality of attributes includes at least a first attribute corresponding to a cause of disease and a second attribute corresponding to an anatomic system of the patient."; paragraphs 12 —14).

As per claim 10, Iliff further discloses said one of said clinical concepts is a diagnostic factor, and wherein said diagnostic factor entry includes a temporality attribute indicating whether or not a patient is currently exhibiting said diagnostic factor,

a negation attribute indicating whether not said diagnostic factor is present in said patient, or an experience attribute indicating whether not said patient experiences said diagnostic factor personally ("the plurality of attributes includes at least a first attribute corresponding to a cause of disease and a second attribute corresponding to an anatomic system of the patient."; paragraphs 12 —14).

As per claim 11, Iliff further discloses extracting from said electronic text a rank indicating how likely it is that one of said clinical concepts is indicative of said medical condition; and add said rank to a location in said database between said medical condition entry and said clinical concepts entries (paragraphs 15, 112).

As per claim 12, Iliff further teaches a computer system for determining a state of a patient, said computer system comprising:

one or more processors; and memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to ("a data structure stored in a memory in data communication with a processor in the computing device"; paragraph 12):

extract from a medical evidence source a plurality of diagnostic factors each indicative of a medical condition and store each of said diagnostic factors and said medical condition as its own node in a database, said medical condition being linked to said diagnostic factors, wherein each of said diagnostic factor nodes do not include information specific to said medical condition ("receiving a plurality of identified attribute values representative of the medical condition of the patient via the interface, accessing,

via the computing device, a data structure based on the plurality of attribute values, and providing a list of one or more selected medical diagnoses associated with a diagnosis of the patient to the user interface based on the accessing."; Abstract; paragraphs 21 – 25);

for at least one of said diagnostic factors, store demographics that indicate said medical condition on the basis of said at least one diagnostic factor between said medical condition node and a node representing said at least one diagnostic factor (The list of one or more selected medical diagnoses for the patient may be identified based on a user-selected subset of the list of possible chief complaints for the patient and one or more criteria when an input signal is received from the user. One of the criteria may comprise the gender of the patient. Another of the criteria may comprise the country or region of the country in which the patient resides. The list of one or more selected medical diagnoses for the patient may be sorted based on the one or more criteria."; paragraph 17);

extract from a medical evidence source a plurality of laboratory tests each indicative of said medical condition and store each of said laboratory tests in said database ("the database includes several tables, such as a chief complaint table and a disease table. A web site may optionally provide updates on new disease information or about new laboratory tests...The lab tests tab 1920 can include a recommended lab tests window 1922, where the recommended lab tests correspond to the top "n" diseases, e.g., three diseases, of the current differential diagnosis window 1960. Each disease has a field in the database for the laboratory test of choice, the special study of

choice (e.g., EKG), the imaging modality of choice and the treatment of choice."; paragraphs 54, 102);

for at least one of said laboratory tests, store a test result in said database; and match patient data from a patient medical chart to at least one of said diagnostic factor nodes, said demographics, or said test result in order to display a result indicating a likelihood that said patient has said medical condition ("The lab tests tab 1920 can include a recommended lab tests window 1922, where the recommended lab tests correspond to the top "n" diseases, e.g., three diseases, of the current differential diagnosis window 1960. Each disease has a field in the database for the laboratory test of choice, the special study of choice (e.g., EKG), the imaging modality of choice and the treatment of choice. The matrix application takes the top "n" diseases, looks up all of the "of choice" tables, discards the duplicate tests and lists them for the doctor or other medical caregiver."; paragraphs 54, 102).

As per claim 13, Iliff further discloses determining a rank of said likelihood that said patient has said medical condition by reference to a node intermediate between said medical condition node and said diagnostic factor nodes that holds said rank of said diagnostic factors (The list of one or more selected medical diagnoses for the patient may include a confidence level associated with each diagnosis, and may comprise a rank ordered differential diagnosis."; paragraphs 15, 19 — 21, 102).

As per claim 14, Iliff further discloses determine a rank of said likelihood that said patient has said medical condition by reference to a node intermediate between said

medical condition node and said laboratory test nodes that holds said rank of said laboratory tests (The list of one or more selected medical diagnoses for the patient may include a confidence level associated with each diagnosis, and may comprise a rank ordered differential diagnosis...The matrix application takes the top "n" diseases, looks up all of the "of choice" tables, discards the duplicate tests and lists them for the doctor or other medical caregiver."; paragraphs 15, 19 — 21, 102).

As per claim 15, Iliff further discloses perform said extract said plurality of diagnostic factors and said extract said plurality of laboratory tests using natural language processing (NLP) ["The lab tests tab 1920 can include a recommended lab tests window 1922, where the recommended lab tests correspond to the top "n" diseases, e.g., three diseases, of the current differential diagnosis window 1960. Each disease has a field in the database for the laboratory test of choice, the special study of choice (e.g., EKG), the imaging modality of choice and the treatment of choice.": paragraphs 54, 102].

As per claim 16, Iliff teaches a computer system for determining a state of a patient, said computer system comprising:

one or more processors; and memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to ("a data structure stored in a memory in data communication with a processor in the computing device"; paragraph 12):

receive a plurality of diagnostic factors known to be present or absent in a patient ("the electronic medical record storing the cause of disease, the anatomic system and at least one of the one or more selected medical diagnoses."; paragraphs 19 — 21, 115);

match said diagnostic factors to factor nodes in a knowledge graph that includes a plurality of medical condition nodes, each of said factor nodes being linked to at least one of said medical condition nodes ("receive a plurality of identified attribute values representative of a medical condition of a patient, and a data structure stored in a memory in data communication with a processor in the computing device, the data structure being configured, such that when accessed by the plurality of attribute values, to provide a list of one or more selected medical diagnoses of the patient for display via the user interface, wherein the plurality of attributes includes at least a first attribute corresponding to a cause of disease and a second attribute corresponding to an anatomic system of the patient'; paragraph 115, see also paragraphs 12, 19 -26);

for each of a plurality of said medical condition nodes, collect a rank value from along a path between said each medical condition node and each matched factor node to which said each medical condition node is linked, said rank value indicating how likely it is that the diagnostic factor matched to said each matched factor node is indicative of a medical condition represented by said each medical condition node; sum all collected rank values for said each medical condition node to produce a final ranking value for said each medical condition node ("the matrix process shows the diseases matching all of the selections to one selection, e.g., from most hits to least hits. The

symptoms, signs, etc. are actually weighted so the disease with the highest score is at the top of the list."; paragraph 92); and

output the medical condition representing said each medical condition node and said final ranking value of said each medical condition node (paragraphs 91 94).

As per claim 17, Iliff further discloses displaying in association with each of said output medical conditions its corresponding final ranking value ("the matrix process shows the diseases matching all of the selections to one selection, e.g., from most hits to least hits. The symptoms, signs, etc. are actually weighted so the disease with the highest score is at the top of the list."; paragraph 92).

As per claim 18, Iliff further discloses said medical condition is a disease, an orthopedic anomaly, an adverse drug reaction, or a drug-to-drug interaction (paragraph 102).

As per claim 19, Iliff further discloses display said output medical conditions in order of final ranking value (paragraphs 91- 94).

As per claim 20, Iliff further discloses receiving said plurality of diagnostic factors at said knowledge graph via an applications programming interface (API); and
output said medical conditions and said final ranking values via said API to a software application ("The application GUI 114 may include a database interface to the medical data storage 116 of the computing device."; paragraphs 51, 92).

As per claim 21, Iliff further discloses for at least one of said diagnostic factors known to be present, traversing upward in a medical ontology link found in one of said matched factor nodes corresponding to said at least one of said diagnostic factors known to be present in order to infer at least one other diagnostic factor present in said patient and matching this other diagnostic factor to a factor node in said knowledge graph ("The list of one or more selected medical diagnoses for the patient may include a confidence level associated with each diagnosis, and may comprise a rank-ordered differential diagnosis... The list of one or more selected medical diagnoses for the patient may be identified based on the list of one or more potential medical diagnoses for the patient and a user-selected subset of the list of possible chief complaints for the patient when an input signal is received from the user."; paragraphs 15 -19).

As per claim 22, Iliff further discloses a demographics node of said knowledge graph located between one of said matched factor nodes and its corresponding linked medical condition node includes demographics of people who exhibit said matched diagnostic factor in the context of said linked medical condition, and wherein the instructions, when executed, further cause the one or more processors to: only collect a rank value from along a path between said matched factor node and said at least one linked medical condition node when information of said patient matches said demographics in said demographics node ("The list of one or more selected medical diagnoses for the patient may be identified based on a user-selected subset of the list of possible chief complaints for the patient and one or more criteria when an input signal is

received from the user. One of the criteria may comprise the gender of the patient. Another of the criteria may comprise the country or region of the country in which the patient resides"; paragraphs 17, 115).

As per claim 23, Iliff further discloses each of said factor nodes does not include information specific to a medical condition represented by said at least one medical condition node ("the EMR can be updated with or store the cause of disease, the anatomic system, at least one of the most likely candidate medical diseases or diagnoses, and/or the user-selected subset of the list of possible Chief Complaints."; paragraph 115, see also paragraphs 12, 19 -26).

11. Claims 24 – 27, 29, 30 are rejected under 35 U.S.C. 102(a)(2) as being anticipated by Iliff (US PAP 2003/0163299).

As per claim 24, Iliff teaches a computer system for determining next-best actions for a medical condition, said system comprising:

one or more processors; and memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to perform the following for at least one medical condition of a patient ("An algorithm processor 160"; paragraph 72):

identify all known factor nodes in a knowledge graph that each represent a diagnostic factor known to be present or absent in said patient, each known factor node being linked to a medical condition node in said knowledge graph representing said at least one medical condition ("the system comprising a data structure configured to be

accessed by a plurality of attributes representative of a medical condition of a patient and providing one or more selected medical diagnoses for the patient"; paragraphs 30 — 32);

identify all unknown factor nodes in said knowledge graph that each represent an unknown diagnostic factor not known to be present or absent in said patient, each unknown factor node being linked to said medical condition node ("If the probability of migraine headaches reaches threshold, but the probability of confirmation of migraine does not reach threshold, then, as mentioned, the system pursues the next diagnostic cause of headache on the patient specific list"; paragraphs 291 — 301);

identify a rank of each unknown factor node that indicates a likelihood that said represented unknown diagnostic factor indicates said at least one medical condition, said rank being stored between said unknown factor node and said medical condition node ("Whichever has the higher score, or exceeds the other by a predetermined threshold, is then assumed to be the more probable cause. The list is, if necessary, again reordered. This time it becomes the final diagnostic list which is a list of differential diagnoses in decreasing levels of probability for this patient."; paragraphs 291 — 301); and

output said unknown diagnostic factors corresponding to said unknown factor nodes in association with said at least one medical condition in order of said rank of said each unknown factor node ("The diagnosis, advice, and treatments can be displayed on the screen and also printed in hardcopy form on a printer (if available)."; paragraph 552).

As per claim 25, Iliff further discloses identifying said unknown factor nodes by traversing down through said knowledge graph from said at least one medical condition node and disregarding said known factor nodes ("If the probability of migraine headaches reaches threshold, but the probability of confirmation of migraine does not reach threshold, then, as mentioned, the system pursues the next diagnostic cause of headache on the patient specific list."; paragraphs 291 — 301).

As per claim 26, Iliff further discloses said rank of said each unknown factor node is located between said at least one medical condition node and said each unknown factor node ("Whichever has the higher score, or exceeds the other by a predetermined threshold, is then assumed to be the more probable cause. The list is, if necessary, again reordered. This time it becomes the final diagnostic list which is a list of differential diagnoses in decreasing levels of probability for this patient."; paragraphs 291 — 301).

As per claim 27, Iliff further discloses for each known factor node, traverse upward in a medical ontology link found in said each known factor node in order to infer other diagnostic factors present in said patient ("the system comprising a data structure configured to be accessed by a plurality of attributes representative of a medical condition of a patient and providing one or more selected medical diagnoses for the patient"; paragraphs 30 — 32).

As per claim 29, Iliff further discloses inputting said diagnostic factors known to be present or absent in said patient to said knowledge graph via an applications programming interface (API); and provide said unknown diagnostic factors in association with said at least one medical condition via said API to a software application (paragraph 90).

As per claim 30, Iliff further discloses said each known factor node does not include information specific to said at least one medical condition (paragraphs 286, 292).

Conclusion

12. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Graettinger et al. teach method for Medical diagnosis and interpretation. Nelson, JR teaches methods and diagnostic support tools for facilitating the diagnosis of medical conditions.
13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to LEONARD SAINT-CYR whose telephone number is (571)272-4247. The examiner can normally be reached Monday- Friday.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Richemond Dorvil can be reached at (571)272-7602. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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/LEONARD SAINT-CYR/
Primary Examiner, Art Unit 2658

Notice of References Cited	Application/Control No. 19/092,400	Applicant(s)/Patent Under Reexamination BATE et al.	
	Examiner LEONARD SAINT-CYR	Art Unit 2658	Page 1 of 1

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*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Name	CPC Classification	US Classification
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*	B	US-5839438-A	1998-11-24	Graettinger; Timothy Joseph	G16H15/00	600/300
*	C	US-20190198172-A1	2019-06-27	Nelson, JR.; Robert P.	G16H50/30	1/1
	D					
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*		Document Number Country Code-Number-Kind Code	Date YYYY-MM-DD	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title, Date, Publisher, Edition or Volume, Pertinent Pages
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in YYYY-MM-DD format are publication dates. Classifications may be US or foreign.

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	19/092,400	BATE et al.
	Examiner	Art Unit
	LEONARD SAINT-CYR	2658

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

CLAIMS

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	05/22/2025								
	1	✓								
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BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	19/092,400	BATE et al.
	Examiner	Art Unit
	LEONARD SAINT-CYR	2658

CPC - Searched*		
Symbol	Date	Examiner
G16H70/$$$$; G16H10/$$$$; G06F40/$$$$	05/22/2025	LS

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
704	7 - 10, 257	05/22/2025	LS

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
See PE2E Search (attached)	05/22/2025	LS
See Google Scholar search (attached)	05/22/2025	LS

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

/LEONARD SAINT-CYR/ Primary Examiner, Art Unit 2658	

BMJ Publishing Group Ex. 1054
BMJ Publishing Group v. Evidium

Form 1449 (Modified) **Information Disclosure Statement By Applicant** (Use Several Sheets if Necessary)	**Atty Docket No.**	RCVRP002C1C5
	Application No.:	Not yet assigned 19/092,400
	Applicant	Unknown Evidium, Inc
	Filing Date	Herewith 03/27/25
	Group	Unknown 2658
		Page 1 of 2
	Date Submitted	March 27, 2025

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Foreign Patent or Published Foreign Patent Application

Examiner Initial	No.	Document No.	Publication Date	Country or Patent Office	Class	Sub-Class	Translation Yes	Translation No
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/L.S/	13.	2012/122198	09/13/12	WO			Yes	
/L.S/	14.	2020/006495	01/02/20	WO			Yes	

Other Documents

Examiner Initial	No.	Author, Title, Place (e.g. Journal) of Publication, Date
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Examiner /LEONARD SAINT-CYR/	Date Considered 05/21/2025

Examiner: Initial citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Form 1449 (Modified) **Information Disclosure Statement By Applicant** (Use Several Sheets if Necessary)	**Atty Docket No.**	RCVRP002C1C5
	Application No.:	Not yet assigned 19/092,400
	Applicant	Unknown Evidium, Inc
	Filing Date	Herewith 03/27/25
	Group	Unknown 2658
		Page 2 of 2
	Date Submitted	March 27, 2025

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Examiner /LEONARD SAINT-CYR/	**Date Considered** 05/21/2025

Examiner: Initial citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L123	9977	(704/8-10,257).ccls.	(US-PGPUB; USPAT)	OR	ON	ON	2025/05/22 10:17 AM
L124	317	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2) WITH (database$2 dictionar$3 dataset knowledge) SAME (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome) SAME (diagnos$3 examination)	(US-PGPUB; USPAT)	OR	ON	ON	2025/05/22 10:19 AM
L125	317	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) SAME (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome) SAME	(US-PGPUB; USPAT)	OR	ON	ON	2025/05/22 10:21 AM

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		(diagnos$3 examination)					
L126	662	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) SAME (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)	(US-PGPUB; USPAT)	OR	ON	ON	2025/05/22 10:22 AM
L128	5	123 AND (medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) SAME (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) SAME (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)	(US-PGPUB; USPAT)	OR	ON	ON	2025/05/22 10:22 AM
L129	376	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus	(US-PGPUB; USPAT)	OR	ON	ON	2025/05/22 10:23 AM

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		syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) WITH (database$2 dictionar$3 dataset knowledge) WITH (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)					
L130	641	(medical near3 (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)) WITH (diagnos$3 examination analysis) AND (user$2 participant$2 person people) WITH (display$3 graphical) AND (node$2 tree$2 trie) SAME (database$2 dictionar$3 dataset knowledge) WITH (condition$2 disease morbidity complaint$2 infirmity disorder malady illness ailing$2 ailment$2 sickness infection bug virus syndrome)	(US-PGPUB; USPAT)	OR	ON	ON	2025/05/22 10:23 AM
L131	352	L129 AND ((G16H50/70 OR G16H50/30 OR G16H70/20 OR G16H50/20 OR G16H20/30 OR G16H40/63 OR G16H10/60 OR G16H10/20 OR G16H20/10 OR G16H15/00 OR G16H40/67 OR G16H70/60 OR G16H50/50 OR G16H80/00 OR G16H40/20 OR	(US-PGPUB; USPAT)	OR	ON	ON	2025/05/22 10:24 AM

		G16H70/00 OR G16H30/40 OR G16H20/70 OR G16H30/20 OR G16H20/60 OR G16H20/17 OR G16H20/00 OR G16H20/40 OR G16H10/40 OR G16H30/00 OR G16H70/40 OR G16H50/80 OR G16H20/13 OR G16H10/00 OR G06F16/24578 OR G06F16/00 OR G06F16/2282 OR G06F16/24575 OR G06F16/285 OR G06F16/951 OR G06F16/9535 OR G06F16/9538 OR G06F16/955 OR G06F16/3329 OR G06F40/30 OR G06F16/288 OR G06F16/2264 OR G06F3/0482 OR G06F40/279 OR G06F16/345 OR G06F16/9024 OR G06F21/31 OR G06F40/20 OR G06F8/34 OR G06F9/453 OR G06F21/6245 OR G06F16/36 OR G06F18/2148 OR G06F3/04842 OR G06F40/169 OR G06F40/237 OR G06F40/40 OR G06F16/2468 OR G06F16/367 OR G06F40/295 OR G06F16/55 OR G06F16/258 OR G06F16/322 OR G06F18/214 OR G06F18/217 OR G06F18/23 OR G06F18/24 OR G06F21/604 OR G06F21/62 OR G06F21/64 OR G06F21/76 OR G06F2221/2113 OR G06F3/04817 OR					

		G06F3/0488 OR G06F3/0489 OR G06F40/211 OR G06F40/35 OR G06F9/543 OR G06F9/547 OR G06F11/3409 OR G06F16/164 OR G06F16/182 OR G06F16/22 OR G06F16/27 OR G06F16/28 OR G06F16/9577 OR G06F18/21 OR G06F18/2113 OR G06F18/23213 OR G06F18/241 OR G06F18/251 OR G06F18/295 OR G06F21/45 OR G06F21/6218 OR G06F21/6254 OR G06F3/048 OR G06F3/0483 OR G06F3/167 OR G06F40/174 OR G06F40/186 OR G06F40/247 OR G06F40/56 OR G06F40/00).cpc.)					
L132	50	(Artificial Intelligence) Similar to: 19/092,400 with 0 CPC Selections and 0 Text Selections Text: (US-11551813-B2 OR US-20060282286-A1 OR US-20120173285-A1 OR US-20190189253-A1 OR US-10311206-B2 OR US-20120101845-A1 OR US-8301465-B2 OR US-10593429-B2 OR US-10489553-B2 OR US-20170161446-A1 OR US-20160117455-A1 OR US-20180089568-A1 OR US-11182550-B2 OR US-20200185103-A1 OR US-11710574-B2 OR US-20050060193-A1 OR US-11200968-B2 OR US-20130226612-A1 OR	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN))	OR	ON	ON	2025/05/22 10:25 AM

		US-20170068789-A1 OR CA-3209118-A1 OR US-20220189590-A1 OR US-7213009-B2 OR US-20180137249-A1 OR US-10818394-B2 OR US-20220068482-A1 OR US-11403330-B2 OR US-20180089381-A1 OR WO-2018092145-A1 OR US-20130197922-A1 OR US-20090192822-A1 OR US-20120173264-A1 OR WO-2015127096-A1 OR CN-116420193-A OR US-20040260666-A1 OR WO-0225528-A1 OR US-20210057098-A1 OR WO-2005114536-A2 OR US-20200167881-A1 OR WO-2022084527-A1 OR US-20200265955-A1 OR US-20150066537-A1 OR CA-2567291-A1 OR US-20100094648-A1 OR US-20190180874-A1 OR US-20200098477-A1 OR WO-2006035383-A1 OR US-20050261941-A1 OR US-20250037823-A1 OR US-20190180872-A1 OR EP-1304629-A1).did.					
L133	596	L130 AND ((G16H50/20 OR G16H50/70 OR G16H10/60 OR G16H50/30 OR G16H70/20 OR G16H40/63 OR G16H15/00 OR G16H10/20 OR G16H20/30 OR G16H20/10 OR G16H70/60 OR G16H40/67 OR G16H80/00 OR G16H50/50 OR G16H20/70 OR G16H40/20 OR	(US-PGPUB; USPAT)	OR	ON	ON	2025/05/22 10:26 AM

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		G16H30/40 OR G16H30/20 OR G16H20/00 OR G16H70/00 OR G16H20/60 OR G16H10/40 OR G16H20/40 OR G16H70/40 OR G16H20/17 OR G16H50/80 OR G16H30/00 OR G16H40/40 OR G16H20/13 OR G16H10/00 OR G16H10/65 OR G16H20/90 OR G06F16/951 OR G06F16/9535 OR G06F16/9538 OR G06F16/24578 OR G06F16/00 OR G06F16/2282 OR G06F16/24575 OR G06F16/285 OR G06F16/955 OR G06F40/30 OR G06F16/3329 OR G06F16/288 OR G06F16/2264 OR G06F40/295 OR G06F40/20 OR G06F3/0482 OR G06F40/169 OR G06F40/279 OR G06F21/6245 OR G06F16/345 OR G06F16/9024 OR G06F21/31 OR G06F8/34 OR G06F9/453 OR G06F40/237 OR G06F16/367 OR G06F3/04842 OR G06F40/35 OR G06F16/36 OR G06F18/214 OR G06F18/2148 OR G06F40/40 OR G06F16/2468 OR G06F18/217 OR G06F16/248 OR G06F16/55 OR G06F21/6254 OR G06F3/04817 OR G06F30/27 OR G06F16/2455 OR G06F16/2465 OR G06F16/25 OR					

		G06F16/258 OR G06F16/322 OR G06F16/35 OR G06F16/904 OR G06F17/11 OR G06F17/18 OR G06F18/10 OR G06F18/22 OR G06F18/23 OR G06F18/2323 OR G06F18/24 OR G06F18/2413 OR G06F18/24155 OR G06F18/24323 OR G06F18/40 OR G06F21/604 OR G06F21/62 OR G06F21/6218 OR G06F21/64 OR G06F21/76 OR G06F2221/2113 OR G06F2221/2145 OR G06F3/0483 OR G06F3/0488 OR G06F3/0489 OR G06F40/205 OR G06F40/211 OR G06F40/253 OR G06F40/284 OR G06F9/543 OR G06F9/547 OR G06F11/3409 OR G06F16/164 OR G06F16/182 OR G06F16/21 OR G06F16/22 OR G06F16/2237 OR G06F16/2246 OR G06F16/2428 OR G06F16/24558 OR G06F16/27 OR G06F16/28 OR G06F16/93 OR G06F16/954 OR G06F16/9577 OR G06F18/21 OR G06F18/2113 OR G06F18/23213 OR G06F18/241 OR G06F18/2411 OR G06F18/251 OR G06F18/295 OR G06F21/45 OR G06F3/048 OR G06F3/167 OR G06F40/174 OR G06F40/186 OR G06F40/232 OR					

		G06F40/247 OR G06F40/56 OR G06F40/00).cpc.)					

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

Bibliographic Data

Application No: 19/092,400

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☐ No ☐ Met After Allowance

Verified and Acknowledged: /LEONARD SAINT-CYR/ Examiner's Signature | Initials

Title: TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
03/27/2025	704	2658	RCVRP002C1C5
RULE			

APPLICANTS

Evidium, Inc., San Francisco, CA, UNITED STATES

INVENTORS

Carl BATE, San Francisco, CA, UNITED STATES

Wian STIPP, San Francisco, CA, UNITED STATES

Thomas UNGER, Tiburon, CA, UNITED STATES

David A. EPSTEIN, Croton-on-Hudson, NY, UNITED STATES

Matthew MCSORLEY, Pittsburgh, PA, UNITED STATES

Fady NAKHLA, San Francisco, CA, UNITED STATES

David ROBINSON, Santa Cruz, CA, UNITED STATES

Jennifer May LEE, London, UNITED KINGDOM

Arthur BÖÖK, San Francisco, CA, UNITED STATES

CONTINUING DATA

This application is a CON of 18446954 08/09/2023

18446954 is a CON of 18135026 04/14/2023 PAT 11869674

18135026 has PRO of 63331526 04/15/2022

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04/30/2025

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Making sense of symptoms, clinicians and systems: a qualitative evaluation of a **facilitated support** group for patients with medically unexplained symptoms [PDF] springer.com

M Marcinow, J Sandercock, C D'Silva, D Daien… - BMC family …, 2021 - Springer

… Our findings show that a **facilitated support** group may provide additional forms of **support** and … Individuals without a **medical diagnosis** and 'socially accepted' biomedical explanation …

Save Cite Cited by 10 Related articles All 14 versions

"Appropriate" **diagnostic** testing: supporting **diagnostics** with evidence-based **medicine** and shared decision making [PDF] springer.com

JJZ Polaris, JN Katz - BMC research notes, 2014 - Springer

… **Diagnosis** should be similarly holistic: we urge clinicians to "… and **facilitate** conversations with providers[4–6]. These aids could potentially be incorporated into clinical decision **support** …

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Improving **diagnosis** in **health** care

JR Ball, BT Miller, EP Balogh - 2015 - books.google.com

… care professionals need to be well prepared and **supported** to engage in **diagnostic** … are concerned that **health** IT currently is not effectively **facilitating** the **diagnostic** process and may …

Save Cite Cited by 1064 Related articles All 7 versions

[HTML] A new approach to **medical diagnostic** decision **support** [HTML] sciencedirect.com

GE Loeb - Journal of Biomedical Informatics, 2021 - Elsevier

… The ICD system (International Classification of Disease) started as an epidemiological tool and evolved to **facilitate** billing and reimbursement rather than differential **diagnosis**. A great …

Save Cite Cited by 14 Related articles All 5 versions

Facilitating diagnostic competences in simulations in higher education: a framework and a research agenda [PDF] publicknowledgepr…

N Heitzmann, T Seidel, A Opitz… - Frontline …, 2019 - flr.journals.publicknowledgeproject …

… However, with a better understanding of **diagnosing** and **diagnostic** competences, it … of learning to **diagnose** in simulations; these include **support** during **problem**-solving activities via …

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Eliciting user decision requirements for designing computerized **diagnostic support** for family physicians [PDF] core.ac.uk

T Porat, O Kostopoulou, A Woolley… - Journal of Cognitive …, 2016 - journals.sagepub.com

… **Facilitating** coding is important for both the acceptance of the tool by physicians and the … are making an important step in the design of patient-centered cognitive **diagnosis support**. …

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Meeting the moment: addressing barriers and **facilitating** clinical adoption of artificial intelligence in **medical diagnosis** [PDF] nih.gov

J Adler-Milstein, N Aggarwal, M Ahmed… - NAM …, 2022 - pmc.ncbi.nlm.nih.gov

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… **condition**. The art and science of clinical **diagnosis** dates to ancient times, with the earliest **diagnostic** … The authors in this paper focus on AI-DDS tools designed to **support health** care …
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Developing **medical** students' broad clinical **diagnostic** reasoning through GP-**facilitated** teaching in hospital placements [PDF] tandfonline.com
A Bansal, D Singh, J Thompson, A Kumra… - Advances in Medical …, 2020 - Taylor & Francis
… planned educational activities to **support** students' clinical **diagnostic** reasoning skills. …
Citation9 By questioning the **reasons** behind the students' proposed **diagnosis** or requested …
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Facilitating diagnostic competences in higher education—a meta-analysis in **medical** and teacher education [PDF] springer.com
O Chernikova, N Heitzmann, MC Fink… - Educational Psychology …, 2020 - Springer
… that accurate and effective **diagnosing** requires advanced **diagnostic** competences. These
… **support** on **facilitating diagnostic** competences includes primary studies from **medical** and …
Save Cite Cited by 188 Related articles All 11 versions

Patients as **diagnostic** collaborators: sharing visit notes to promote accuracy and safety
CR Blease, SK Bell - Diagnosis, 2019 - degruyter.com
… culture that **supports** the **diagnostic** process and improvements in **diagnostic** performance. …
; such feedback may also **facilitate** clinician recalibration about **diagnostic** decisions [46]. …
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
19/092,400	03/27/2025	Carl BATE	RCVRP002C1C5	6474

58766 7590 05/09/2025

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Palo Alto, CA 94303-1887

EXAMINER	
CENTRAL, DOCKET	

ART UNIT	PAPER NUMBER
OPAP	

NOTIFICATION DATE	DELIVERY MODE
05/09/2025	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

USPTOmail@beyerlaw.com

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Decision Granting Request for Prioritized Examination (Track I)	**Application No.** 19/092,400	**Applicant(s)** BATE et al.	
	Examiner FIKIRTE A GEREMEW	**Art Unit** OMBL	**AIA (FITF) Status** Yes

1. THE REQUEST FILED 27 March 2025 IS **GRANTED** .

The above-identified application has met the requirements for prioritized examination

A. ☑ for an original nonprovisional application (Track I).
B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination**. The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:

A. filing a **petition for extension of time** to extend the time period for filing a reply;

B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims** , or a multiple dependent claim;

C. filing a **request for continued examination** ;

D. filing a notice of appeal;

E. filing a request for suspension of action;

F. mailing of a notice of allowance;

G. mailing of a final Office action;

H. completion of examination as defined in 37 CFR 41.102; or

I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to FIKIRTE GEREMEW at (703) 756-1930. In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.

/FIKIRTE A GEREMEW/ PROGRAM SUPPORT SPECIALIST, OMBL	

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
19/092,400	03/27/2025		1770	RCVRP002C1C5	30	4

CONFIRMATION NO. 6474

FILING RECEIPT

58766
Beyer Law Group LLP
P. O. Box 51887
Palo Alto, CA 94303-1887

OC00000008797329

Date Mailed: 05/01/2025

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

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Inventor(s)

Carl BATE, San Francisco, CA;
Wian STIPP, San Francisco, CA;
Thomas UNGER, Tiburon, CA;
David A. EPSTEIN, Croton-on-Hudson, NY;
Matthew MCSORLEY, Pittsburgh, PA;
Fady NAKHLA, San Francisco, CA;
David ROBINSON, Santa Cruz, CA;
Jennifer May LEE, London, UNITED KINGDOM;
Arthur BÖÖK, San Francisco, CA;

Applicant(s)

Evidium, Inc., San Francisco, CA;

Power of Attorney: The patent practitioners associated with Customer Number 58766

Domestic Applications for which benefit is claimed

This application is a CON of 18/446,954 08/09/2023
which is a CON of 18/135,026 04/14/2023 PAT 11,869,674
which claims benefit of 63/331,526 04/15/2022

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) **- None.**
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

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Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 04/30/2025
The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 19/092,400**
Projected Publication Date: 08/07/2025
Non-Publication Request: No
Early Publication Request: No
**** SMALL ENTITY ****
Title

TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 19/092,400

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	70		N/A	
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A	308		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	352		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	30 minus 20 =	* 10	x 80 =	800	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	4 minus 3 =	* 1	x 240 =	240			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	1770		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☑ United States application or PCT international application number 18/446,954

filed on August 9, 2023.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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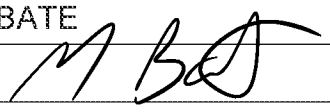
LEGAL NAME OF INVENTOR

Inventor: Carl BATE Date (Optional): 3/6/24

Signature: 

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

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Title of Invention	TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☑ United States application or PCT international application number 18/135,026 filed on April 14, 2023.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

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LEGAL NAME OF INVENTOR

Inventor: Wian STIPP Date (Optional): 04-17-2023

Signature: wstipp

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

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This declaration is directed to:

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- ☑ United States application or PCT international application number 18/135,026 filed on April 14, 2023.

The above-identified application was made or authorized to be made by me.

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Text

LEGAL NAME OF INVENTOR

Inventor: Thomas UNGER Date (Optional): April 16, 2023

Signature:

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LEGAL NAME OF INVENTOR

Inventor: David A. EPSTEIN Date (Optional): 4/15/2023

Signature: David A. Epstein

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

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The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

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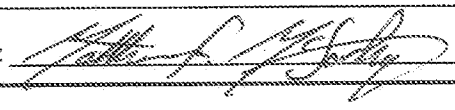
LEGAL NAME OF INVENTOR

Inventor: Matthew MCSORLEY Date (Optional): 04/28/2023

Signature: 

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LEGAL NAME OF INVENTOR

Inventor: Fady NAKHLA Date (Optional): 04-24-2023

Signature: *Fady Nakhla*

Note: An application data sheet (PTO/AIA/14 or equivalent), including naming the entire inventive entity, must accompany this form. Use an additional PTO/SB/AIA01 form for each additional inventor.

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The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

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LEGAL NAME OF INVENTOR

Inventor: David ROBINSON Date (Optional) :

Signature: David Robinson

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☑ United States application or PCT international application number 18/135,026 filed on April 14, 2023.

The above-identified application was made or authorized to be made by me.

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LEGAL NAME OF INVENTOR

Inventor: Jennifer May LEE Date (Optional) :

Signature: JMLee

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LEGAL NAME OF INVENTOR

Inventor: Arthur BÖÖK Date (Optional): 19 Apr 2023

Signature: _____

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(71) Applicants: **AI TECHNOLOGIES INC.** [GB/GB]; P.O. Box 2075, #31 The Strand, 46 Canal Point Drive, Grand Cayman, KY1-1105 (KY). **THE REGENTS OF THE UNIVERSITY OF CALIFORNIA** [US/US]; 1111 Franklin Street, 12th Floor, Oakland, California 94607-5200 (US).

(72) Inventors: **ZHANG, Kang**; 14329 San Dieguito Road, San Diego, California 92130 (US). **LI, Zhihuan**; Jinghu Chunxiao, Building 42, Unit 2, Room 1302, No. 2, Dongjun Road, Dongcheng District, Dongguan City, Guangdong 523000 (CN). **ZHENG, Lianghong**; #17, Hunnan District, Pujiangyuan, Shenyang, Liaoning 110000 (CN).

(74) Agent: **DENG, Qiming**; Wilson Sonsini Goodrich & Rosati, 650 Page Mill Road, Palo Alto, California 94304 (US).

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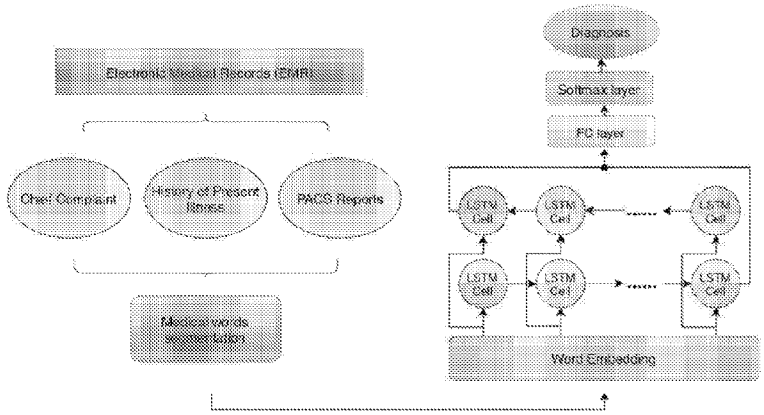
(54) Title: DEEP LEARNING-BASED DIAGNOSIS AND REFERRAL OF DISEASES AND DISORDERS USING NATURAL LANGUAGE PROCESSING

FIG. 5



(57) Abstract: Disclosed herein are methods and systems for Artificial Intelligence (AI)-based methods for performing medical diagnosis of diseases and conditions. An automated natural language processing (NLP) system performs deep learning techniques to extract clinically relevant information from electronic health records (EHRs). This framework provides a high diagnostic accuracy that demonstrates a successful AI-based method for systematic disease diagnosis and management.

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[Continuing on next page]

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Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

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DEEP LEARNING-BASED DIAGNOSIS AND REFERRAL OF DISEASES AND DISORDERS USING NATURAL LANGUAGE PROCESSING

CROSS-REFERENCE

[0001] This application claims the benefit of U.S. Provisional Application No. 62/692,572, filed June 29, 2018, U.S. Provisional Application No. 62/749,612, filed October 23, 2018, and U.S. Provisional Application No. 62/783,962, filed December 21, 2018, which each of the applications is incorporated herein by reference in its entirety.

BACKGROUND OF THE DISCLOSURE

[0002] Medical information has become increasingly complex over time. The range of disease entities, diagnostic testing and biomarkers, and treatment modalities has increased exponentially in recent years. Subsequently, clinical decision-making has also become more complex and demands the synthesis of numerous data points.

SUMMARY OF THE DISCLOSURE

[0003] In the current digital age, the electronic health record (EHR) represents a massive repository of electronic data points representing a diverse array of clinical information. Disclosed herein are Artificial intelligence (AI) methods that provide powerful tools to mine and utilize EHR data for disease diagnosis and management, which can mimic and/or augment the clinical decision-making of human physicians.

[0004] To formulate a diagnosis for any given patient, physicians frequently use hypothetical deductive reasoning. Starting with the chief complaint, the physician then asks appropriately targeted questions relating to that complaint. From this initial small feature set, the physician forms a differential diagnosis and decides what feature (historical questions, physical exam findings, laboratory testing, and/or imaging studies) to obtain next to rule in or rule out the diagnoses in the differential diagnosis set. The most useful features are identified, such that when the probability of one of the diagnoses reaches a predetermined level of acceptability, the process is stopped, and the diagnosis is accepted. It may be possible to achieve an acceptable level of certainty of the diagnosis with only a few features without having to process the entire feature set. Therefore, the physician can be considered a classifier of sorts.

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[0005] Described herein is an AI-based system using machine learning to extract clinically relevant features from EHR notes to mimic the clinical reasoning of human physicians. In medicine, machine learning methods have been generally limited to image-based diagnoses, but analysis of EHR data presents a number of difficult challenges. These challenges include the vast quantity of data, the use of unstructured text, the complexity of language processing, high dimensionality, data sparsity, the extent of irregularity (noise), and deviations or systematic errors in medical data. Furthermore, the same clinical phenotype can be expressed as multiple different codes and terms. These challenges make it difficult to use machine learning methods to perform accurate pattern recognition and generate predictive clinical models. Conventional approaches typically require expert knowledge and are labor-intensive, which make it difficult to scale and generalize, or are sparse, noisy, and repetitive. The machine learning methods described herein can overcome these limitations.

[0006] Described herein are systems and methods utilizing a data mining framework for EHR data that integrates prior medical knowledge and data-driven modeling. In some embodiments, an automated deep learning-based language processing system is developed and utilized to extract clinically relevant information. In some embodiments, a diagnostic system is established based on extracted clinical features. In some embodiments, this framework is applied to the diagnosis of diseases such as pediatric diseases. This approach was tested in a large pediatric population to investigate the ability of AI-based methods to automate natural language processing methods across a large number of patient records and additionally across a diverse range of conditions.

[0007] The present disclosure solves various technical problems of automating analysis and diagnosis of diseases based on EHRs. The systems and methods described herein resolve the technical challenges discussed herein by extracting semantic data using an information model, identifying clinically relevant features using deep learning-based language processing, and utilizing the features to successfully classify or diagnose diseases.

[0008] The technological solutions to the technological problem of effectively implementing computer-based algorithmic disease diagnosis using electronic health records described herein opens up the previously unrealized potential of machine learning techniques to revolutionize EHR-based analysis and diagnosis.

[0009] Disclosed herein is a method for providing a medical diagnosis, comprising: obtaining medical data; using a natural language processing (NLP) information extraction model to extract and annotate clinical features from the medical data; and analyzing at least

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one of the clinical features with a disease prediction classifier to generate a classification of a disease or disorder, the classification having a sensitivity of at least 80%. In some embodiments, the NLP information extraction model comprises a deep learning procedure. In some embodiments, the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes. In some embodiments, the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value. In some embodiments, the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. In some embodiments, the method comprises tokenizing the medical data for processing by the NLP information extraction model. In some embodiments, the medical data comprises an electronic health record (EHR). In some embodiments, the classification has a specificity of at least 80%. In some embodiments, the classification has an F1 score of at least 80%. In some embodiments, the clinical features are extracted in a structured format comprising data in query-answer pairs. In some embodiments, the disease prediction classifier comprises a logistic regression classifier. In some embodiments, the disease prediction classifier comprises a decision tree. In some embodiments, the classification differentiates between a serious and a non-serious condition. In some embodiments, the classification comprises at least two levels of categorization. In some embodiments, the classification comprises a first level category indicative of an organ system. In some embodiments, the classification comprises a second level indicative of a subcategory of the organ system. In some embodiments, the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. In some embodiments, the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases. In some embodiments, the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. In some embodiments, the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. In some embodiments, the classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. In some embodiments, the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. In some embodiments, the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial

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meningitis, encephalitis, or convulsions. In some embodiments, the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum. In some embodiments, the method further comprises making a medical treatment recommendation based on the classification.

[0010] Disclosed herein is non-transitory computer-readable medium comprising machine-executable code that, upon execution by one or more computer processors, implements a method for providing a classification of a disease or disorder, the method comprising: obtaining medical data; using a natural language processing (NLP) information extraction model to extract and annotate clinical features from the medical data; and analyzing at least one of the clinical features with a disease prediction classifier to generate the classification of a disease or disorder, the classification having a sensitivity of at least 80%. In some embodiments, the NLP information extraction model comprises a deep learning procedure. In some embodiments, the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes. In some embodiments, the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value. In some embodiments, the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. In some embodiments, the method comprises tokenizing the medical data for processing by the NLP information extraction model. In some embodiments, the medical data comprises an electronic health record (EHR). In some embodiments, the classification has a specificity of at least 80%. In some embodiments, the classification has an F1 score of at least 80%. In some embodiments, the clinical features are extracted in a structured format comprising data in query-answer pairs. In some embodiments, the disease prediction classifier comprises a logistic regression classifier. In some embodiments, the disease prediction classifier comprises a decision tree. In some embodiments, the classification differentiates between a serious and a non-serious condition. In some embodiments, the classification comprises at least two levels of categorization. In some embodiments, the classification comprises a first level category indicative of an organ system. In some embodiments, the classification comprises a second level indicative of a subcategory of the organ system. In some embodiments, the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. In some embodiments, the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases,

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neuropsychiatric diseases, and systemic generalized diseases. In some embodiments, the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. In some embodiments, the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. In some embodiments, the classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. In some embodiments, the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. In some embodiments, the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions. In some embodiments, the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum. In some embodiments, the method further comprises making a medical treatment recommendation based on the classification.

[0011] Disclosed herein is a computer-implemented system comprising: a digital processing device comprising: at least one processor, an operating system configured to perform executable instructions, a memory, and a computer program including instructions executable by the digital processing device to create an application for providing a medical diagnosis, the application comprising: a software module obtaining medical data; a software module using a natural language processing (NLP) information extraction model to extract and annotate clinical features from the medical data; and a software module analyzing at least one of the clinical features with a disease prediction classifier to generate the classification of a disease or disorder, the classification having a sensitivity of at least 80%. In some embodiments, the NLP information extraction model comprises a deep learning procedure. In some embodiments, the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes. In some embodiments, the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value. In some embodiments, the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. In some embodiments, the system further comprises a software module tokenizing the medical data for processing by the NLP information extraction model. In some embodiments, the medical data comprises an electronic health record (EHR). In some embodiments, the classification has a specificity of at least 80%. In

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some embodiments, the classification has an F1 score of at least 80%. In some embodiments, the clinical features are extracted in a structured format comprising data in query-answer pairs. In some embodiments, the disease prediction classifier comprises a logistic regression classifier. In some embodiments, the disease prediction classifier comprises a decision tree. In some embodiments, the classification differentiates between a serious and a non-serious condition. In some embodiments, the classification comprises at least two levels of categorization. In some embodiments, the classification comprises a first level category indicative of an organ system. In some embodiments, the classification comprises a second level indicative of a subcategory of the organ system. In some embodiments, the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. In some embodiments, the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases. In some embodiments, the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. In some embodiments, the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. In some embodiments, the classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. In some embodiments, the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. In some embodiments, the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions. In some embodiments, the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum. In some embodiments, the method further comprises making a medical treatment recommendation based on the classification.

[0012] In another aspect, disclosed herein is a computer-implemented method for generating a disease prediction classifier for providing a medical diagnosis, comprising: a) providing a lexicon constructed based on medical texts, wherein the lexicon comprises keywords relating to clinical information; b) obtaining medical data comprising electronic health records (EHRs); c) extracting clinical features from the medical data using an NLP information extraction model; d) mapping the clinical features to hypothetical clinical queries to generate question-answer pairs; and e) training the NLP classifier using the question-

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answer pairs, wherein the NLP classifier is configured to generate classifications having a sensitivity of at least 80% when tested against an independent dataset of at least 100 EHRs. In some embodiments, the NLP information extraction model comprises a deep learning procedure. In some embodiments, the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes. In some embodiments, the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value. In some embodiments, the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. In some embodiments, the method comprises tokenizing the medical data for processing by the NLP information extraction model. In some embodiments, the medical data comprises an electronic health record (EHR). In some embodiments, the classification has a specificity of at least 80%. In some embodiments, the classification has an F1 score of at least 80%. In some embodiments, the clinical features are extracted in a structured format comprising data in query-answer pairs. In some embodiments, the disease prediction classifier comprises a logistic regression classifier. In some embodiments, the disease prediction classifier comprises a decision tree. In some embodiments, the classification differentiates between a serious and a non-serious condition. In some embodiments, the classification comprises at least two levels of categorization. In some embodiments, the classification comprises a first level category indicative of an organ system. In some embodiments, the classification comprises a second level indicative of a subcategory of the organ system. In some embodiments, the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. In some embodiments, the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases. In some embodiments, the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. In some embodiments, the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. In some embodiments, the classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. In some embodiments, the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. In some embodiments, the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial

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[0013] In another aspect, disclosed herein is a non-transitory computer-readable medium comprising machine-executable code that, upon execution by one or more computer processors, implements a method for generating a natural language processing (NLP) classifier for providing a classification of a disease or disorder, the method comprising: a) providing a lexicon constructed based on medical texts, wherein the lexicon comprises keywords relating to clinical information; b) obtaining medical data comprising electronic health records (EHRs); c) extracting clinical features from the medical data using an NLP information extraction model; d) mapping the clinical features to hypothetical clinical queries to generate question-answer pairs; and e) training the NLP classifier using the question-answer pairs, wherein the NLP classifier is configured to generate classifications having a sensitivity of at least 80% when tested against an independent dataset of at least 100 EHRs. In some embodiments, the NLP information extraction model comprises a deep learning procedure. In some embodiments, the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes. In some embodiments, the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value. In some embodiments, the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. In some embodiments, the method comprises tokenizing the medical data for processing by the NLP information extraction model. In some embodiments, the medical data comprises an electronic health record (EHR). In some embodiments, the classification has a specificity of at least 80%. In some embodiments, the classification has an F1 score of at least 80%. In some embodiments, the clinical features are extracted in a structured format comprising data in query-answer pairs. In some embodiments, the disease prediction classifier comprises a logistic regression classifier. In some embodiments, the disease prediction classifier comprises a decision tree. In some embodiments, the classification differentiates between a serious and a non-serious condition. In some embodiments, the classification comprises at least two levels of categorization. In some embodiments, the classification comprises a first level category indicative of an organ system. In some embodiments, the classification comprises a second level indicative of a

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subcategory of the organ system. In some embodiments, the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. In some embodiments, the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases. In some embodiments, the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. In some embodiments, the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. In some embodiments, the classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. In some embodiments, the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. In some embodiments, the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions. In some embodiments, the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum. In some embodiments, the method further comprises making a medical treatment recommendation based on the classification.

[0014] In another aspect, disclosed herein is a computer-implemented system comprising: a digital processing device comprising: at least one processor, an operating system configured to perform executable instructions, a memory, and a computer program including instructions executable by the digital processing device to create an application for generating a disease prediction classifier for providing a medical diagnosis, the application comprising: a) a software module for providing a lexicon constructed based on medical texts, wherein the lexicon comprises keywords relating to clinical information; b) a software module for obtaining medical data comprising electronic health records (EHRs); c) a software module for extracting clinical features from the medical data using an NLP information extraction model; d) a software module for mapping the clinical features to hypothetical clinical queries to generate question-answer pairs; and e) a software module for training the NLP classifier using the question-answer pairs, wherein the NLP classifier is configured to generate classifications having a sensitivity of at least 80% when tested against an independent dataset of at least 100 EHRs. In some embodiments, the NLP information extraction model comprises a deep learning procedure. In some embodiments, the NLP information extraction

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model utilizes a standard lexicon comprising keywords representative of assertion classes. In some embodiments, the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value. In some embodiments, the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. In some embodiments, the method comprises tokenizing the medical data for processing by the NLP information extraction model. In some embodiments, the medical data comprises an electronic health record (EHR). In some embodiments, the classification has a specificity of at least 80%. In some embodiments, the classification has an F1 score of at least 80%. In some embodiments, the clinical features are extracted in a structured format comprising data in query-answer pairs. In some embodiments, the disease prediction classifier comprises a logistic regression classifier. In some embodiments, the disease prediction classifier comprises a decision tree. In some embodiments, the classification differentiates between a serious and a non-serious condition. In some embodiments, the classification comprises at least two levels of categorization. In some embodiments, the classification comprises a first level category indicative of an organ system. In some embodiments, the classification comprises a second level indicative of a subcategory of the organ system. In some embodiments, the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. In some embodiments, the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases. In some embodiments, the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. In some embodiments, the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. In some embodiments, the classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. In some embodiments, the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. In some embodiments, the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions. In some embodiments, the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum. In some

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embodiments, the method further comprises making a medical treatment recommendation based on the classification.

[0015] In another aspect, disclosed herein is a digital processing device comprising: at least one processor, an operating system configured to perform executable instructions, a memory, and a computer program including instructions executable by the digital processing device to create an application for generating a disease prediction classifier for providing a medical diagnosis, the application comprising: a) a software module for providing a lexicon constructed based on medical texts, wherein the lexicon comprises keywords relating to clinical information; b) a software module for obtaining medical data comprising electronic health records (EHRs); c) a software module for extracting clinical features from the medical data using an NLP information extraction model; d) a software module for mapping the clinical features to hypothetical clinical queries to generate question-answer pairs; and e) a software module for training the NLP classifier using the question-answer pairs, wherein the NLP classifier is configured to generate classifications having a sensitivity of at least 80% when tested against an independent dataset of at least 100 EHRs. In some embodiments, the NLP information extraction model comprises a deep learning procedure. In some embodiments, the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes. In some embodiments, the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value. In some embodiments, the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. In some embodiments, the method comprises tokenizing the medical data for processing by the NLP information extraction model. In some embodiments, the medical data comprises an electronic health record (EHR). In some embodiments, the classification has a specificity of at least 80%. In some embodiments, the classification has an F1 score of at least 80%. In some embodiments, the clinical features are extracted in a structured format comprising data in query-answer pairs. In some embodiments, the disease prediction classifier comprises a logistic regression classifier. In some embodiments, the disease prediction classifier comprises a decision tree. In some embodiments, the classification differentiates between a serious and a non-serious condition. In some embodiments, the classification comprises at least two levels of categorization. In some embodiments, the classification comprises a first level category indicative of an organ system. In some embodiments, the classification comprises a second level indicative of a subcategory of the organ system. In some embodiments, the classification comprises a

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diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. In some embodiments, the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases. In some embodiments, the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. In some embodiments, the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. In some embodiments, the classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. In some embodiments, the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. In some embodiments, the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions. In some embodiments, the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum. In some embodiments, the method further comprises making a medical treatment recommendation based on the classification.

INCORPORATION BY REFERENCE

[0016] All publications, patents, and patent applications mentioned in this specification are herein incorporated by reference to the same extent as if each individual publication, patent, or patent application was specifically and individually indicated to be incorporated by reference.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The patent or application file contains at least one drawing executed in color. Copies of this patent or patent application publication with color drawing(s) will be provided by the Office upon request and payment of the necessary fee.

[0018] A better understanding of the features and advantages of the present invention will be obtained by reference to the following detailed description that sets forth illustrative embodiments, in which the principles of the invention are utilized, and the accompanying drawings of which:

[0019] **FIG. 1** shows the results of unsupervised clustering of pediatric diseases.

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[0020] **FIG. 2** shows an example of a workflow diagram for data extraction, analysis, and diagnosis.

[0021] **FIG. 3** shows an example of a hierarchy of the diagnostic framework in a large pediatric cohort.

[0022] **FIG. 4** shows a flow chart illustrating extraction of relevant information from an input EHR sentence segment to generate question-answer query-answer pairs using a LSTM model.

[0023] **FIG. 5** shows a workflow diagram that depicts an embodiment of the hybrid natural language processing and machine learning AI-based system.

[0024] **FIGs. 6A-6D** shows the diagnostic efficiencies and model performance for GMU1 adult data and GWCMC1 pediatric data. **FIG. 6A** shows a convolutional table showing diagnostic efficiencies across adult populations. **FIG. 6B** shows an ROC-AUC curve for model performance across adult populations. **FIG. 6C** shows a convolutional table showing diagnostic efficiencies across pediatric populations. **FIG. 6D** shows an ROC-AUC curve for model performance across pediatric populations.

[0025] **FIGs. 7A-7D** shows the diagnostic efficiencies and model performance for GMU2 adult data and GWCMC2 pediatric data. **FIG. 7A** shows a convolutional table showing diagnostic efficiencies across adult populations. **FIG. 7B** shows an ROC-AUC curve for model performance across adult populations. **FIG. 7C** shows a convolutional table showing diagnostic efficiencies across pediatric populations. **FIG. 7D** shows an ROC-AUC curve for model performance across pediatric populations.

[0026] **FIGs. 8A-8F** shows Comparison of Hierarchical Diagnosis Approach (right) versus end-to-end approach in pediatric respiratory diseases (left). FIGs. 8A-8C shows an end-to-end approach. **FIG. 8A** depicts a confusion table showing diagnostic efficiencies between upper and lower respiratory systems in pediatric patients. **FIG. 8B** depicts a confusion table showing diagnostic efficiencies in top four upper-respiratory diseases. **FIG. 8C** shows a confusion table showing diagnostic efficiencies in top six lower-respiratory diseases. **FIGs. 8D-8F** show a hierarchical diagnostic approach. **FIG. 8D** depicts a confusion table showing diagnostic efficiencies for upper and lower respiratory systems in pediatric patients. **FIG. 8E** depicts a confusion table showing diagnostic efficiencies in top four upper-respiratory diseases. **FIG. 8F** depicts a confusion table showing diagnostic efficiencies in top six lower-respiratory diseases.

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[0027] **FIG. 9** shows an example of free-text document record of an endocrinological and metabolic disease case that can be used in segmentation.

[0028] **FIGs. 10A-10D** shows model performance over time with percent classification and loss over number of epochs in adult and pediatric internal validations.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0029] It is recognized that implementation of clinical decision support algorithms for medical imaging with improved reliability and clinical interpretability can be achieved through one or combinations of technical features of the present disclosure. According to some aspects, disclosed herein is a diagnostic tool to correctly identify diseases or disorders by presenting a machine learning framework developed for diseases or conditions such as common and dangerous pediatric disorders. In some embodiments, the machine learning framework utilizes deep learning models such as artificial neural networks. In some embodiments, the model disclosed herein generalizes and performs well on many medical classification tasks. This framework can be applied towards medical data such as electronic health records. Certain embodiments of this approach yield superior performance across many types of medical records.

Medical Data

[0030] In certain aspects, the machine learning framework disclosed herein is used for analyzing medical data. In some embodiments, the medical data comprises electronic health records (EHRs). In some embodiments, an EHR is a digital version of a paper chart used in a clinician's office. In some embodiments, an EHR comprises the medical and treatment history of a patient. In some embodiments, an EHR allows patient data to be tracked over time.

[0031] In some embodiments, medical data comprises patient information such as identifying information, age, sex or gender, race or ethnicity, weight, height, body mass index (BMI), heart rate (e.g. ECG and/or peripheral pulse rate), blood pressure, body temperature, respiration rate, past checkups, treatments or therapies, drugs administered, observations, vaccinations, current and/or past symptoms (e.g. fever, vomiting, cough, etc.), known health conditions (e.g. allergies), known diseases or disorders, health history (e.g. past diagnoses), lab test results (e.g. blood test), lab imaging results (e.g. X-rays, MRIs, etc.), genetic information (e.g. known genetic abnormalities associated with disease), family medical history, or any combination thereof. The framework described herein is applicable to various types of medical data in addition to EHRs.

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Machine Learning

[0032] In certain aspects, disclosed herein are machine learning frameworks for generating models or classifiers that diagnose, predict, or classify one or more disorders or conditions. In some embodiments, disclosed herein is a classifier diagnosing one or more disorders or conditions based on medical data such as an electronic health record (EHR). In some embodiments, the medical data comprises one or more clinical features entered or uploaded by a user. In some embodiments, the classifier exhibits higher sensitivity, specificity, and/or AUC for an independent sample set compared to an average human clinician (e.g. an average clinician). In some embodiments, the classifier provides a sensitivity (true positive rate) of at least about 0.7, about 0.75, about 0.8, about 0.85, about 0.9, about 0.95, or about 0.99 and/or a specificity (true negative rate) of at least about 0.7, about 0.75, about 0.8, about 0.85, about 0.9, about 0.95, or about 0.99 when tested against at least 100, 200, 300, 400, 500, 600, 700, 800, 900, or 1000 independent samples (e.g. an EHR or medical data entered by a clinician). In some embodiments, the classifier has an AUC of at least about 0.7, about 0.75, about 0.8, about 0.85, about 0.9, about 0.95, or about 0.99 when tested against at least 100, 200, 300, 400, 500, 600, 700, 800, 900, or 1000 independent samples.

[0033] Various algorithms can be used to generate models that generate a prediction based on the input data (e.g., EHR information). In some instances, machine learning methods are applied to the generation of such models (e.g. trained classifier). In some embodiments, the model is generated by providing a machine learning algorithm with training data in which the expected output is known in advance.

[0034] In some embodiments, the systems, devices, and methods described herein generate one or more recommendations such as treatment and/or healthcare options for a subject. In some embodiments, the one or more treatment recommendations are provided in addition to a diagnosis or detection of a disease or condition. In some embodiments, a treatment recommendation is a recommended treatment according to standard medical guidelines for the diagnosed disease or condition. In some embodiments, the systems, devices, and methods herein comprise a software module providing one or more recommendations to a user. In some embodiments, the treatment and/or healthcare option are specific to the diagnosed disease or condition.

[0035] In some embodiments, a classifier or trained machine learning algorithm of the present disclosure comprises a feature space. In some cases, the classifier comprises two or more feature spaces. The two or more feature spaces may be distinct from one another. In some embodiments, a feature space comprises information such as formatted and/or

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processed EHR data. When training the machine learning algorithm, training data such as EHR data is input into the algorithm which processes the input features to generate a model. In some embodiments, the machine learning algorithm is provided with training data that includes the classification (e.g., diagnostic or test result), thus enabling the algorithm to train by comparing its output with the actual output to modify and improve the model. This is often referred to as supervised learning. Alternatively, in some embodiments, the machine learning algorithm can be provided with unlabeled or unclassified data, which leaves the algorithm to identify hidden structure amongst the cases (referred to as unsupervised learning). Sometimes, unsupervised learning is useful for identifying the features that are most useful for classifying raw data into separate cohorts.

[0036] In some embodiments, one or more sets of training data are used to train a machine learning algorithm. Although exemplar embodiments of the present disclosure include machine learning algorithms that use convolutional neural networks, various types of algorithms are contemplated. In some embodiments, the algorithm utilizes a predictive model such as a neural network, a decision tree, a support vector machine, or other applicable model. In some embodiments, the machine learning algorithm is selected from the group consisting of a supervised, semi-supervised and unsupervised learning, such as, for example, a support vector machine (SVM), a Naïve Bayes classification, a random forest, an artificial neural network, a decision tree, a K-means, learning vector quantization (LVQ), self-organizing map (SOM), graphical model, regression algorithm (e.g., linear, logistic, multivariate, association rule learning, deep learning, dimensionality reduction and ensemble selection algorithms. In some embodiments, the machine learning algorithm is selected from the group consisting of: a support vector machine (SVM), a Naïve Bayes classification, a random forest, and an artificial neural network. Machine learning techniques include bagging procedures, boosting procedures, random forest algorithms, and combinations thereof. Illustrative algorithms for analyzing the data include but are not limited to methods that handle large numbers of variables directly such as statistical methods and methods based on machine learning techniques. Statistical methods include penalized logistic regression, prediction analysis of microarrays (PAM), methods based on shrunken centroids, support vector machine analysis, and regularized linear discriminant analysis.

Unsupervised Diagnostic Grouping

[0037] Disclosed herein are systems and methods utilizing unsupervised clustering to identify trends in clinical features. In some embodiments, the EHR(s) are analyzed in the absence of a defined classification system with human input. In some embodiments, trends in

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clinical features were detected in the absence of pre-defined labeling in order to generate a grouping structure such as shown in **FIG. 1**. In some embodiments, at least some of the diagnoses that were clustered together had related ICD-10 codes. This reflects the ability to detect trends in clinical features that align with a human-defined classification system. In some embodiments, at least some of the related diagnoses (e.g. based on ICD-10 codes) were clustered together, but did not include other similar diagnoses within this cluster.

Medical Record Reformatting Using Natural Language Processing

[0038] Disclosed herein are systems and methods utilizing natural language processing to extract the key concepts and/or features from medical data. In some embodiments, the NLP framework comprises at least one of the following: 1) lexicon construction, 2) tokenization, 3) word embedding, 4) schema construction, and 5) sentence classification using Long Short Term Memory (LSTM) architecture. In some embodiments, medical charts are manually annotated using a schema. In some embodiments, the annotated charts are used to train a NLP information extraction model. In some embodiments, a subset of the annotated charts are withheld from the training set and used to validate the model. In some embodiments, the information extraction model summarized the key conceptual categories representing clinical data (**FIG. 2**). In some embodiments, the NLP model utilizes deep learning techniques to automate the annotation of the free text EHR notes into a standardized lexicon. In some embodiments, the NLP model allows further processing of the standardized data for diagnostic classification.

[0039] In some embodiments, an information extraction model was generated for summarizing the key concepts and associated categories used in representing reformatted clinical data (Supplementary Table 1). In some embodiments, the reformatted chart groups the relevant symptoms into categories. This has the benefit of increased transparency by showing the exact features that the model relies on to make a diagnosis. In some embodiments, the schemas are curated and validated by physician(s) and/or medical experts. In some embodiments, the schemas include at least one of chief complaint, history of present illness, physical examination, and lab reports.

[0040] Lexicon construction

[0041] In some embodiments, an initial lexicon is developed based on history of present illness (HPI) narratives presented in standard medical texts. In some embodiments, the lexicon is enriched by manually reading sentences in the training data (e.g. 1% of each class, consisting of over 11,967 sentences) and selecting words representative of the assertion classes. In some embodiments, the keywords are curated by physicians. In some

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embodiments, the keywords are optionally generated by using a medical dictionary such as the Chinese medical dictionary (e.g. the Unified Medical Language System, or UMLS16). In some embodiments, the errors in the lexicon are revised according to physicians' clinical knowledge and experience, as well as expert consensus guidelines. In some embodiments, the lexicon is revised based on information derived from board-certified internal medicine physicians, informaticians, health information management professionals, or any combination thereof. In some embodiments, this procedure is iteratively conducted until no new concepts of HPI and PE are found.

[0042] Schema design

[0043] In some embodiments, an information schema is a rule-based synthesis of medical knowledge and/or physician experience. In some embodiments, once the schema is fixed, the information that natural language processing can obtain from the medical records is also fixed.In some embodiments, schema comprises question-and-answer pairs. In some embodiments, the question-and-answer pairs are physician curated. In some embodiments, the curated question-and-answer pairs are used by the physician(s) in extracting symptom information towards making a diagnosis. Examples of questions are the following: *Is patient having a fever?*, *Is the patient coughing?*, etc. The answer consists of a key_location and a numeric feature. The key_location encodes anatomical locations such as lung, gastrointestinal tract, etc.

[0044] In some embodiments, the value is either a categorical variable or a binary number depending on the feature type. In some embodiments, a schema is constructed for each type of medical record data such as, for example, the history of present illness and chief complaint, physical examination, laboratory tests, and radiology reports. In some embodiments, this schema is applied towards the text re-formatting model construction.

[0045] One advantage for this schema design is the increase or maximization of data interoperability across hospitals for future study. The pre-defined space of query-answers pairs simplifies the data interpolation process across EHR systems from multiple hospitals. Also, providing clinical information in reduced formats can help protect patient privacy compared to providing raw clinical notes which could be patient-identifiable. Even with removal of patient-identifiable variables, the style of writing in the EHR may potentially reveal the identity of the examining physician, as suggested by advances in stylometry tools, which could increase patient identifiability

[0046] In some embodiments, a schema comprises a group of items. In some embodiments, a schema comprises three items <item_name, key_location, value>. In some embodiments,

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the item_name is the feature name. In some embodiments, the key_location encodes anatomical locations. In some embodiments, the value consists of either free text or a binary number depending on the query type. In some embodiments, when doing pattern matching, the NLP results are assessed to check if they could match to certain schema, and the results are filled out to the fourth column of the form while the first three columns remained unchanged unchanged.

[0047] In some embodiments, a schema is constructed with the curation of physicians. In some embodiments, a schema is selected from: history of present illness, physical examination, laboratory tests, and radiology reports. In some embodiments, the chief complaint and history of present illness shared the same schema. Non-limiting embodiments of information schema are shown in Supplementary Table 1.

[0048] Tokenization and word embedding

[0049] In some embodiments, standard datasets for word segmentation are generated. This provides a solution to any lack of publicly available community annotated resources. In some embodiments, the tool used for tokenization is mecab (url: https://github.com/taku910/mecab), with the curated lexicons described herein as the optional parameter. In some embodiments, a minimum number of tokens are generated for use in the NLP framework. In some embodiments, a maximum number of tokens are generated for use in the NLP framework. In some embodiments, the NLP framework utilizes at least 500 tokens, at least 1000 tokens, at least 2000 tokens, at least 3000 tokens, at least 4000 tokens, at least 5000 tokens, at least 6000 tokens, at least 7000 tokens, at least 8000 tokens, at least 9000 tokens, or at least 10000 tokens or more. In some embodiments, the NLP framework utilizes no more than 500 tokens, no more than 1000 tokens, no more than 2000 tokens, no more than 3000 tokens, no more than 4000 tokens, no more than 5000 tokens, no more than 6000 tokens, no more than 7000 tokens, no more than 8000 tokens, no more than 9000 tokens, or no more than 10000 tokens. In some embodiments, the NLP framework described herein utilizes a number of features. In some embodiments, the features are high dimensional features. In some embodiments, the tokens are embedded with features. In some embodiments, the tokens are embedded with at least 10 features, at least 20 features, at least 30 features, at least 40 features, at least 50 features, at least 60 features, at least 70 features, at least 80 features, at least 90 features, at least 100 features, at least 120 features, at least 140 features, at least 160 features, at least 180 features, at least 200 features, at least 250 features, at least 300 features, at least 400 features, or at least 500 features. For example, word2vec

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from python Tensorflow package was used to embed 4363 tokens with 100 high dimensional features.

[0050] LSTM model training data set and testing data set construction

[0051] In some embodiments, a data set is curated for training the text classification model. In some embodiments, the query-answer pairs in the training and validation cohort are manually annotated. In some embodiments, the training data set comprises at least 500, at least 1000, at least 1500, at least 2000, at least 2500, at least 3000, at least 3500, at least 4000, at least 4500, at least 5000, at least 6000, at least 7000, at least 8000, at least 9000, or at least 10000 query-answer pairs. In some embodiments, the training data set comprises no more than 500, no more than 1000, no more than 1500, no more than 2000, no more than 2500, no more than 3000, no more than 3500, no more than 4000, no more than 4500, no more than 5000, no more than 6000, no more than 7000, no more than 8000, no more than 9000, or no more than 10000 query-answer pairs. In some embodiments, for questions with binary answers, 0/1 is used to indicate if the text gave a no/yes. For example, given the text snippet "patient has fever", query "is patient having fever?" can be assigned a value of 1. In some embodiments, for queries with categorical/numerical values, the pre-defined categorical free text answer is extracted as shown in the schema (Supplementary Table 1).

[0052] In some embodiments, the free-text harmonization process is modeled by an attention-based LSTM. In some embodiments, the model is implemented using tensorflow and trained with a number of steps. In some embodiments, the number of steps is at least 50,000, at least 75,000 steps, at least 100,000 steps, at least 125,000 steps, at least 150,000 steps, at least 175,000 steps, at least 200,000 steps, at least 250,000 steps, at least 300,000 steps, at least 400,000 steps, or at least 500,000 steps. In some embodiments, the number of steps is no more than 50,000, no more than 75,000 steps, no more than 100,000 steps, no more than 125,000 steps, no more than 150,000 steps, no more than 175,000 steps, no more than 200,000 steps, no more than 250,000 steps, no more than 300,000 steps, no more than 400,000 steps, or no more than 500,000 steps. In some embodiments, the NLP model is applied to physician notes, which have been converted into the structured format, where each structured record contained data in query-answer pairs.

[0053] A non-limiting embodiment of the NLP model demonstrates excellent results in annotation of the EHR physician notes (see Table 2 in Example 1). Across all categories of clinical data (chief complaint, history of present illness, physical examination, laboratory testing, and PACS reports), the F1 score exceeded 90% except in one instance, which was for categorical variables detected in laboratory testing. The recall of the NLP model was highest

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for physical examination (95.62% for categorical variables, 99.08% for free text), and lowest for laboratory testing (72.26% for categorical variables, 88.26% for free text). The precision of the NLP model was highest for chief complaint (97.66% for categorical variables, 98.71% for free text), and lowest for laboratory testing (93.78% for categorical variables, and 96.67% for free text). In general, the precision (or positive predictive value) of the NLP labeling was slightly greater than the recall (the sensitivity), but the system demonstrated overall strong performance across all domains.

[0054] In some embodiments, the NLP model produces annotation of the medical data sample (e.g. EHR physician notes) with a performance measured by certain metrics such as recall, precision, F1 score, and/or instances of exact matches for each category of clinical data. In some embodiments, the NLP model has an F1 score of at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% for at least one category of clinical data. In some embodiments, the NLP model produces a recall of at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% for at least one category of clinical data. In some embodiments, the NLP model produces a precision of at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% for at least one category of clinical data. In some embodiments, the NLP model produces an exact match of at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% for at least one category of clinical data. In some embodiments, the at least one category of clinical data comprises chief complaint, history of present illness, physical examination, laboratory testing, PACS report, or any combination thereof. In some embodiments, a category of clinical data comprises a classification, categorical variable(s), free text, or any combination thereof.

[0055] Performance of the model in diagnostic accuracy

[0056] In some embodiments, after annotation of the EHR notes, a logistic regression classifier is used to establish a diagnostic system (**FIG. 3**). In some embodiments, the diagnostic system is based on anatomic divisions, e.g. organ systems. This is meant to mimic traditional frameworks used in physician reasoning in which an organ-based approach can be employed for formulation of a differential diagnosis.

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[0057] In some embodiments, a logistic regression classifier is used to allow straightforward identification of relevant clinical features and ease of establishing transparency for the diagnostic classification.

[0058] In some embodiments, the first level of the diagnostic system categorizes the EHR notes into broad organ systems such as: respiratory, gastrointestinal, neuropsychiatric, genitourinary, and generalized systemic conditions. In some embodiments, this is the only level of separation in the diagnostic hierarchy. In some embodiments, this was the first level of separation in the diagnostic hierarchy. In some embodiments, within at least one of the organ systems in the first level, further sub-classifications and hierarchical layers are made. In some embodiments, the organ systems used in the diagnostic hierarchy comprise at least one of integumentary system, muscular system, skeletal system, nervous system, circulatory system, lymphatic system, respiratory system, endocrine system, urinary/excretory system, reproductive system, and digestive system. In some embodiments, the diagnostic system comprises multiple levels of categorization such as a first level, a second level, a third level, a fourth level, and/or a fifth level. In some embodiments, the diagnostic system comprises at least two levels, at least three levels, at least four levels, or at least five levels of categorization. For example, in some embodiments, the respiratory system is further divided into upper respiratory conditions and lower respiratory conditions. Next, the conditions are further separated into more specific anatomic divisions (e.g. laryngitis, tracheitis, bronchitis, pneumonia). **FIG. 3** illustrates an embodiment of hierarchical classification of pediatric diseases. As shown in **FIG. 3**, general pediatric diseases are classified in a first level into respiratory diseases, genitourinary diseases, gastrointestinal diseases, systemic generalized diseases, and neuropsychiatric diseases. In some embodiments, respiratory diseases are further classified into upper or lower respiratory diseases. In some embodiments, upper respiratory diseases are further classified into acute upper respiratory infection, sinusitis, or acute laryngitis. In some embodiments, sinusitis is further classified into acute sinusitis or acute recurrent sinusitis. In some embodiments, lower respiratory disease is further classified into bronchitis, pneumonia, asthma, or acute tracheitis. In some embodiments, bronchitis is further classified into acute bronchitis, bronchiolitis, or acute bronchitis due to mycoplasma pneumonia. In some embodiments, pneumonia is further classified into bacterial pneumonia or mycoplasma infection. In some embodiments, bacterial pneumonia is further classified into bronchopneumonia or bacterial pneumonia (elsewhere). In some embodiments, asthma is further classified into asthma (uncomplicated), cough variant asthma, or asthma with acute exacerbation. In some embodiments, gastrointestinal disease is further classified into diarrhea,

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mouth-related diseases, or acute pharyngitis. In some embodiments, systemic generalized disease is further classified into hand, foot & mouth disease, varicella (without complications), influenza, infectious mononucleosis, sepsis, or exanthema subitum. In some embodiments, neuropsychiatric disease is further classified into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions.

[0059] In some embodiments, the performance of the classifier is evaluated at each level of the diagnostic hierarchy. Accordingly, in some embodiments, the system is designed to evaluate the extracted features of each patient record and categorize the set of features into finer levels of diagnostic specificity along the levels of the decision tree, similar to how a human physician might evaluate a patient's features to achieve a diagnosis based on the same clinical data incorporated into the information model. In some embodiments, encounters labeled by physicians as having a primary diagnosis of "fever" or "cough" are eliminated, as these represented symptoms rather than specific disease entities.

[0060] In some embodiments, across all levels of the diagnostic hierarchy, this diagnostic system achieved a high level of accuracy between the predicted primary diagnoses based on the extracted clinical features by the NLP information model and the initial diagnoses designated by the examining physician (see Table 3 in Example 1). For the first level where the diagnostic system classified the patient's diagnosis into a broad organ system, the median accuracy was 0.90, ranging from 0.85 for gastrointestinal diseases to 0.98 for neuropsychiatric disorders (see Table 3a of Example 1). Even at deeper levels of diagnostic specification, the system retained a strong level of performance. To illustrate, within the respiratory system, the next division in the diagnostic hierarchy was between upper respiratory and lower respiratory conditions. The system achieved an accuracy of 0.89 of upper respiratory conditions and 0.87 of lower respiratory conditions between predicted diagnoses and initial diagnoses (Table 3b). When dividing the upper respiratory subsystem into more specific categories, the median accuracy was 0.92 (range: 0.86 for acute laryngitis to 0.96 for sinusitis, Table 3c). Acute upper respiratory infection was the single most common diagnosis among the cohort, and the model was able to accurately predict the diagnosis in 95% of the encounters (Table 3c). Within the respiratory system, asthma was categorized separately as its own subcategory, and the accuracy ranged from 0.83 for cough variant asthma to 0.97 for unspecified asthma with acute exacerbation (Table 3d).

[0061] In some embodiments, the diagnostic model described herein is assessed according to one or more performance metrics. In some embodiments, the model has an accuracy of at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 91%,

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at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% for at least 200 independent samples. In some embodiments, the model produces a sensitivity of at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% for at least 200 independent samples. In some embodiments, the model produces a specificity of at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% for at least 200 independent samples. In some embodiments, the model produces a positive predictive value of at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% for at least 200 independent samples. In some embodiments, the model produces a negative predictive value of at least 70%, at least 75%, at least 80%, at least 85%, at least 90%, at least 91%, at least 92%, at least 93%, at least 94%, at least 95%, at least 96%, at least 97%, at least 98%, or at least 99% for at least 200 independent samples.

[0062] Identification of common features driving diagnostic prediction

[0063] Disclosed herein are systems and methods for gaining insight into how the diagnostic system utilizes the clinical features extracted by the deep NLP information model and generates a predicted diagnosis. In some embodiments, the key clinical features driving the diagnosis prediction are identified. For each feature, the category of EHR clinical data the feature was derived from (e.g. history of present illness, physical exam, etc.) is determined along with its classification (e.g. binary or free text classification). This ability to review clinical features driving the computer-predicted diagnosis allowed an evaluation as to whether the prediction was based on clinically relevant features. In some embodiments, these features are provided and/or explained to the user or subject (e.g. patient or a healthcare provider diagnosing and/or treating the patient) to build transparency and trust of the diagnosis and diagnostic system.

[0064] For instance, taking gastroenteritis as an example, the diagnostic system identified the presence of words such as “abdominal pain” and “vomiting” as key associated clinical features. The binary classifiers were coded such that presence of the feature was denoted as “1” and absence was denoted as “0”. In this case, “vomiting = 1” and “abdominal pain = 1” were identified as key features for both chief complaint and history of present illness. Under physical exam, “abdominal tenderness = 1” and “rash = 1” were noted to be associated with this diagnosis. Interestingly, “palpable mass = 0” was also associated, meaning that the

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patients predicted to have gastroenteritis usually did not have a palpable mass, which is consistent with human clinical experience. In addition to binary classifiers, there were also "free text" categories in the schema. The feature of "fever" with a text entry of greater than 39 degrees Celsius also emerged as an associated clinical feature driving the diagnosis for gastroenteritis. Laboratory and imaging features were not identified as strongly driving the prediction of this diagnosis, perhaps reflecting the fact that most cases of gastroenteritis are diagnosed without extensive ancillary testing.

Diagnostic Platforms, Systems, Devices, and Media

[0065] Provided herein, in certain aspects, are platforms, systems, devices, and media for analyzing medical data according to any of the methods of the present disclosure. In some embodiments, the systems and electronic devices are integrated with a program including instructions executable by a processor to carry out analysis of medical data. In some embodiments, the analysis comprises processing medical data for at least one subject with a classifier generated and trained using EHRs. In some embodiments, the analysis is performed locally on the device utilizing local software integrated into the device. In some embodiments, the analysis is performed remotely on the cloud after the medical data is uploaded by the system or device over a network. In some embodiments, the system or device is an existing system or device adapted to interface with a web application operating on the network or cloud for uploading and analyzing medical data such as an EHR (or alternatively, a feature set extracted from the EHR containing the relevant clinical features for disease diagnosis/classification).

[0066] In some aspects, disclosed herein is a computer-implemented system configured to carry out cloud-based analysis of medical data such as electronic health records. In some embodiments, the cloud-based analysis is performed on batch uploads of data. In some embodiments, the cloud-based analysis is performed in real-time on individual or small groupings of medical data for one or more subjects. In some embodiments, a batch of medical data comprises medical data for at least 5 subjects, at least 10 subjects, at least 20 subjects, at least 30 subjects, at least 40 subjects, at least 50 subjects, at least 60 subjects, at least 70 subjects, at least 80 subjects, at least 90 subjects, at least 100 subjects, at least 150 subjects, at least 200 subjects, at least 300 subjects, at least 400 subjects, or at least 500 subjects.

[0067] In some embodiments, the electronic device comprises a user interface for communicating with and/or receiving instructions from a user or subject, a memory, at least one processor, and non-transitory computer readable media providing instructions executable by the at least one processor for analyzing medical data. In some embodiments, the electronic

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device comprises a network component for communicating with a network or cloud. The network component is configured to communicate over a network using wired or wireless technology. In some embodiments, the network component communicates over a network using Wi-Fi, Bluetooth, 2G, 3G, 4G, 4G LTE, 5G, WiMAX, WiMAN, or other radiofrequency communication standards and protocols.

[0068] In some embodiments, the system or electronic device obtains medical data such as one or more electronic health records. In some embodiments, the electronic health records are merged and/or analyzed collectively. In some embodiments, the electronic device is not configured to carry out analysis of the medical data, instead uploading the data to a network for cloud-based or remote analysis. In some embodiments, the electronic device comprises a web portal application that interfaces with the network or cloud for remote analysis and does not carry out any analysis locally. An advantage of this configuration is that medical data is not stored locally and thus less vulnerable to being hacked or lost. Alternatively or in combination, the electronic device is configured to carry out analysis of the medical data locally. An advantage of this configuration is the ability to perform analysis in locations lacking network access or coverage (e.g. in certain remote locations lacking internet coverage). In some embodiments, the electronic device is configured to carry out analysis of the medical data locally when network access is not available as a backup function such as in case of an internet outage or temporary network failure. In some embodiments, the medical data is uploaded for storage on the cloud regardless of where the analysis is carried out. For example, in certain instances, the medical data is temporarily stored on the electronic device for analysis, and subsequently uploaded on the cloud and/or deleted from the electronic device's local memory.

[0069] In some embodiments, the electronic device comprises a display for providing the results of the analysis such as a diagnosis or prediction (of the presence and/or progression of a disease or disorder), a treatment recommendation, treatment options, healthcare provider information (e.g. nearby providers that can provide the recommended treatment and/or confirm the diagnosis), or a combination thereof. In some embodiments, the diagnosis or prediction is generated from analysis of current medical data (e.g. most recent medical data or EHR entered for analysis) in comparison to historical medical data (e.g. medical data or EHR from previous medical visits) for the same subject to determine the progression of a disease or disorder. In some embodiments, the medical data such as electronic health records are time-stamped. In some embodiments, electronic health records are stored as data, which optionally includes meta-data such as a timestamp, location, user info, or other information.

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In some embodiments, the electronic device comprises a portal providing tools for a user to input information such as name, address, email, phone number, and/or other identifying information. In some embodiments, the portal provides tools for inputting or uploading medical information (e.g. EHRs, blood pressure, temperature, symptoms, etc.). In some embodiments, the portal provides the user with the option to receive the results of the analysis by email, messaging (e.g. SMS, text message), physical printout (e.g. a printed report), social media, by phone (e.g. an automated phone message or a consultation by a healthcare provider or adviser), or a combination thereof. In some embodiments, the portal is displayed on a digital screen of the electronic device. In some embodiments, the electronic device comprises an analog interface. In some embodiments, the electronic device comprises a digital interface such as a touchscreen.

[0070] In some embodiments, disclosed herein is an online diagnosis, triage, and/or referral AI system. In some embodiments, the system utilizes keywords extracted from an EHR or other data. In some embodiments, the system generates a diagnosis based on analysis of the keywords. In some embodiments, the diagnosis is used to triage a patient relative to a plurality of patients. In some embodiments, the diagnosis is used to refer a patient to a healthcare provider.

Digital processing device

[0071] In some embodiments, the platforms, media, methods and applications described herein include or utilize a digital processing device, a processor, or use of the same. In some embodiments, a digital processing device is configured to perform any of the methods described herein such as generating a natural language processing information extraction model and/or utilizing said model to analyze medical data such as EHRs. In further embodiments, the digital processing device includes one or more processors or hardware central processing units (CPU) that carry out the device's functions. In still further embodiments, the digital processing device further comprises an operating system configured to perform executable instructions. In some embodiments, the digital processing device is optionally connected a computer network. In further embodiments, the digital processing device is optionally connected to the Internet such that it accesses the World Wide Web. In still further embodiments, the digital processing device is optionally connected to a cloud computing infrastructure. In other embodiments, the digital processing device is optionally connected to an intranet. In other embodiments, the digital processing device is optionally connected to a data storage device. In accordance with the description herein, suitable digital

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processing devices include, by way of non-limiting examples, server computers, desktop computers, laptop computers, notebook computers, sub-notebook computers, netbook computers, netpad computers, set-top computers, handheld computers, Internet appliances, mobile smartphones, tablet computers, personal digital assistants, video game consoles, and vehicles. Those of skill in the art will recognize that many smartphones are suitable for use in the system described herein. Those of skill in the art will also recognize that select televisions, video players, and digital music players with optional computer network connectivity are suitable for use in the system described herein. Suitable tablet computers include those with booklet, slate, and convertible configurations, known to those of skill in the art.

[0072] In some embodiments, the digital processing device includes an operating system configured to perform executable instructions. The operating system is, for example, software, including programs and data, which manages the device's hardware and provides services for execution of applications. Those of skill in the art will recognize that suitable server operating systems include, by way of non-limiting examples, FreeBSD, OpenBSD, NetBSD®, Linux, Apple® Mac OS X Server®, Oracle® Solaris®, Windows Server®, and Novell® NetWare®. Those of skill in the art will recognize that suitable personal computer operating systems include, by way of non-limiting examples, Microsoft® Windows®, Apple® Mac OS X®, UNIX®, and UNIX-like operating systems such as GNU/Linux®. In some embodiments, the operating system is provided by cloud computing. Those of skill in the art will also recognize that suitable mobile smart phone operating systems include, by way of non-limiting examples, Nokia® Symbian® OS, Apple® iOS®, Research In Motion® BlackBerry OS®, Google® Android®, Microsoft® Windows Phone® OS, Microsoft® Windows Mobile® OS, Linux®, and Palm® WebOS®.

[0073] In some embodiments, the device includes a storage and/or memory device. The storage and/or memory device is one or more physical apparatuses used to store data or programs on a temporary or permanent basis. In some embodiments, the device is volatile memory and requires power to maintain stored information. In some embodiments, the device is non-volatile memory and retains stored information when the digital processing device is not powered. In further embodiments, the non-volatile memory comprises flash memory. In some embodiments, the non-volatile memory comprises dynamic random-access memory (DRAM). In some embodiments, the non-volatile memory comprises ferroelectric random access memory (FRAM). In some embodiments, the non-volatile memory comprises phase-

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change random access memory (PRAM). In some embodiments, the non-volatile memory comprises magnetoresistive random-access memory (MRAM). In other embodiments, the device is a storage device including, by way of non-limiting examples, CD-ROMs, DVDs, flash memory devices, magnetic disk drives, magnetic tapes drives, optical disk drives, and cloud computing based storage. In further embodiments, the storage and/or memory device is a combination of devices such as those disclosed herein.

[0074] In some embodiments, the digital processing device includes a display to send visual information to a subject. In some embodiments, the display is a cathode ray tube (CRT). In some embodiments, the display is a liquid crystal display (LCD). In further embodiments, the display is a thin film transistor liquid crystal display (TFT-LCD). In some embodiments, the display is an organic light emitting diode (OLED) display. In various further embodiments, on OLED display is a passive-matrix OLED (PMOLED) or active-matrix OLED (AMOLED) display. In some embodiments, the display is a plasma display. In some embodiments, the display is E-paper or E ink. In other embodiments, the display is a video projector. In still further embodiments, the display is a combination of devices such as those disclosed herein.

[0075] In some embodiments, the digital processing device includes an input device to receive information from a subject. In some embodiments, the input device is a keyboard. In some embodiments, the input device is a pointing device including, by way of non-limiting examples, a mouse, trackball, track pad, joystick, game controller, or stylus. In some embodiments, the input device is a touch screen or a multi-touch screen. In other embodiments, the input device is a microphone to capture voice or other sound input. In other embodiments, the input device is a video camera or other sensor to capture motion or visual input. In further embodiments, the input device is a Kinect, Leap Motion, or the like. In still further embodiments, the input device is a combination of devices such as those disclosed herein.

Non-transitory computer readable storage medium

[0076] In some embodiments, the platforms, media, methods and applications described herein include one or more non-transitory computer readable storage media encoded with a program including instructions executable by the operating system of an optionally networked digital processing device. In further embodiments, a computer readable storage medium is a tangible component of a digital processing device. In still further embodiments,

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a computer readable storage medium is optionally removable from a digital processing device. In some embodiments, a computer readable storage medium includes, by way of non-limiting examples, CD-ROMs, DVDs, flash memory devices, solid state memory, magnetic disk drives, magnetic tape drives, optical disk drives, cloud computing systems and services, and the like. In some cases, the program and instructions are permanently, substantially permanently, semi-permanently, or non-transitorily encoded on the media.

Computer program

[0077] In some embodiments, the platforms, media, methods and applications described herein include at least one computer program, or use of the same. A computer program includes a sequence of instructions, executable in the digital processing device's CPU, written to perform a specified task. Computer readable instructions may be implemented as program modules, such as functions, objects, Application Programming Interfaces (APIs), data structures, and the like, that perform particular tasks or implement particular abstract data types. In light of the disclosure provided herein, those of skill in the art will recognize that a computer program may be written in various versions of various languages.

[0078] The functionality of the computer readable instructions may be combined or distributed as desired in various environments. In some embodiments, a computer program comprises one sequence of instructions. In some embodiments, a computer program comprises a plurality of sequences of instructions. In some embodiments, a computer program is provided from one location. In other embodiments, a computer program is provided from a plurality of locations. In various embodiments, a computer program includes one or more software modules. In various embodiments, a computer program includes, in part or in whole, one or more web applications, one or more mobile applications, one or more standalone applications, one or more web browser plug-ins, extensions, add-ins, or add-ons, or combinations thereof.

Web application

[0079] In some embodiments, a computer program includes a web application. In light of the disclosure provided herein, those of skill in the art will recognize that a web application, in various embodiments, utilizes one or more software frameworks and one or more database systems. In some embodiments, a web application is created upon a software framework such as Microsoft® .NET or Ruby on Rails (RoR). In some embodiments, a web application utilizes one or more database systems including, by way of non-limiting examples, relational,

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non-relational, object oriented, associative, and XML database systems. In further embodiments, suitable relational database systems include, by way of non-limiting examples, Microsoft® SQL Server, mySQL™, and Oracle®. Those of skill in the art will also recognize that a web application, in various embodiments, is written in one or more versions of one or more languages. A web application may be written in one or more markup languages, presentation definition languages, client-side scripting languages, server-side coding languages, database query languages, or combinations thereof. In some embodiments, a web application is written to some extent in a markup language such as Hypertext Markup Language (HTML), Extensible Hypertext Markup Language (XHTML), or eXtensible Markup Language (XML). In some embodiments, a web application is written to some extent in a presentation definition language such as Cascading Style Sheets (CSS). In some embodiments, a web application is written to some extent in a client-side scripting language such as Asynchronous Javascript and XML (AJAX), Flash® Actionscript, Javascript, or Silverlight®. In some embodiments, a web application is written to some extent in a server-side coding language such as Active Server Pages (ASP), ColdFusion®, Perl, Java™, JavaServer Pages (JSP), Hypertext Preprocessor (PHP), Python™, Ruby, Tcl, Smalltalk, WebDNA®, or Groovy. In some embodiments, a web application is written to some extent in a database query language such as Structured Query Language (SQL). In some embodiments, a web application integrates enterprise server products such as IBM® Lotus Domino®. In some embodiments, a web application includes a media player element. In various further embodiments, a media player element utilizes one or more of many suitable multimedia technologies including, by way of non-limiting examples, Adobe® Flash®, HTML 5, Apple® QuickTime®, Microsoft® Silverlight®, Java™, and Unity®.

Mobile application

[0080] In some embodiments, a computer program includes a mobile application provided to a mobile digital processing device such as a smartphone. In some embodiments, the mobile application is provided to a mobile digital processing device at the time it is manufactured. In other embodiments, the mobile application is provided to a mobile digital processing device via the computer network described herein.

[0081] In view of the disclosure provided herein, a mobile application is created by techniques known to those of skill in the art using hardware, languages, and development environments known to the art. Those of skill in the art will recognize that mobile applications are written in several languages. Suitable programming languages include, by

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way of non-limiting examples, C, C++, C#, Objective-C, Java™, Javascript, Pascal, Object Pascal, Python™, Ruby, VB.NET, WML, and XHTML/HTML with or without CSS, or combinations thereof.

[0082] Suitable mobile application development environments are available from several sources. Commercially available development environments include, by way of non-limiting examples, AirplaySDK, alcheMo, Appcelerator®, Celsius, Bedrock, Flash Lite, .NET Compact Framework, Rhomobile, and WorkLight Mobile Platform. Other development environments are available without cost including, by way of non-limiting examples, Lazarus, MobiFlex, MoSync, and Phonegap. Also, mobile device manufacturers distribute software developer kits including, by way of non-limiting examples, iPhone and iPad (iOS) SDK, Android™ SDK, BlackBerry® SDK, BREW SDK, Palm® OS SDK, Symbian SDK, webOS SDK, and Windows® Mobile SDK.

[0083] Those of skill in the art will recognize that several commercial forums are available for distribution of mobile applications including, by way of non-limiting examples, Apple® App Store, Android™ Market, BlackBerry® App World, App Store for Palm devices, App Catalog for webOS, Windows® Marketplace for Mobile, Ovi Store for Nokia® devices, Samsung® Apps, and Nintendo® DSi Shop.

Standalone application

[0084] In some embodiments, a computer program includes a standalone application, which is a program that is run as an independent computer process, not an add-on to an existing process, e.g. not a plug-in. Those of skill in the art will recognize that standalone applications are often compiled. A compiler is a computer program(s) that transforms source code written in a programming language into binary object code such as assembly language or machine code. Suitable compiled programming languages include, by way of non-limiting examples, C, C++, Objective-C, COBOL, Delphi, Eiffel, Java™, Lisp, Python™, Visual Basic, and VB .NET, or combinations thereof. Compilation is often performed, at least in part, to create an executable program. In some embodiments, a computer program includes one or more executable complied applications.

Software modules

[0085] In some embodiments, the platforms, media, methods and applications described herein include software, server, and/or database modules, or use of the same. In view of the disclosure provided herein, software modules are created by techniques known to those of

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skill in the art using machines, software, and languages known to the art. The software modules disclosed herein are implemented in a multitude of ways. In various embodiments, a software module comprises a file, a section of code, a programming object, a programming structure, or combinations thereof. In further various embodiments, a software module comprises a plurality of files, a plurality of sections of code, a plurality of programming objects, a plurality of programming structures, or combinations thereof. In various embodiments, the one or more software modules comprise, by way of non-limiting examples, a web application, a mobile application, and a standalone application. In some embodiments, software modules are in one computer program or application. In other embodiments, software modules are in more than one computer program or application. In some embodiments, software modules are hosted on one machine. In other embodiments, software modules are hosted on more than one machine. In further embodiments, software modules are hosted on cloud computing platforms. In some embodiments, software modules are hosted on one or more machines in one location. In other embodiments, software modules are hosted on one or more machines in more than one location.

Databases

[0086] In some embodiments, the platforms, systems, media, and methods disclosed herein include one or more databases, or use of the same. In view of the disclosure provided herein, those of skill in the art will recognize that many databases are suitable for storage and retrieval of barcode, route, parcel, subject, or network information. In various embodiments, suitable databases include, by way of non-limiting examples, relational databases, non-relational databases, object oriented databases, object databases, entity-relationship model databases, associative databases, and XML databases. In some embodiments, a database is internet-based. In further embodiments, a database is web-based. In still further embodiments, a database is cloud computing-based. In other embodiments, a database is based on one or more local computer storage devices.

Detailed Figure Descriptions

[0087] **FIG. 1** shows the results of unsupervised clustering of pediatric diseases. The diagnostic system described herein analyzed electronic health records in the absence of a defined classification system. This grouping structure reflects the detection of trends in clinical features by the deep-learning based model without pre-defined labeling or human input. The clustered blocks are marked with the boxes with grey lines.

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[0088] **FIG. 2** shows an embodiment of a workflow diagram depicting the process of data extraction from electronic medical records, followed by deep learning-based natural language processing (NLP) analysis of these encounters, which were then processed with a disease classifier to predict a clinical diagnosis for each encounter.

[0089] **FIG. 3** shows an example of a hierarchy of the diagnostic framework in a large pediatric cohort. A logistic regression classifier was used to establish a diagnostic system based on anatomic divisions. An organ-based approach was used, wherein diagnoses were first separated into broad organ systems, and then subsequently divided into organ sub-systems and/or into more specific diagnosis groups.

[0090] **FIG. 4** shows an example of a design of the natural language processing (NLP) information extraction model. Segmented sentences from the raw text of the electronic health record were embedded using word2vec. The LSTM model then output the structured records in query answer format. In this particular example, a sample EHR sentence segment is used as input ("Lesion in the left upper lobe of the patient's lung"). Next, word embedding is performed, followed by sentence classification using Long Short Term Memory (LSTM) architecture. Finally, the input is evaluated against a set of queries and their corresponding answers. Specifically, the queries shown in **FIG. 4** include in order from left to right: "Q: Is the upper left lobe of the lung detectable?" / "A: 1"; "Q: Is there a mass in the upper left lobe?"/ "A: 1"; "Q: Is there a detectable lesion in the upper left lobe?" / "A: 1"; "Q: Is there a detectable obstruction in the bronchus" / "A: 0"; "Q: Is there an abnormality in the bronchus" / "A: 0".

[0091] **FIG. 5** shows a workflow diagram that depicts an embodiment of the hybrid natural language processing and machine learning AI-based system. A comprehensive medical dictionary and open-source Chinese language segmentation software was applied to EHR data as a means to extract clinically relevant text. This information was fed through a NLP analysis and then processed with a disease classifier to predict a diagnosis for each encounter.

[0092] **FIGs. 6A-6D** shows the diagnostic efficiencies and model performance for GMU1 adult data and GWCMC1 pediatric data. **FIG. 6A** shows a convolutional table showing diagnostic efficiencies across adult populations. **FIG. 6B** shows an ROC-AUC curve for model performance across adult populations. **FIG. 6C** shows a convolutional table showing diagnostic efficiencies across pediatric populations. **FIG. 6D** shows an ROC-AUC curve for model performance across pediatric populations.

[0093] **FIGs. 7A-7D** shows the diagnostic efficiencies and model performance for GMU2

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adult data and GWCMC2 pediatric data. **FIG. 7A** shows a convolutional table showing diagnostic efficiencies across adult populations. **FIG. 7B** shows an ROC-AUC curve for model performance across adult populations. **FIG. 7C** shows a convolutional table showing diagnostic efficiencies across pediatric populations. **FIG. 7D** shows an ROC-AUC curve for model performance across pediatric populations.

[0094] **FIGs. 8A-8F** shows Comparison of Hierarchical Diagnosis Approach (right) versus end-to-end approach in pediatric respiratory diseases (left). FIGs. 8A-8C shows an end-to-end approach. **FIG. 8A** depicts a confusion table showing diagnostic efficiencies between upper and lower respiratory systems in pediatric patients. **FIG. 8B** depicts a confusion table showing diagnostic efficiencies in top four upper-respiratory diseases. **FIG. 8C** shows a confusion table showing diagnostic efficiencies in top six lower-respiratory diseases. **FIGs. 8D-8F** show a hierarchical diagnostic approach. **FIG. 8D** depicts a confusion table showing diagnostic efficiencies for upper and lower respiratory systems in pediatric patients. **FIG. 8E** depicts a confusion table showing diagnostic efficiencies in top four upper-respiratory diseases. **FIG. 8F** depicts a confusion table showing diagnostic efficiencies in top six lower-respiratory diseases.

[0095] **FIG. 9** shows an example of free-text document record of an endocrinological and metabolic disease case that can be used in segmentation.

[0096] **FIG. 10** shows model performance over time with percent classification and loss over number of epochs in adult and pediatric internal validations.

Numbered Embodiments

[0097] The following embodiments recite nonlimiting permutations of combinations of features disclosed herein. Other permutations of combinations of features are also contemplated. A method for providing a medical diagnosis, comprising: obtaining medical data; using a natural language processing (NLP) information extraction model to extract and annotate clinical features from the medical data; and analyzing at least one of the clinical features with a disease prediction classifier to generate a classification of a disease or disorder, the classification having a sensitivity of at least 80%. The method of embodiment 1, wherein the NLP information extraction model comprises a deep learning procedure. The method of embodiment 1 or 2, wherein the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes. The method of any one of embodiments 1-3, wherein the NLP information extraction model utilizes a plurality of

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schema, each schema comprising a feature name, anatomical location, and value. The method of embodiment 4, wherein the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. The method any one of embodiments 1-5, further comprising tokenizing the medical data for processing by the NLP information extraction model. The method of any one of embodiments 1-6, wherein the medical data comprises an electronic health record (EHR). The method of any one of embodiments 1-7, wherein the classification has a specificity of at least 80%. The method of any one of embodiments 1-8, wherein the classification has an F1 score of at least 80%. The method of any of embodiments 1-9, wherein the clinical features are extracted in a structured format comprising data in query-answer pairs. The method of any of embodiments 1-10, wherein the disease prediction classifier comprises a logistic regression classifier. The method of any one of embodiments 1-11, wherein the disease prediction classifier comprises a decision tree. The method of any one of embodiments 1-12, wherein the classification differentiates between a serious and a non-serious condition. The method of any one of embodiments 1-13, wherein the classification comprises at least two levels of categorization. The method of any one of embodiments 1-14, wherein the classification comprises a first level category indicative of an organ system. The method of embodiments 15, wherein the classification comprises a second level indicative of a subcategory of the organ system. The method of any one of embodiments 1-16, wherein the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. The method of embodiment 16, wherein the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases. The method of embodiment 18, wherein the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. The method of embodiment 19, wherein the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. The method of embodiment 19, wherein the classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. The method of embodiment 18, wherein the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. The method of embodiment 18, wherein the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions. The method of embodiment 18,

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wherein the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum. The method of any one of embodiments 1-24, further comprising making a medical treatment recommendation based on the classification. The method of any one of embodiments 1-25, wherein the disease prediction classifier is trained using end-to-end deep learning. A non-transitory computer-readable medium comprising machine-executable code that, upon execution by one or more computer processors, implements a method for providing a classification of a disease or disorder, the method comprising: obtaining medical data; using a natural language processing (NLP) information extraction model to extract and annotate clinical features from the medical data; and analyzing at least one of the clinical features with a disease prediction classifier to generate the classification of a disease or disorder, the classification having a sensitivity of at least 80%. The media of embodiment 27, wherein the NLP information extraction model comprises a deep learning procedure. The media of embodiment 27 or 28, wherein the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes. The media of any one of embodiments 27-29, wherein the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value. The media of embodiment 30, wherein the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. The media of any one of embodiments 27-31, wherein the method further comprises tokenizing the medical data for processing by the NLP information extraction model. The media of any one of embodiments 27-32, wherein the medical data comprises an electronic health record (EHR). The media of any one of embodiments 27-33, wherein the classification has a specificity of at least 80%. The media of any one of embodiments 27-34, wherein the classification has an F1 score of at least 80%. The media of any of embodiments 27-35, wherein the clinical features are extracted in a structured format comprising data in query-answer pairs. The media of any of embodiments 27-36, wherein the disease prediction classifier comprises a logistic regression classifier. The media of any one of embodiments 27-37, wherein the disease prediction classifier comprises a decision tree. The media of any one of embodiments 27-38, wherein the classification differentiates between a serious and a non-serious condition. The media of any one of embodiments 27-39, wherein the classification comprises at least two levels of categorization. The media of any one of embodiments 27-40, wherein the classification comprises a first level category indicative of an organ system. The media of embodiments 41,

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wherein the classification comprises a second level indicative of a subcategory of the organ system. The media of any one of embodiments 27-42, wherein the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. The media of embodiment 43, wherein the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases. The media of embodiment 44, wherein the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. The media of embodiment 45, wherein the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. The media of embodiment 45, wherein the classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. The media of embodiment 44, wherein the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. The media of embodiment 44, wherein the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions. The media of embodiment 44, wherein the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum. The media of any one of embodiments 27-50, further comprising making a medical treatment recommendation based on the classification. The media of any one of embodiments 27-51, wherein the disease prediction classifier is trained using end-to-end deep learning. A computer-implemented system comprising: a digital processing device comprising: at least one processor, an operating system configured to perform executable instructions, a memory, and a computer program including instructions executable by the digital processing device to create an application for providing a medical diagnosis, the application comprising: a software module obtaining medical data; a software module using a natural language processing (NLP) information extraction model to extract and annotate clinical features from the medical data; and a software module analyzing at least one of the clinical features with a disease prediction classifier to generate the classification of a disease or disorder, the classification having a sensitivity of at least 80%. The system of embodiment 53, wherein the NLP information extraction model comprises a deep learning procedure. The system of embodiment 53 or 54, wherein the NLP information extraction model utilizes a standard lexicon comprising

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keywords representative of assertion classes. The system of any one of embodiments 53-55, wherein the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value. The system of embodiment 56, wherein the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. The system of any one of embodiments 53-57, further comprising a software module tokenizing the medical data for processing by the NLP information extraction model. The system of any one of embodiments 53-58, wherein the medical data comprises an electronic health record (EHR). The system of any one of embodiments 53-59, wherein the classification has a specificity of at least 80%. The system of any one of embodiments 53-60, wherein the classification has an F1 score of at least 80%. The system of any of embodiments 53-61, wherein the clinical features are extracted in a structured format comprising data in query-answer pairs. The system of any of embodiments 53-62, wherein the disease prediction classifier comprises a logistic regression classifier. The system of any one of embodiments 53-63, wherein the disease prediction classifier comprises a decision tree. The system of any one of embodiments 53-64, wherein the classification differentiates between a serious and a non-serious condition. The system of any one of embodiments 53-65, wherein the classification comprises at least two levels of categorization. The system of any one of embodiments 53-66, wherein the classification comprises a first level category indicative of an organ system. The system of embodiments 67, wherein the classification comprises a second level indicative of a subcategory of the organ system. The system of any one of embodiments 53-68, wherein the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. The system of embodiment 69, wherein the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases. The system of embodiment 70, wherein the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. The system of embodiment 71, wherein the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. The system of embodiment 71, wherein the classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. The system of embodiment 70, wherein the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. The system of embodiment 70, wherein the classification

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further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions. The system of embodiment 70, wherein the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum. The system of any one of embodiments 53-76, further comprising making a medical treatment recommendation based on the classification. The system of any one of embodiments 53-77, wherein the disease prediction classifier is trained using end-to-end deep learning. A digital processing device comprising: at least one processor, an operating system configured to perform executable instructions, a memory, and a computer program including instructions executable by the digital processing device to create an application for providing a medical diagnosis, the application comprising: a software module obtaining medical data; a software module using a natural language processing (NLP) information extraction model to extract and annotate clinical features from the medical data; and a software module analyzing at least one of the clinical features with a disease prediction classifier to generate the classification of a disease or disorder, the classification having a sensitivity of at least 80%. The device of embodiment 79, wherein the NLP information extraction model comprises a deep learning procedure. The device of embodiment 79 or 80, wherein the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes. The device of any one of embodiments 79-81, wherein the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value. The device of embodiment 82, wherein the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. The device of any one of embodiments 79-83, further comprising a software module tokenizing the medical data for processing by the NLP information extraction model. The device of any one of embodiments 79-84, wherein the medical data comprises an electronic health record (EHR). The device of any one of embodiments 79-85, wherein the classification has a specificity of at least 80%. The device of any one of embodiments 79-86, wherein the classification has an F1 score of at least 80%. The device of any of embodiments 79-87, wherein the clinical features are extracted in a structured format comprising data in query-answer pairs. The device of any of embodiments 79-88, wherein the disease prediction classifier comprises a logistic regression classifier. The device of any one of embodiments 79-89, wherein the disease prediction classifier comprises a decision tree. The device of any one of embodiments 79-90, wherein the classification differentiates between a serious and a

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non-serious condition. The device of any one of embodiments 79-91, wherein the classification comprises at least two levels of categorization. The device of any one of embodiments 79-92, wherein the classification comprises a first level category indicative of an organ system. The device of embodiments 93, wherein the classification comprises a second level indicative of a subcategory of the organ system. The device of any one of embodiments 79-94, wherein the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. The device of embodiment 95, wherein the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases. The device of embodiment 96, wherein the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. The device of embodiment 97, wherein the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. The device of embodiment 97, wherein the classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. The device of embodiment 96, wherein the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. The device of embodiment 96, wherein the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions. The device of embodiment 96, wherein the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum. The device of any one of embodiments 79-102, further comprising making a medical treatment recommendation based on the classification. The device of any one of embodiments 79-103, wherein the disease prediction classifier is trained using end-to-end deep learning. A computer-implemented method for generating a disease prediction classifier for providing a medical diagnosis, comprising: providing a lexicon constructed based on medical texts, wherein the lexicon comprises keywords relating to clinical information; obtaining medical data comprising electronic health records (EHRs); extracting clinical features from the medical data using an NLP information extraction model; mapping the clinical features to hypothetical clinical queries to generate question-answer pairs; and training the NLP classifier using the question-answer pairs, wherein the NLP classifier is configured to generate classifications having a sensitivity of at least 80% when tested against

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an independent dataset of at least 100 EHRs. The method of embodiment 105, wherein the NLP information extraction model comprises a deep learning procedure. The method of embodiment 105 or 106, wherein the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes. The method of any one of embodiments 105-107, wherein the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value. The method of embodiment 108, wherein the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. The method any one of embodiments 105-109, further comprising tokenizing the medical data for processing by the NLP information extraction model. The method of any one of embodiments 105-110, wherein the medical data comprises an electronic health record (EHR). The method of any one of embodiments 105-111, wherein the classification has a specificity of at least 80%. The method of any one of embodiments 105-112, wherein the classification has an F1 score of at least 80%. The method of any of embodiments 105-113, wherein the clinical features are extracted in a structured format comprising data in query-answer pairs. The method of any of embodiments 105-114, wherein the disease prediction classifier comprises a logistic regression classifier. The method of any one of embodiments 105-115, wherein the disease prediction classifier comprises a decision tree. The method of any one of embodiments 105-116, wherein the classification differentiates between a serious and a non-serious condition. The method of any one of embodiments 105-117, wherein the classification comprises at least two levels of categorization. The method of any one of embodiments 105-118, wherein the classification comprises a first level category indicative of an organ system. The method of embodiments 119, wherein the classification comprises a second level indicative of a subcategory of the organ system. The method of any one of embodiments 105-120, wherein the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. The method of embodiment 120, wherein the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases. The method of embodiment 122, wherein the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. The method of embodiment 123, wherein the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. The method of embodiment 123, wherein the classification further comprises a subcategorization of lower

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respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. The method of embodiment 122, wherein the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. The method of embodiment 122, wherein the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions. The method of embodiment 122, wherein the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum. The method of any one of embodiments 105-128, further comprising making a medical treatment recommendation based on the classification. The method of any one of embodiments 105-129, wherein the disease prediction classifier is trained using end-to-end deep learning. A non-transitory computer-readable medium comprising machine-executable code that, upon execution by one or more computer processors, implements a method for generating a natural language processing (NLP) classifier for providing a classification of a disease or disorder, the method comprising: providing a lexicon constructed based on medical texts, wherein the lexicon comprises keywords relating to clinical information; obtaining medical data comprising electronic health records (EHRs); extracting clinical features from the medical data using an NLP information extraction model; mapping the clinical features to hypothetical clinical queries to generate question-answer pairs; and training the NLP classifier using the question-answer pairs, wherein the NLP classifier is configured to generate classifications having a sensitivity of at least 80% when tested against an independent dataset of at least 100 EHRs. The media of embodiment 131, wherein the NLP information extraction model comprises a deep learning procedure. The media of embodiment 131 or 132, wherein the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes. The media of any one of embodiments 131-133, wherein the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value. The media of embodiment 134, wherein the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. The media of any one of embodiments 131-135, wherein the method further comprises tokenizing the medical data for processing by the NLP information extraction model. The media of any one of embodiments 131-136, wherein the medical data comprises an electronic health record (EHR). The media of any one of embodiments 131-137, wherein the classification has a specificity of at least 80%. The

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media of any one of embodiments 131-138, wherein the classification has an F1 score of at least 80%. The media of any of embodiments 131-139, wherein the clinical features are extracted in a structured format comprising data in query-answer pairs. The media of any of embodiments 131-140, wherein the disease prediction classifier comprises a logistic regression classifier. The media of any one of embodiments 131-141, wherein the disease prediction classifier comprises a decision tree. The media of any one of embodiments 131-142, wherein the classification differentiates between a serious and a non-serious condition. The media of any one of embodiments 131-143, wherein the classification comprises at least two levels of categorization. The media of any one of embodiments 131-144, wherein the classification comprises a first level category indicative of an organ system. The media of embodiments 145, wherein the classification comprises a second level indicative of a subcategory of the organ system. The media of any one of embodiments 131-146, wherein the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. The media of embodiment 147, wherein the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases. The media of embodiment 148, wherein the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. The media of embodiment 149, wherein the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. The media of embodiment 149, wherein the classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. The media of embodiment 148, wherein the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. The media of embodiment 148, wherein the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions. The media of embodiment 148, wherein the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum. The media of any one of embodiments 131-154, further comprising making a medical treatment recommendation based on the classification. The media of any one of embodiments 131-155, wherein the disease prediction classifier is trained using end-to-end deep learning. A computer-implemented system comprising: a digital processing device

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comprising: at least one processor, an operating system configured to perform executable instructions, a memory, and a computer program including instructions executable by the digital processing device to create an application for generating a natural language processing (NLP) classifier for providing a medical diagnosis, the application comprising: a software module for providing a lexicon constructed based on medical texts, wherein the lexicon comprises keywords relating to clinical information; a software module for obtaining medical data comprising electronic health records (EHRs); a software module for extracting clinical features from the medical data using an NLP information extraction model; a software module for mapping the clinical features to hypothetical clinical queries to generate question-answer pairs; and a software module for training the NLP classifier using the question-answer pairs, wherein the NLP classifier is configured to generate classifications having a sensitivity of at least 80% when tested against an independent dataset of at least 100 EHRs. The system of embodiment 157, wherein the NLP information extraction model comprises a deep learning procedure. The system of embodiment 157 or 158, wherein the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes. The system of any one of embodiments 157-159, wherein the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value. The system of embodiment 160, wherein the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. The system of any one of embodiments 157-161, further comprising a software module tokenizing the medical data for processing by the NLP information extraction model. The system of any one of embodiments 157-162, wherein the medical data comprises an electronic health record (EHR). The system of any one of embodiments 157-163, wherein the classification has a specificity of at least 80%. The system of any one of embodiments 157-164, wherein the classification has an F1 score of at least 80%. The system of any of embodiments 157-165, wherein the clinical features are extracted in a structured format comprising data in query-answer pairs. The system of any of embodiments 157-166, wherein the disease prediction classifier comprises a logistic regression classifier. The system of any one of embodiments 157-167, wherein the disease prediction classifier comprises a decision tree. The system of any one of embodiments 157-168, wherein the classification differentiates between a serious and a non-serious condition. The system of any one of embodiments 157-169, wherein the classification comprises at least two levels of categorization. The system of any one of embodiments 157-170, wherein the classification comprises a first level category indicative of an organ system. The system of

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embodiments 171, wherein the classification comprises a second level indicative of a subcategory of the organ system. The system of any one of embodiments 157-172, wherein the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. The system of embodiment 173, wherein the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases. The system of embodiment 174, wherein the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. The system of embodiment 175, wherein the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. The system of embodiment 175, wherein the classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. The system of embodiment 174, wherein the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. The system of embodiment 174, wherein the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions. The system of embodiment 174, wherein the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum. The system of any one of embodiments 157-180, further comprising making a medical treatment recommendation based on the classification. The system of any one of embodiments 157-181, wherein the disease prediction classifier is trained using end-to-end deep learning. A digital processing device comprising: at least one processor, an operating system configured to perform executable instructions, a memory, and a computer program including instructions executable by the digital processing device to create an application for generating a disease prediction classifier for providing a medical diagnosis, the application comprising: a software module for providing a lexicon constructed based on medical texts, wherein the lexicon comprises keywords relating to clinical information; a software module for obtaining medical data comprising electronic health records (EHRs); a software module for extracting clinical features from the medical data using an NLP information extraction model; a software module for mapping the clinical features to hypothetical clinical queries to generate question-answer pairs; and a software module for training the NLP classifier using the question-answer pairs, wherein the NLP classifier is configured to generate classifications

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having a sensitivity of at least 80% when tested against an independent dataset of at least 100 EHRs. The device of embodiment 183, wherein the NLP information extraction model comprises a deep learning procedure. The device of embodiment 183 or 183.a), wherein the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes. The device of any one of embodiments 183-185, wherein the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value. The device of embodiment 186, wherein the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint. The device of any one of embodiments 183-187, further comprising a software module tokenizing the medical data for processing by the NLP information extraction model. The device of any one of embodiments 183-188, wherein the medical data comprises an electronic health record (EHR). The device of any one of embodiments 183-189, wherein the classification has a specificity of at least 80%. The device of any one of embodiments 183-190, wherein the classification has an F1 score of at least 80%. The device of any of embodiments 183-191, wherein the clinical features are extracted in a structured format comprising data in query-answer pairs. The device of any of embodiments 183-192, wherein the disease prediction classifier comprises a logistic regression classifier. The device of any one of embodiments 183-193, wherein the disease prediction classifier comprises a decision tree. The device of any one of embodiments 183-194, wherein the classification differentiates between a serious and a non-serious condition. The device of any one of embodiments 183-195, wherein the classification comprises at least two levels of categorization. The device of any one of embodiments 183-196, wherein the classification comprises a first level category indicative of an organ system. The device of embodiments 197, wherein the classification comprises a second level indicative of a subcategory of the organ system. The device of any one of embodiments 183-198, wherein the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories. The device of embodiment 199, wherein the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases. The device of embodiment 200, wherein the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases. The device of embodiment 201, wherein the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis. The device of embodiment 201, wherein the

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classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis. The device of embodiment 200, wherein the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis. The device of embodiment 200, wherein the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions. The device of embodiment 200, wherein the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum. The device of any one of embodiments 183-206, further comprising making a medical treatment recommendation based on the classification. The device of any one of embodiments 183-207, wherein the disease prediction classifier is trained using end-to-end deep learning.

EXAMPLES

EXAMPLE 1

[0098] A retrospective study was carried out using electronic health records obtained from electronic health records from Guangzhou Women and Children's Medical Center, a major Chinese academic medical referral center.

[0099] **METHODS**

[0100] Data collection

[0101] A retrospective study was carried out based on electronic health records obtained from 1,362,559 outpatient patient visits from 567,498 patients from the Guangzhou Women and Children's Medical Center. These records encompassed physician encounters for pediatric patients presenting to this institution from January 2016 to July 2017. The median age was 2.35 years (range: 0 to 18, 95% confidence interval: 0.2 to 9.7 years old), and 40.11% were female (Table 1). 11,926 patient visit records from an independent cohort of pediatric patients from Zhengcheng Women and Children's Hospital (Guangdong Province, China) were used for a comparison study between the present AI system and human physicians.

[0102] The study was approved by the Guangzhou Women and Children's Medical Center and Zhengcheng Women and Children's Hospital institutional review board and ethics committee and complied with the Declaration of Helsinki. Consents were obtained from all participants at the initial hospital visit. Patient sensitive information was removed during the

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initial extraction of EHR data and EHR were de-identified. A data use agreement was composed and upheld by all institutions involved in the data collection and analysis. Data were stored in a fully HIPAA-compliant manner.

[0103] Inpatient disease prevalence from Table 1 is derived from the official government statistics report from the Guangdong province. Nursing flowsheets, such as the medication administration record, were not included. All encounters were labeled with a primary diagnosis in the International Classification of Disease ICD-10 coding that was determined by the examining physician.

[0104] **Table 1. General characteristics of the study cohort.** Characteristics for the patients whose encounters were documented in the electronic health record (EHR) and included in the training and testing cohorts for the analysis.

		Gender and age	**Training Cohort**	**Testing Cohort**	**Total**
		Males	571,080 (59.87%)	244,839 (59.90%)	815,919 (59.88%)
		Females	382,709 (40.13%)	163,931 (40.10%)	546,640 (40.11%)
		Median Age at Visit (years)	2.35	2.36	2.35
Disease group	Cantonese population incidence rate	**Most Common Primary Diagnoses**			
Respiratory disease	38.00%	Acute upper respiratory infection	144,754	338,300	483,054
		Bronchitis (acute or chronic)	123,447	286,393	409,840
		Acute bronchiolitis	14,092	33,002	47,094
		Bronchopneumonia	13,359	30,870	44,229
		Acute sinusitis	8,606	20,131	28,737
		Acute tonsillitis	10,487	24,077	34,564
Digestive disease	11.10%	Infectious gastroenteritis and colitis	7,756	17,690	25,446
		Diarrhea	16,337	38,267	54,604
		Enteroviral vesicular stomatitis with exanthem	8,864	20,771	29,635

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	Most Common Departments Represented			
	General Pediatrics	693,596	297,491	991,087
	Special Clinic for Children	74,954	32,147	107,101
	Pediatric Pulmonology	53,885	23,204	77,089
	Pediatric Emergency Medicine	48,820	20,900	69,720
	Otolaryngology	19,943	8,529	28,472
	Infectious Disease Clinic	17,096	7,260	24,356
	Pediatric Rehabilitation	12,977	5,348	18,325
	Neonatology	8,234	3,505	11,739
	Pediatric Gastroenterology	8,067	3,599	11,666

[0105] The primary diagnoses included 55 diagnosis codes encompassing common diseases in pediatrics and representing a wide range of pathology. Some of the most frequently encountered diagnoses included acute upper respiratory infection, bronchitis, diarrhea, bronchopneumonia, acute tonsillitis, stomatitis, and acute sinusitis (Table 1). The records originated from a wide range of specialties, with the top three most represented departments being general pediatrics, the Special Clinic for Children, and pediatric pulmonology (Table 1). The Special Clinic for Children consisted of a specific clinic for private or VIP patients at this institution and encompassed care for a range of conditions.

[0106] (A) NLP Model Construction

[0107] An information extraction model was established, which extracted the key concepts and associated categories in EHR raw data and transformed them into reformatted clinical data in query-answer pairs (**FIG. 4**). The reformatted chart grouped the relevant symptoms into categories, which increased transparency by showing the exact features that the model relies on to make a diagnosis. The schemas had been curated and validated by three physicians, which encompassed chief complaint, history of present illness, physical examination, and lab reports. There were multiple components to the NLP framework: 1) lexicon construction, 2) tokenization, 3) word embedding, 4) schema construction, and 5) sentence classification using Long Short Term Memory (LSTM) architecture.

[0108] Lexicon construction

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[0109] The lexicon was generated by manually reading sentences in the training data (approximately 1% of each class, consisting of over 11,967 sentences) and selecting clinically relevant words for the purpose of query-answer model construction. The keywords were curated by physicians and were generated by using a Chinese medical dictionary, which is analogous to the Unified Medical Language System (UMLS) in the United States. Next, any errors in the lexicon were revised according to physicians' clinical knowledge and experience, as well as expert consensus guidelines, based on conversations between board-certified internal medicine physicians, informaticians, and one health information management professional. This procedure was iteratively conducted until no new concepts of history of present illness (HPI) and physical exam (PE) were found.

[0110] Schema design

[0111] A schema is a type of abstract synthesis of medical knowledge and physician experience, which is fixed in the form of certain rules. Once the schema is fixed, the information that natural language processing can obtain from the medical records is also fixed.

[0112] A schema is a group of three items <item_name, key_location, value>. The item_name is the feature name. The key_location encodes anatomical locations. The value consists of either free text or a binary number depending on the query type. When doing pattern matching, the NLP results were assessed to check if they could match to certain schema, and the results were filled out to the fourth column of the form while the first three columns remained unchanged.

[0113] Four information schemas were constructed with the curation of three physicians: history of present illness, physical examination, laboratory tests, and radiology reports (Supplementary Table 1). The chief complaint and history of present illness shared the same schema. The information contained in the schemas is shown in Supplementary Table 1.

[0114] Tokenization and word embedding

[0115] Due to the lack of publicly available community annotated resources for the clinical domain in Chinese, standard datasets for word segmentation were generated. The tool used for tokenization was mecab (url: https://github.com/taku910/mecab), with the curated lexicons described herein as the optional parameter. There were a total of 4363 tokens. Word2vec from python Tensorflow package was used to embed the 4363 tokens with 100 high dimensional features.

[0116] LSTM model training data set and testing data set construction

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[0117] A small set of data was curated for training the text classification model. The query-answer pair in the training (n=3564) and validation (n=2619) cohort were manually annotated. For questions with binary answers, 0/1 were used to indicate if the text gave a no/yes. For example, given the text snippet "patient has fever", query "is patient having fever?" will be assigned a value of 1. For queries with categorical/numerical values, the pre-defined categorical free text answer was extracted as shown in the schema (Supplementary Table 1).

[0118] The free-text harmonization process was modeled by the attention-based LSTM described in Luong et al. 20151. The model was implemented using tensorflow and trained with 200,000 steps. The NLP model was applied to all the physician notes, which were converted into the structured format (e.g., machine readable format), where each structured record contained data in query-answer pairs.

[0119] The hyperparameters were not tuned, and instead either default or commonly used settings of hyperparameters were used for the LSTM model. A total of 128 hidden units per layer and 2 layers of LSTM cells were used along with a default learning rate of 0.001 from Tensorflow.

[0120] (B) Hierarchical Multi-Label Diagnosis Model Construction

[0121] Diagnosis hierarchy curation

[0122] The relationship between the labels was curated by one US board-certified physician and two Chinese board-certified physicians. An anatomically based classification was used for the diagnostic hierarchy, as this was a common method of formulating a differential diagnosis when a human physician evaluates a patient. First, the diagnoses were separated into general organ systems (e.g. respiratory, neurologic, gastrointestinal, etc.). Within each organ system, there was a subdivision into subsystems (e.g. upper respiratory and lower respiratory). A separate category was labeled "generalized systemic" in order to include conditions that affected more than one organ system and/or were more generalized in nature (e.g. mononucleosis, influenza).

[0123] Model training and validation process

[0124] The data was split into a training cohort, consisting of 70% of the total visit records, and a testing cohort, comprised of the remaining 30%. The feature space was then encoded as a visit by constructing a query-answer membership matrix for both the testing and training cohorts.

[0125] For each intermediate node, a multiclass linear logistic regression classifier was trained based on the immediate children terms. All the subclasses of the children terms were collapsed to the level of the children level. The one versus rest multiclass classifier was

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trained using Sklearn class LogisticRegression. A regularization penalty of l1 (Lasso) was also applied, simulating the case where physicians often rely on a limited number of symptoms to diagnose. The inputs were in query-answer pairs as described above. To further evaluate the model, the Receiver Operating Characteristic - Area Under Curves (ROC-AUC) (Supplementary Table 5) were also generated to evaluate the sensitivity and specificity of our multiclass linear logistic regression classifiers. The robustness of the classification models were also evaluated using a 5-fold cross-validation (Supplementary Table 6). The inputs were in query-answer pairs as described above.

[0126] Supplementary Table 5. ROC-AUC for each classification class in each classification group. The multi-classification diagnosis models are composed of binary classifiers and thus can also be evaluated in terms of ROC-AUC.

Classification group	Classes	ROC-AUC
Asthma	Cough variant asthma	0.964
	Unspecified asthma with (acute) exacerbation	0.996
	Unspecified asthma, uncomplicated	0.975
Bacterial pneumonia	Bacterial pneumonia, not elsewhere classified	0.848
	Bronchopneumonia	0.848
Encephalitis	Unspecified viral encephalitis	0.869
	Sequelae of viral encephalitis	0.869
GI	Acute pharyngitis	0.939
	Mouth-related Diseases	0.942

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	Diarrhea, unspecified	0.996
Mouth-related Diseases	Stomatitis and related lesions	0.973
	Acute sialoadenitis	0.979
	Diseases of lips	0.993
	Acute tonsillitis, unspecified	0.974
Group: "Acute laryngitis"	Acute laryngotracheitis	0.907
	Acute laryngitis	0.876
	Acute laryngopharyngitis	0.972
Group: "Bronchitis"	Bronchiolitis	0.965
	Acute bronchitis, unspecified	0.965
Group: "Pneumonia"	Mycoplasma infection, unspecified site	0.952
	Bacterial pneumonia	0.952
Group: "Sinusitis"	Acute recurrent sinusitis, unspecified	0.977
	Acute sinusitis, unspecified	0.977
Lower Respiratory	Asthma	0.973
	Group: "Bronchitis"	0.887

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	Group: "Pneumonia"	0.927
	Acute tracheitis	0.976
Neuro-Psych	Convulsions	0.989
	Bacterial meningitis, unspecified	0.984
	Encephalitis	0.977
	Tic disorder, unspecified	0.989
	Attention-deficit hyperactivity disorders	0.981
Respiratory	Lower Respiratory	0.973
	Upper respiratory	0.973
Upper respiratory	Group: "Sinusitis"	0.994
	Acute upper respiratory infection, unspecified	0.978
	Group: "Acute laryngitis"	0.986
root	Systemic-Generalized	0.968
	Neuro-Psych	0.996
	GI	0.972
	Respiratory	0.977

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	Genitourinary	0.983
Systemic-Generalized	Influenza	0.989
	Sepsis, unspecified organism	0.985
	Exanthema subitum [sixth disease]	0.995
	Hand, foot, and mouth disease	0.989
	Infectious mononucleosis	0.99
	Varicella without complication	0.993

[0127] Supplementary Table 6. Illustration of the diagnostic performance of the logistic regression classifier at multiple levels of the diagnostic hierarchy with 5-fold cross-validation. The classification performance of each diagnosis level is listed on each row. The classification performance of each fold is listed in each column.

	Folds					
	0	**1**	**2**	**3**	**4**	Median accuracy across folds
Asthma	0.886	0.934	0.927	0.913	0.899	**0.913**
Encephalitis	0.83	0.771	0.809	0.868	0.848	**0.83**
GI	0.824	0.749	0.807	0.839	0.846	**0.824**
Mouth-related Diseases	0.865	0.899	0.857	0.884	0.915	**0.884**

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Group: "Bronchitis"	0.881	0.905	0.885	0.916	0.887	**0.887**
Group: "Pneumonia"	0.838	0.804	0.92	0.916	0.861	**0.861**
Group: "Sinusitis"	0.874	0.952	0.925	0.925	0.882	**0.925**
Neuro-Psych	0.849	0.869	0.864	0.862	0.87	**0.864**
Respiratory	0.778	0.934	0.938	0.934	0.916	**0.934**
Upper respiratory	0.844	0.891	0.918	0.928	0.932	**0.918**
root	0.786	0.884	0.886	0.88	0.861	**0.88**
Systemic-Generalized	0.905	0.922	0.897	0.904	0.915	**0.905**
					Median accuracy across folds and classes	**0.885**

[0128] Hierarchical clustering of disease

[0129] The mean profile of the feature membership matrix was correlated using Pearson correlation. Hierarchical clustering was done by clustermap function from python seaborn package with default parameters.

[0130] To evaluate the robustness of the clustering result (Fig. 1), the data was first split into training and test sets by half and regenerated the two cluster maps for the training and test data independently. The leaves in both the training and test cluster maps were assigned to ten classes by cutting the associated dendrogram at the corresponding height independently. The class assignment concordance between the training and test data was evaluated by the Adjusted Rand Index (ARI). An ARI value closer to 1 indicates higher concordance between training class assignment and test class assignment, whereas an ARI closer to 0 indicates

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close to the null background. A high ARI of 0.8986 between the training and test class assignments was observed, suggesting that the cluster map is robust.

[0131] Comparative performance between our AI system and human physicians

[0132] A comparison study between the present AI system versus human physicians was conducted using 11,926 records from an independent cohort of pediatric patients from Zhengcheng Women and Children's Hospital, Guangdong Province, China. 20 pediatricians in five group with increasing levels of proficiency and years of clinical practice experience (4 in each level) were chosen to manually grade 11,926 records. These five groups are: senior resident physicians with more than three-year practice experience, junior physicians with eight-year practice experience, mid-level physicians with 15-year practice experience, attending physicians with 20-year practice experience, senior attending physicians with more than 25-year practice experience. A physician in each group read a random subset of 2981 clinical notes from this independent validation dataset and assigned a diagnosis. Each patient record was randomly assigned and graded by four physicians (one in each physician group). The diagnostic performance of each physician group in each of top 15 diagnosis categories was evaluated using an F1-score (Table 4)

[0133] **RESULTS**

[0134] Unsupervised diagnosis grouping

[0135] First, the diagnostic system analyzed the EHR in the absence of a defined classification system with human input. In the absence of pre-defined labeling, the computer was still able to detect trends in clinical features to generate a relatively sensible grouping structure (**FIG. 1**). In several instances, the computer clustered together diagnoses with related ICD-10 codes, illustrating that it was able to detect trends in clinical features that align with a human-defined classification system. However, in other instances, it clustered together related diagnoses but did not include other very similar diagnoses within this cluster. For example, it clustered "asthma" and "cough variant asthma" into the same cluster, but it did not include "acute asthma exacerbation," which was instead grouped with "acute sinusitis". Several similar pneumonia-related diagnosis codes were also spread across several different clusters instead of being grouped together. However, in many instances, it successfully established broad grouping of related diagnoses even without any directed labeling or classification system in place.

[0136] Medical record reformatting using NLP

[0137] A total of 6,183 charts were manually annotated using the schema described in the Methods section by senior attending physicians with more than 15 years clinical practice

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experience. The 3,564 manually annotated charts were then used to train the NLP information extraction model, and the remaining 2,619 were used to validate the model. The information extraction model summarized the key conceptual categories representing clinical data (**FIG. 2**). This NLP model utilized deep learning techniques (see Methods) to automate the annotation of the free text EHR notes into the standardized lexicon and clinical features allowing the further processing for diagnostic classification.

[0138] The median number of records included in the training cohort for any given diagnosis was 1,677, but there was a wide range (4 to 321,948) depending on the specific diagnosis. Similarly, the median number of records in the test cohort for any given diagnosis was 822, but the number of records also varied (range: 3 to 161,136) depending on the diagnosis.

[0139] The NLP model achieved excellent results in the annotation of the EHR physician notes (**Table 2**). Across all categories of clinical data, e.g., chief complaint, history of present illness, physical examination, laboratory testing, and PACS (Picture Archiving and Communication System) reports, the F1 scores exceeded 90% except in one instance, which was for categorical variables detected in laboratory testing. The highest recall of the NLP model was achieved for physical examination (95.62% for categorical variables, 99.08% for free text), and the lowest for laboratory testing (72.26% for categorical variables, 88.26% for free text). The precision of the NLP model was highest for chief complaint (97.66% for categorical variables, 98.71% for free text), and lowest for laboratory testing (93.78% for categorical variables, and 96.67% for free text). In general, the precision (or positive predictive value) of the NLP labeling was slightly greater than the recall (the sensitivity), but the system demonstrated overall strong performance across all domains (**Table 2**).

[0140] **Table 2. Performance of the natural language processing (NLP) model.** The performance of the deep learning-based NLP model in annotating the physician-patient encounters based on recall, precision, F1 scores, and instances of exact matches are detailed here for each category of clinical data.

Category of Clinical Data	**Type**	**Count**	**Recall**	**Precision**	**F1 Score**	**Exact Match**
Chief Complaint	Classification	23,130	--	--	--	98.14%
	Categorical	71	83.19%	97.66%	89.85%	52.11%

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	Variables					
	Free Text	10,416	97.92%	98.71%	98.31%	96.58%
History of Present Illness	Classification	147,725	--	--	--	98.92%
	Categorical Variables	1,434	89.09%	94.05%	91.50%	72.66%
	Free Text	25,352	96.24%	96.73%	96.49%	92.67%
Physical Examination	Classification	170,075	--	--	--	99.48%
	Categorical Variables	1,900	95.62%	96.22%	95.92%	90.26%
	Free Text	85,315	99.08%	99.30%	99.19%	98.41%
Laboratory Testing	Classification	19,365	--	--	--	96.32%
	Categorical Variables	456	72.26%	93.78%	81.62%	54.17%
	Free Text	9,407	88.26%	96.67%	92.27%	93.27%
PACS Reports	Classification	69,346	--	--	--	96.02%
	Categorical Variables	1,521	91.02%	95.08%	93.00%	73.24%
	Free Text	16,751	95.64%	95.13%	95.38%	89.56%

[0141] Performance of the hierarchical diagnosis model

[0142] After the EHR notes were annotated using the deep NLP information extraction model, logistic regression classifiers were used to establish a hierarchical diagnostic system. The diagnostic system was primarily based on anatomic divisions, e.g. organ systems. This was meant to mimic traditional frameworks used in physician reasoning in which an organ-based approach can be employed for the formulation of a differential diagnosis. Logistic regression classifiers were used to allow straightforward identification of relevant clinical features and ease of establishing transparency for the diagnostic classification.

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[0143] The first level of the diagnostic system categorized the EHR notes into broad organ systems: respiratory, gastrointestinal, neuropsychiatric, genitourinary, and generalized systemic conditions (**FIG. 3**). This was the first level of separation in the diagnostic hierarchy. Then, within each organ system, further sub-classifications and hierarchical layers were made where applicable. The most number of diagnoses in this cohort fell into the respiratory system, which was further divided into upper respiratory conditions and lower respiratory conditions. These were further separated into more specific anatomic divisions (e.g. laryngitis, tracheitis, bronchitis, pneumonia) (see Methods). The performance of the classifier was evaluated at each level of the diagnostic hierarchy. In short, the system was designed to evaluate the extracted features of each patient record and categorize the set of features into finer levels of diagnostic specificity along the levels of this decision tree, similar to how a human physician might evaluate a patient's features to achieve a diagnosis based on the same clinical data incorporated into the information model. Encounters labeled by physicians as having a primary diagnosis of "fever" or "cough" were eliminated, as these represented symptoms rather than specific disease entities.

[0144] Across all levels of the diagnostic hierarchy, this diagnostic system achieved a high level of accuracy between the predicted primary diagnoses based on the extracted clinical features by the NLP information model and the initial diagnoses designated by the examining physician (Table 3). For the first level where the diagnostic system classified the patient's diagnosis into a broad organ system, the median accuracy was 0.90, ranging from 0.85 for gastrointestinal diseases to 0.98 for neuropsychiatric disorders (Table 3a). Even at deeper levels of diagnostic specification, the system retained a strong level of performance. To illustrate, within the respiratory system, the next division in the diagnostic hierarchy was between upper respiratory and lower respiratory conditions. The system achieved an accuracy of 0.89 of upper respiratory conditions and 0.87 of lower respiratory conditions between predicted diagnoses and initial diagnoses (Table 3b). When dividing the upper respiratory subsystem into more specific categories, the median accuracy was 0.92 (range: 0.86 for acute laryngitis to 0.96 for sinusitis, Table 3c). Acute upper respiratory infection was the single most common diagnosis among the cohort, and the model was able to accurately predict the diagnosis in 95% of the encounters (Table 3c). Within the respiratory system, asthma was categorized separately as its own subcategory, and the accuracy ranged from 0.83 for cough variant asthma to 0.97 for unspecified asthma with acute exacerbation (Table 3d).

[0145] **Table 3. Illustration of diagnostic performance of the logistic regression classifier at multiple levels of the diagnostic hierarchy.** A) At the first level of the

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diagnostic hierarchy, the framework accurately discerned broad anatomic classifications between organ systems in this large cohort of pediatric patients. For example, among 315,661 encounters with primary respiratory diagnoses as determined by human physicians, the computer was able to correctly predict the diagnoses in 295,403 (92%) of them. B) Within the respiratory system, at the next level of the diagnostic hierarchy, the framework could discern between upper respiratory conditions and lower respiratory conditions. C) Within the upper respiratory system, further distinctions could be made into acute upper respiratory infection, sinusitis, and laryngitis. Acute upper respiratory infection and sinusitis were among the most common conditions in the entire cohort, and diagnostic accuracy exceeded 95% in both entities. D) Asthma was categorized as a separate category within the respiratory system, and the diagnostic system accurately distinguished between uncomplicated asthma, cough variant asthma, and acute asthma exacerbation.

[0146] Table 3A

	Physician-Assigned Diagnoses				
Computer-Predicted Diagnoses	Respiratory (n=315,661)	Gastro-intestinal (n=41,098)	Systemic Generalized (n=11,698)	Neuropsychiatric (n=8,410)	Genitourinary (n=1,326)
Respiratory (n=295,403)	0.92	0.1	0.048	0.0052	0.049
Gastrointestinal (n=55,704)	0.063	0.85	0.066	0.0052	0.044
Systemic/Generalized (n=14,267)	0.009	0.028	0.87	0.0034	0.012
Neuropsychiatric (n=9,007)	0.0018	0.0032	0.0034	0.98	0.0053
Genitourinary (n=3,812)	0.0062	0.014	0.0077	0.0044	0.89

[0147] Table 3B

	Physician-Assigned Diagnoses	
Computer-Predicted Diagnoses	Upper Respiratory (n=156,176)	Lower Respiratory (n=159,485)
Upper Respiratory (n=158,890)	0.89	0.11
Lower Respiratory (n=156,771)	0.13	0.87

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[0148] Table 3C

	Physician-Assigned Diagnoses		
Computer-Predicted Diagnoses	Acute upper respiratory infection (n=144,503)	Sinusitis (n=8,828)	Acute laryngitis (n=2845)
Acute upper respiratory infection (n=137,995)	0.95	0.033	0.11
Sinusitis (n=10,859)	0.016	0.96	0.028
Acute laryngitis (n=7,322)	0.033	0.01	0.86

[0149] Table 3D

	Physician-Assigned Diagnoses		
Computer-Predicted Diagnoses	Uncomplicated asthma (n=776)	Cough variant asthma (n=201)	Acute asthma exacerbation (n=121)
Uncomplicated asthma (n=740)	0.91	0.16	0
Cough variant asthma (n=236)	0.085	0.83	0.033
Acute asthma exacerbation (n=122)	0.0039	0.01	0.97

[0150] In addition to the strong performance in the respiratory system, the diagnostic model performed comparably in the other organ subsystems (see Supplementary Tables 1-4). Notably, the classifier achieved a very high level of association between predicted diagnoses and initial diagnoses for the generalized systemic conditions, with a accuracy of 0.90 for infectious mononucleosis, 0.93 for roseola (sixth disease), 0.94 for influenza, 0.93 for varicella, and 0.97 for hand-foot-mouth disease (Supplementary Table 4). The diagnostic framework also achieved high accuracy for conditions with potential for high morbidity, such as bacterial meningitis, for which the accuracy between computer-predicted diagnosis and physician-assigned diagnosis was 0.93 (Supplementary Table 3).

[0151] **Supplementary Table 1. Diagnostic performance in the gastrointestinal system.** A) The classifier performed with high accuracy across multiple entities grouped under the category of gastrointestinal diseases in this pediatric cohort. B) In the mouth-related

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disease category, the classifier exhibited a high level of correlation with physician-assigned diagnoses even for very specific entities.

[0152] Supplementary Table 1A

	Physician-Assigned Diagnoses		
Computer-Predicted Diagnoses	Mouth-related diseases (n=13,315)	Acute pharyngitis (n=11,429)	Diarrhea (n=16,354)
Mouth-related diseases (n=13,024)	0.86	0.11	0.016
Acute pharyngitis (n=11,774)	0.12	0.87	0.0079
Diarrhea (n=16,300)	0.012	0.016	0.98

[0153] Supplementary Table 1B

	Physician-Assigned Diagnoses			
Computer-Predicted Diagnoses	Acute tonsillitis (n=10,269)	Stomatitis (n=2,596)	Acute sialoadenitis (n=309)	Disease of the lips (n=141)
Acute tonsillitis (n=9,874)	0.94	0.065	0.084	0.0071
Stomatitis (n=2,836)	0.042	0.91	0.074	0.071
Acute sialoadenitis (n=469)	0.015	0.021	0.83	0.0071
Diseases of the lips (n=136)	0	0.0015	0.0097	0.91

[0154] Supplementary Table 2. Diagnostic performance in respiratory system subgroups. a) The classifier could accurately distinguish between acute bronchitis and bronchiolitis, as well as b) between different types of pneumonia, demonstrating high performance even within very specific diagnoses.

[0155] Supplementary Table 2a

	Physician-Assigned Diagnoses	
Computer-Predicted Diagnoses	Acute bronchitis (n=30,530)	Bronchiolitis (n=14,152)
Acute bronchitis (n=29,727)	0.94	0.065
Bronchiolitis (n=14,955)	0.057	0.93

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[0156] Supplementary Table 2b

	Physician-Assigned Diagnoses	
Computer-Predicted Diagnoses	Bacterial Pneumonia (n=16,895)	Mycoplasma Pneumonia (n=1,926)
Bacterial Pneumonia (n=15,339)	0.89	0.13
Mycoplasma Pneumonia (n=3,482)	0.11	0.87

[0157] Supplementary Table 3. Diagnostic performance in the neuropsychiatric system. The classifier performed with generally high accuracy across disease entities in the neuropsychiatric system. "Convulsions" included both epileptic conditions and febrile convulsions, and performance may have been affected by the small sample size.

	Physician-Assigned Diagnoses				
Computer-Predicted Diagnoses	Tic disorder (n=4,625)	Attention deficit hyperactivity disorder (n=2,819)	Bacterial meningitis (n=516)	Encephalitis (n=394)	Convulsions (n=56)
Tic disorder (n=4,552)	0.94	0.071	0.0097	0.028	0.054
Attention deficit hyperactivity disorder (n=2,792)	0.046	0.91	0.0078	0.015	0
Bacterial meningitis (n=580)	0.0067	0.0074	0.93	0.11	0.089
Encephalitis (n=384)	0.0032	0.0053	0.039	0.84	0.071
Convulsions (n=102)	0.0074	0.0046	0.014	0.01	0.79

[0158] Supplementary Table 4. Diagnostic performance among generalized systemic disorders. These diagnoses were included for affecting multiple organ systems or for producing generalized symptoms.

	Physician-Assigned Diagnoses					
Computer-Predicted Diagnoses	Hand-foot-mouth disease (n=8,987)	Varicella (n=748)	Influenza (n=691)	Infectious mononucleosis (n=563)	Sepsis (n=406)	Exanthema subitum (sixth disease) (n=303)
Hand-foot-mouth disease (n=8,789)	0.97	0.024	0.0058	0.0071	0.037	0.0066
Varicella (n=783)	0.0075	0.93	0.0043	0.0071	0.0025	0.033
Influenza (n=815)	0.01	0.012	0.94	0.059	0.054	0.02

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Infectious mononucleosis (n=577)	0.0032	0.0053	0.025	0.9	0.037	0.0099
Sepsis (n=390)	0.0012	0.004	0.022	0.02	0.86	0
Exanthema subitum (sixth disease) (n=344)	0.0045	0.021	0.0014	0.0036	0.0074	0.93

[0159] Identification of common features driving diagnostic prediction

[0160] To gain insight into how the diagnostic system generated a predicted diagnosis, we identified key clinical features driving the diagnosis prediction. For each feature, we identified what category of EHR clinical data it was derived from (e.g. history of present illness, physical exam, etc.) and whether it was coded as a binary classification or categorical. The interpretability of the predictive impact of used in the diagnostic system allowed the evaluation of whether the prediction was based on clinically relevant features.

[0161] For instance, using gastroenteritis as an example, the diagnostic system identified words such as "abdominal pain" and "vomiting" as key associated clinical features. The binary classifiers were coded such that the presence of a feature was denoted as "1" and absence was denoted as "0". In this case, "vomiting = 1" and "abdominal pain = 1" were identified as key features for both chief complaint and history of present illness. Under physical exam, "abdominal tenderness = 1" and "rash = 1" were noted to be associated with this diagnosis. Interestingly, "palpable mass = 0" was also associated, meaning that the patients predicted to have gastroenteritis usually did not have a palpable mass, which is consistent with human clinical experience. In addition to binary classifiers, there were also nominal categories in the schema. The feature of "fever" with a text entry of greater than 39 degrees Celsius also emerged as an associated clinical feature driving the diagnosis of gastroenteritis. Laboratory and imaging features were not identified as strongly driving the prediction of this diagnosis, perhaps reflecting the fact that most cases of gastroenteritis are diagnosed without extensive ancillary tests.

[0162] AI comparison to human physicians

[0163] The performance of the diagnosis between the AI model and human physicians was compared using 11,926 records from an independent cohort of pediatric patients. Twenty pediatricians in five groups with increasing levels of proficiency and years of clinical practice experience (see method section for description) manually graded 11,926 records. A physician in each group read a random subset of the raw clinical notes from this independent validation data and assigned a diagnosis. Next, the diagnostic performance of each physician

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group in each of top 15 diagnosis categories was evaluated using an F1-score (Table 4). Our model achieved an average F1-score higher than the two junior physician groups but lower than the three senior physician groups. This result suggests that this AI model may potentially assist junior physicians in diagnosis.

[0164] Table 4. Illustration of diagnostic performance between our AI model and physicians. F1-score was used to evaluate the diagnosis performance across different diagnosis groups (rows) between the model, and two junior physician groups and three senior physician groups (columns, see method section for description). It was observed that the model performed better than junior physician groups but slightly worse than three experienced physician groups.

	Our model	**Physicians**				
		Physician group #1	Physician group #2	Physician group #3	Physician group #4	Physician group #5
Asthma	0.92	0.801	0.837	0.904	0.89	0.935
Encephalitis	0.837	0.947	0.961	0.95	0.959	0.965
GI	0.865	0.818	0.872	0.854	0.896	0.893
Group: "Acute laryngitis"	0.786	0.808	0.73	0.879	0.94	0.943
Group: "Pneumonia"	0.888	0.829	0.767	0.946	0.952	0.972
Group: "Sinusitis"	0.932	0.839	0.797	0.896	0.873	0.87
Lower Respiratory	0.803	0.803	0.815	0.91	0.903	0.935
Mouth-related Diseases	0.897	0.818	0.872	0.854	0.896	0.893

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Neuro-Psych	0.895	0.925	0.963	0.96	0.962	0.906
Respiratory	0.935	0.808	0.769	0.89	0.907	0.917
Systemic-Generalized	0.925	0.879	0.907	0.952	0.907	0.944
Upper respiratory	0.929	0.817	0.754	0.884	0.916	0.916
root	0.889	0.843	0.863	0.908	0.903	0.912
Average F-score	**0.885**	**0.841**	**0.839**	**0.907**	**0.915**	**0.923**

[0165] DISCUSSION

[0166] In this study, an artificial intelligence (AI)-based natural language processing (NLP) model was generated which could process free text from physician notes in the electronic health record (EHR) to accurately predict the primary diagnosis in a large pediatric population. The model was initially trained by a set of notes that were manually annotated by an expert team of physicians and informatics researchers. Once trained, the NLP information extraction model used deep learning techniques to automate the annotation process for notes from over 1.4 million encounters (pediatric patient visits) from a single institution in China. With the clinical features extracted and annotated by the deep NLP model, logistic regression classifiers were used to predict the primary diagnosis for each encounter. This system achieved excellent performance across all organ systems and subsystems, demonstrating a high level of accuracy for its predicted diagnoses when compared to the initial diagnoses determined by an examining physician.

[0167] This diagnostic system demonstrated particularly strong performance for two important categories of disease: common conditions that are frequently encountered in the population of interest, and dangerous or even potentially life-threatening conditions, such as acute asthma exacerbation and meningitis. Being able to predict common diagnoses as well as dangerous diagnoses is crucial for any diagnostic system to be clinically useful. For common conditions, there is a large pool of data to train the model, so this diagnostic system

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is expected to exhibit better performance with more training data. Accordingly, the performance of the diagnostic system described herein was especially strong for the common conditions of acute upper respiratory infection and sinusitis, both which had an accuracy of 0.95 between the machine-predicted diagnosis and the human-generated diagnosis. In contrast, dangerous conditions tend to be less common and would have less training data. Despite this, a key goal for any diagnostic system is to achieve high accuracy for these dangerous conditions in order to promote patient safety. The present diagnostic system was able to achieve this in several disease categories, as illustrated by its performance for acute asthma exacerbations (0.97), bacterial meningitis (0.93) and across multiple diagnoses related to systemic generalized conditions, such as varicella (0.93), influenza (0.94), mononucleosis (0.90), and roseola (0.93). These are all conditions that can have potentially serious and sometimes life-threatening sequelae, so accurate diagnosis is of utmost importance.

[0168] In addition to its diagnostic accuracy, this system featured several other key strengths. One was that it allowed visualization of clinical features used for establishing the diagnosis. A key concern of AI-based methods in medicine is the "black box" nature of the analysis, but here the present approach provided the identification of the key clinical features for each diagnosis. This transparency allowed confirmation that the features being used by the deep-learning based model were clinically relevant and aligned with what human physicians have identified as important distinguishing or even pathognomonic features for diagnosis. Another strength of this study was the massive volume of data that was used, with over 1.4 million records included in the analysis. The large volume of encounters contributed to the robustness of the diagnostic system. Furthermore, another strength was that the data inputs in this model were harmonized. This represents an unconventional improvement upon other techniques, such as mapping the attributes to a fixed format (FHIR). Harmonized inputs describe the data in a consistent fashion and improve the quality of the data using machine learning capabilities. These strengths of transparency, high volume of data, and harmonization of data inputs are key advantages of this model compared with other NLP frameworks that have been previously reported.

[0169] Our overall framework of automating the extraction of clinical data concepts and features to facilitate diagnostic prediction can be applied across a wide array of clinical applications. The present study used primarily an anatomical or organ systems-based approach to the diagnostic classification. This broad generalized approach is often used in the formulation of differential diagnoses by physicians. However, the present disclosure can be modified to carry out a pathophysiologic or etiologic approach (e.g. "infectious" vs.

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"inflammatory" vs. "traumatic" vs. "neoplastic" and so forth). The design of the diagnostic hierarchy decision tree can be adjusted to what is most appropriate for the clinical situation.

[0170] In conclusion, this study describes an AI framework to extract clinically relevant information from free text EHR notes to accurately predict a patient's diagnosis. The NLP information model is able to perform the information extraction with high recall and precision across multiple categories of clinical data, and when processed with a logistic regression classifier, is able to achieve high association between predicted diagnoses and initial diagnoses determined by a human physician. This type of framework is useful for streamlining patient care, such as in triaging patients and differentiating between those patients who are likely to have a common cold from those who need urgent intervention for a more serious condition. Furthermore, this AI framework can be used as a diagnostic aid for physicians and assist in cases of diagnostic uncertainty or complexity, thus not only mimicking physician reasoning but actually augmenting it as well. Although this impact may be most obvious in areas where healthcare providers are in relative shortage compared to the overall population, such as China, healthcare resources are in high demand worldwide, and the benefits of such a system are likely to be universal.

EXAMPLE 2

[0171] The study of Example 1 is carried out on a patient population including non-Chinese and non-pediatric patients. Because the study of Example 1 focused on pediatric patients, most of whom presented for acute care visits, longitudinal analysis over time was less relevant. However, because the present study includes non-pediatric patients, a single patient's various encounters into a single timeline are collated to generate additional insights, particularly for adult patients or patients with chronic diseases that need long term management over time. Thus, the present study includes non-Chinese patients for purposes of diversifying the sources of data used to train the model.

[0172] An AI framework is generated to extract clinically relevant information from free text EHR notes to accurately predict a patient's diagnosis. The NLP information model is able to perform the information extraction with high recall and precision across multiple categories of clinical data, and when processed with a logistic regression classifier, is able to achieve high association between predicted diagnoses and initial diagnoses determined by a human physician.

EXAMPLE 3

[0173] Various biases can create problems with developing a reliable and trustworthy diagnostic model. Different measures can be taken to handle be potential biases in the model

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such as the model of example 1. For example, different hospitals from different regions of China might use different dialect, or use different EHR systems to structure the data, which might confuse the NLP model when the model is trained only in a hospital from Guangdong. Other models for word embeddings can be used to reduce bias. For example, word2vec is known to suffer outlier effect in word counts during word embeddings construction which may be avoided by adopting sense2vec. The performance of using LSTM-RNN versus adopting conditional random fields neural network (CRF-RNN) in the diagnostic model is also evaluated.

EXAMPLE 4

[0174] The AI-assisted diagnostic system incorporating the machine learning models or algorithms described in examples 1-2 can be implemented to improve clinical practice in several ways. First, it could assist with triage procedures. For example, when patients come to the emergency department or to an urgent care setting, their vital signs, basic history, and physical exam obtained by a nurse or midlevel provider could be entered into the framework, allowing the algorithm to generate a predicted diagnosis. These predicted diagnoses could help to prioritize which patients should get seen first by a physician. Some patients with relatively benign or non-urgent conditions may even be able to bypass the physician evaluation altogether and be referred for routine outpatient follow-up in lieu of urgent evaluation. This diagnostic prediction would help ensure that physicians' time is dedicated to the patients with the highest and/or most urgent needs. By triaging patients more effectively, wait times for emergent or urgent care may decrease, allowing improved access to care within a healthcare system of limited resources.

[0175] Another potential application of this framework is to assist physicians with the diagnosis of patients with complex or rare conditions. While formulating a differential diagnosis, physicians often draw upon their own experiences, and therefore the differential may be biased toward conditions that they have seen recently or that they have commonly encountered in the past. However, for patients presenting with complex or rare conditions, a physician may not have extensive experience with that particular condition. Misdiagnosis may be a distinct possibility in these cases. Utilizing this AI-based diagnostic framework harnesses the power generated by data from millions of patients and would be less prone to the biases of individual physicians. In this way, a physician could use the AI-generated diagnosis to help broaden his/her differential and think of diagnostic possibilities that may not have been immediately obvious.

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[0176] In practical terms, implementation of the models described herein in various clinical settings would require validation in the population of interest. Ongoing data would need to be collected and used for continuous training of the algorithm to ensure that it is best serving the needs of the local patient population. Essentially, a local benchmark can be established to establish a reference standard, similar to how clinical laboratories establish local reference standards for blood-based biomarkers.

EXAMPLE 5

[0177] Abstract

[0178] Artificial intelligence (AI) has emerged as a powerful tool to transform medical care and patient management. Here we created an end-to-end AI platform using natural language processing (NLP) and deep learning techniques to extract relevant clinical information from adult and pediatric electronic health records (EHRs). This platform was applied to 2.6 million medical records from 1,805,795 adult and pediatric patients to train and validate the framework, which captures common pediatric and adult disease classifications. We validated our results in independent external cohorts. In an independent evaluation comparing AI and human physician diagnosis, AI achieves high diagnostic accuracy comparable to human physician and can improve healthcare delivery by preventing unnecessary hospital stays and reducing costs and readmission rates. Therefore, this study provides a proof of concept for the feasibility of an AI system in accurate diagnosis and triage of common human diseases with increased hospital efficiency, resulting in improved clinical outcomes.

[0179] Introduction

[0180] Within the past few decades, advances in computer science have met a long-standing need for structured and organized clinical data by introducing electronic health records (EHRs). EHRs represent a massive repository of electronic data points containing a diverse array of clinical information. Current advantages include standardization of clinical documentation, improvement of communication between healthcare providers, ease of access to clinical records, and an overall reduction in systematic errors. Given their safety, efficacy, and ability to provide a higher standard of care, medical communities have been transitioning to EHRs within the past decade, but the reservoir of information they contain has remained unexploited. With the advent of data mining, EHRs have emerged as a valuable resource for machine learning algorithms given their ability to find associations between many clinical variables and outcomes. EHRs not only contain a preliminary diagnosis and treatment plans but other information modalities, such as patient demographics, health risk factors, and

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family history that have the potential to guide disease management and improve outcomes both at the individual and population levels.

[0181] Current medical practice often uses hypothetical-deductive reasoning to determine disease diagnosis. In a typical clinical encounter, the patient provides the physician with a chief complaint, usually consisting of a few symptoms with a history of onset. This information 'input' then prompts the physician to ask a subset of appropriately targeted questions, which further explores the chief complaint and help to narrow down the differential diagnoses. Each subset of questions will be dependent upon the information provided from the patient's previous answer. Additional inputs such as past medical history, family history, physical examination findings, laboratory tests and/or imaging studies act as independent variables, which the physician assesses to rule in or out certain diagnoses. Whereas a physician can weigh up a handful of variables, AI algorithms have the potential to rapidly and accurately assess the probabilistic effects of hundreds of variables to reach likely diagnoses. This would provide physicians with a valuable aid in the field of healthcare. Already, machine learning methods have demonstrated efficacy in image-based diagnoses, notably in radiology, dermatology, and ophthalmology. We devised a machine learning artificial intelligence (AI)-based platform to extract pertinent features from EHR clinical entries by natural language processing and reach probable diagnoses in both adult and pediatric patient populations in an 'end-to-end' manner. This platform achieved high diagnostic efficiency across a diverse disease spectrum while demonstrating comparable performance to experienced physicians.

[0182] Results

[0183] Patient characteristics

[0184] A total of 2,612,114 EHR records (380,665 adult; 2,231,449 pediatric) from 1,085,795 patients (223,907 adult, 861,888 pediatric) were collected for analysis. The First Affiliated Hospital of Guangzhou Medical University (GMU 1), provided 333,672 EHRs from 186,745 adult patients for machine learning and internal validation purposes. Guangzhou Women and Children's Medical Center (GWCMC1), provided 1,516,458 EHRs from 552,789 outpatient and inpatient pediatric visits for machine learning and internal validation purposes. The resulting AI-platform was externally validated on 46,993 EHRs involving 37,162 adult patients from The Second Affiliated Hospital of Guangzhou Medical University (GMU 2). External validation in the pediatric populations was performed on 714,991 EHRs from 339,099 pediatric patients from Guangzhou Women and Children's Medical Center (GWCMC2) from a second site in a different city (ZhuHai city). The

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weighted mean age across adult cohorts was 54.99 years (SD: +/- 17.28; range: 18-104; 50.30% female) (Table 7A). The weighted mean age across pediatric cohorts was 3.28 years (SD: 2.75; range: 0 to 18; 41.10% female, Table 7B). Table 8A-B shows the breakdown percentages of respective adult and pediatric disease classifications in the study cohorts. For all encounters, physicians classified primary diagnosis through the use of the International Classification of Disease ICD-10 codes (World Health Organisation), which were then grouped according to organ-based systems (See Methods). Twelve adult and six pediatric organ-based diagnostic classifications encompassed a wide range of pathology across adult and pediatric cohorts. Cancer, respiratory, and cardiovascular diseases were the most frequently encountered diagnoses in adults (Table 8A), while ear-nose-throat, respiratory, and gastrointestinal diseases most frequently occurred in pediatric populations (Table 8B).

[0185] Table 7A | General characteristics of the adult cohorts. Characteristics for the patients across all cohorts used in both training internal/external validations. Encounters were documented in the electronic health record (EHR).

Cohort	Training and Internal Validations	External Validations	Overall
	GMU 1	GMU 2	Combined
Mean Age +/- SD	54.23 +/- 17.27	58.81 +/- 17.33	54.99 +/- 17.28
Age Range	18-104	18-104	18-104
Males	93,623	17,659	111,282 (49.70%)
Females	93,122	19,503	112,625 (50.30%)
Number of Patients	186,745	37,162	223,907
Number of EHRs	333,672	46,993	380,665

[0186] Table 7B | General characteristics of the pediatric cohorts. Characteristics for the patients across all cohorts used in both training internal/external validations. Encounters were documented in the electronic health record (EHR).

Cohort	Training and Internal Validations	External Validations	Overall
	GWCMC1	GWCMC2	combined
Mean Age +/- SD	3.36 +/- 2.77	3.15 +/- 2.72	3.28 +/- 2.75

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Age Range	0-18	0-18	0-18
Males	308,458	199,184	507,642 (58.90%)
Females	214,331	139,915	354,246 (41.10%)
Number of Patients	522,789	339,099	861,888
Number of EHRs	1,516,458	714,991	2,231,449

[0187] Table 8A | Overview of Primary Diagnoses Across Adult Cohorts. Breakdown of primary organ-based diagnostic classifications by percentage across adult cohorts. Free segmented text implemented for training and validation purposes from electronic health records (EHRs) obtained from The First Affiliated Hospital of Guangzhou Medical University (GMU 1) and The Second Affiliated Hospital of Guangzhou Medical University (GMU 2).

Training and Testing on Adult Cohorts	GMU 1		GMU2	Total	
	Train set	Test set	Test set	Total Charts	Percent Ratio
Tumor or cancer disease	120386	834	9544	130,764	34.35%
Respiratory disease	82065	834	3944	86,843	22.81%
Cardiovascular disease	24574	834	5177	30,585	8.03%
Gynecological and Obstetric disease	22561	834	2102	25,497	6.70%
Neuropsychiatric disease	15611	834	4585	21,030	5.52%
Gastrointestinal disease	19190	834	11270	31,294	8.22%
Urological disease	12926	834	2002	15,762	4.14%
Orthopedic disease	9261	834	3679	13,774	3.62%
Endocrinologic and metabolic disease	7269	834	1856	9,959	2.62%
Ear-Nose-Throat disease	3828	834	870	5,532	1.45%
Nephrological disease	3378	834	1389	5,601	1.47%
Ophthalmological disease	2615	834	575	4,024	1.06%

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Total	**323,664**	**10,008**	**46,993**	**380,665**	**100.00%**

[0188] **Table 8B** | Overview of Primary Diagnoses Across Pediatric Cohorts. Breakdown of primary organ-based diagnostic classifications by percentage across pediatric cohorts. Free segmented text implemented for training and validation purposes from electronic health records (EHRs) obtained from separate Guangzhou Women and Children's Medical Center cohorts (GWCMC1 and GWCMC2).

Training and Testing on Pediatric Cohorts	GWCMC1		GWCMC2	Total	
	Train set	Test set	Test set	Total Charts	Percent Ratio
Ear-Nose-Throat disease	1084146	1000	520,295	1605441	71.95%
Respiratory disease	234925	1000	112,475	348400	15.61%
Gastrointestinal disease	95114	1000	34,998	131112	5.88%
General Systemic disease	55620	1000	23,049	79669	3.57%
Neuropsychiatric disease	31075	1000	20,813	52888	2.37%
Urological disease	9578	1000	3,361	13939	0.62%
Total	**1,510,458**	**6,000**	**714,991**	**2,231,449**	**100.00%**

[0189] An end-to-end approach for building an AI diagnostic model

[0190] A diagnostic classifier (**FIG. 5**) was built using end-to-end deep learning. The model reviewed the following three parameters per patient visit; chief complaint, history of present illness, and picture archiving and communication system (PACS) reports. Given that all EHRs were obtained from Chinese cohorts, text segmentation was essential in Chinese NLP due to the lack of spacing that separates meaningful units of text. As such, a comprehensive Chinese medical dictionary and Jieba, an open-source general-purpose Chinese word/phrase segmentation software, were applied to each record in order to extract relevant medical text (**FIG. 9**). Segmented words were then fed into a word embedding layer, followed by a bi-directional long-short term memory (LSTM) neural network layer. A diagnosis was selected by combining the forward and backward directional outputs of the LSTM layers (**FIG. 5**). The model was trained end-to-end to obtain optimal model parameters for all layers without any feature engineering other than the initial word segmentation. No labor-intensive labeling

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of clinical text features was necessary to train the model. Details of the model design and justification are given in Methods.

[0191] Performance of diagnosing common adult and pediatric conditions

[0192] Internal validations achieved high accuracies across all general disease categories. Average diagnostic efficiency for adults was 96.35% and ranged from 93.17% (Neuropsychiatric diseases) to 97.84% (Urological diseases) in the GMU1 internal validation test (**FIG. 6A** and Table 9A). The AUC of the micro-average ROC for adult classifications was 0.996 (**FIG. 6B**). Average diagnostic efficiency for pediatrics was 91.85% and ranged from 83.50% (Ear-Nose-Throat diseases) to 97.80% (Neuropsychiatric diseases) in GWCMC1 internal validation tests (**FIG. 6C** and Table 9B). The AUC of the micro-average ROC for pediatric classifications was 0.983 (**FIG. 6D**). Percent correct classification and model loss over time can be seen in **FIG. 10**. To further explore the precision of the model, a binary comparison between upper and lower respiratory diseases was performed in both adult and pediatric cohorts. The model achieved an average accuracy of 91.30% for adults (Table 10A) and 86.71% for pediatric patients (Table 10B). Next we evaluated if our AI model could distinguish the phenotypes between four common upper respiratory diseases and four common lower respiratory diseases. Multiclass comparisons showed high accuracies, where the average diagnostic efficiency for common upper and lower respiratory diseases were 92.25% and 84.85% respectively (Table 11A-11B) The highest upper and lower respiratory disease diagnoses were sinusitis and asthma with accuracies of 96.30% and 90.90% respectively. Other respiratory diseases showed high diagnostic efficiency and can be seen in Table 11A-11B. We also saw a high average accuracy of 93.30% in classifying between malignant and benign tumor among the adult patients from the oncology department (Table 12), suggesting that our AI model is useful towards assisting physicians in the diagnosis process.

[0193] **Table 9A** | End-To-End Model Performance in Organ-System Based Diagnostic Classifications of Adult Diseases

Adult AI Model	GMU 1		GMU2
	Train set	Test set	Test set
Tumor or cancer disease	99.40%	93.29%	89.79%
Respiratory disease	99.61%	97.84%	97.11%
Cardiovascular disease	99.80%	97.36%	96.54%

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Gynecological and Obstetric disease	99.83%	97.48%	84.68%
Gastrointestinal disease	99.83%	97.00%	95.81%
Neuropsychiatric disease	99.81%	93.17%	97.17%
Urological disease	99.95%	97.84%	94.11%
Orthopedic disease	99.96%	97.24%	96.38%
Endocrinologic and metabolic disease	99.93%	96.16%	96.93%
Ear-Nose-Throat disease	100.00%	97.12%	88.05%
Nephrological disease	100.00%	94.12%	96.18%
Ophthalmological disease	99.96%	97.60%	81.39%
Average	**99.63%**	**96.35%**	**94.31%**

[0194] Table 9B | End-To-End Model Performance in Organ-System Based Diagnostic Classifications of Pediatric Diseases

Pediatric AI Model	GWCMC1		GWCMC2
	Train set	Test set	Test set
Respiratory disease	87.54%	88.50%	80.00%
Ear-Nose-Throat disease	85.74%	83.50%	79.10%
Gastrointestinal disease	97.24%	96.80%	95.30%
General Systemic disease	93.46%	92.10%	88.70%
Neuropsychiatric disease	99.34%	97.80%	97.40%
Urological disease	99.10%	92.40%	81.20%
Average	**88.38%**	**91.85%**	**86.95%**

[0195] Table 10A | End-To-End Model Performance in Classifying Upper vs Lower Respiratory Diseases in Adults

Adult Upper vs. Lower Respiratory Systems	GMU 1	
	Train	Test
Upper Respiratory	95.73%	88.60%

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Lower Respiratory	93.74%	94.00%
Average	**94.74%**	**91.30%**

[0196] Table 10B | End-To-End Model Performance in Classifying Upper vs Lower Respiratory Diseases in Pediatrics

Pediatric Upper vs. Lower Respiratory Systems	GWCMC1	
	Train	Test
Upper Respiratory	89.89%	88.23%
Lower Respiratory	87.25%	86.01%
Average	**88.57%**	**87.12%**

[0197] Table 11A | End-To-End Model Performance in Diagnosing Common Pediatric Upper Respiratory Diseases

Common Pediatric Upper Respiratory Diseases	Model Performance
Acute Upper Respiratory Infection	93.90%
Sinusitis	96.30%
Acute Laryngitis	88.10%
Upper Tract Cough Syndrome	90.70%
Overall Accuracy	**92.25%**

[0198] Table 11B | End-To-End Model Performance in Diagnosing Common Pediatric Lower Respiratory Diseases

Common Pediatric Lower Respiratory Diseases	Model Performance
Bronchitis	81.30%
Pneumonia	76.80%
Tracheitis	90.40%
Asthma	90.90%
Overall Accuracy:	**84.85%**

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[0199] **Table 12** | Model Performance in Diagnosing Malignant vs. Benign Tumors

Malignant vs. Benign Tumor Comparisons	GMU 1	
	Train set	Test set
Malignant Tumors	95.51%	95.20%
Benign Tumors	96.56%	91.40%
Average	**95.60%**	**93.30%**

[0200] Validation of the AI framework in independent adult and pediatric cohorts

[0201] External validations achieved comparable accuracies to internal validations thus confirming the diagnostic ability of the AI model. In diagnosing common disease categories, average diagnostic efficiency for adults was 94.31% and ranged from 81.39% (Ophthalmologic diseases) to 97.17% (Neuropsychiatric disease) in GMU2 external validation tests (**FIG. 7A** and Table 9A). The AUC of the micro-average ROC for adult classifications was 0.993 (**FIG. 7B**).Average diagnostic efficiency for pediatrics was 86.95% and ranged from 79.10% (Ear-Nose-Throat diseases) to 97.40% (Neuropsychiatric diseases) in the GWCMC2 external validation test (**FIG. 7C** and Table 9B). The AUC of the micro-average ROC for pediatric classifications was 0.983 (**FIG. 7D**).

[0202] Results of Error Analysis

[0203] We sought to characterize the cases misclassified by the end-to-end AI model by comparing occurrences of key discriminating words and phrases that led to a misdiagnosed prediction for the adult population. We analyzed the clinical document text to extract keywords for each common condition by evaluating the term-frequency-inverse-term-frequency (TF-IDF) scores (cite??) for each keyword within documents of each common condition diagnosis and across all conditions. The evaluation was done independently of the diagnosis model and its diagnosis. A total of 3,679 keywords were evaluated. Among those keywords with top TF-IDF scores, a physician manually selected an average of 13.83 keywords for each of the 12 common adult conditions that are uniquely distinctive in each of the common conditions (Table 13). From these selected keywords, we analyzed the misclassified clinical documents by our end-to-end AI model by a set of inclusion criteria to check if they contain sufficient information regarding ground-truth condition compared to the model diagnosed condition. A document was marked as containing insufficient or ambiguous information for the diagnosis if they satisfy one of the inclusion criteria (see Methods). 91.78% (335/365) of the misclassified documents were marked (Table 13). The analysis

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shows that misclassified EHRs by the framework are mostly due to either ambiguous or missing information related to ground-truth diagnosis conditions.

[0204] Table 13 | Examples of AI-Labeled Text as Clinically Significant Features in Disease Classification and Diagnosis

Tumor Or Cancer Disease	Respiratory Disease	Cardio-Vascular Disease	Gyneco-Logical And Obstetric Disease	Gastro-Intestinal Disease	Neuro-Psychiatric Disease	Urological Disease	Orthopedic Disease	Endocrinologic And Metabolic Disease	Ear-Nose-Throat Disease	Nephrological Disease	Ophthalmological Disease
化疗	咳嗽咳痰	血压	停经	上腹	肢体	结石	关节	血糖	右耳	肌酐	右眼
淋巴结	咳嗽	心脏	阴道	腹痛	肢体乏力	尿管	腰椎	多饮	左耳	透析	左眼
细胞	感染	冠心病	阴道流血	胆囊	头晕	输尿管	骨折	糖尿	听力下降	浮肿	红眼
腺癌	气管	心悸	妊娠	腹胀	麻木	肾结石	膝关节	糖尿病	声嘶	蛋白	视网膜
肺癌	气促	胸闷	胎动	恶心呕吐	言语	右肾	麻木	甲状腺	声带	血肌酐	脱离
方案	喘息	胸痛	月经	酸嗳气	脑梗	左肾	下肢	多尿	耳鸣	泡沫	视网膜脱离
病理	支气管	大汗	孕妇	腹部	梗塞	频尿	椎间	血糖升高	耳漏	尿蛋白	遮挡
免疫	咳痰	心前区	下腹	疼痛	左侧肢体	尿频尿急	间盘	口干	鼻塞	肾病	眼科
癌	咯血	狭窄	产期	胆管	右侧肢体	尿频尿急尿痛	椎间盘	降糖	鼻出血	血液透析	眼痛
肿瘤	抗感染	动脉	性伴	黑便	耳鸣	血尿	椎体	多食	打鼾	尿量	眼红

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转移	呼吸	头晕	妊娠试验	右上腹	意识	双肾	腰痛	空腹	咽痛	血尿	视力
术后	肺炎	恶心呕吐		肛门	震颤	尿频	受限	控制	中耳炎	肾衰	流泪
肿物	粘痰			嗳气	抽搐	尿痛	活动受限	胰岛素	呼吸暂停	肾衰竭	视物变形
组织				反酸		尿急	骨质疏松	颈前	声带息肉	无尿	眼球转动
				腹泻			退行			肾功能	
				呕吐							
				结石							

[0205] Performance comparison between the end-to-end approach and the hierarchical diagnosis approach

[0206] We previously developed an AI model to generate diagnoses in pediatric patients. This previous model followed a query-answer based schema curated by physicians to replicate clinical settings. Free text was extracted from EHRs to create clinical features or "answers" that were then manually mapped to hypothetical clinical queries following a hierarchical approach. These pairs were then fed through an attention-based LSTM using Tensorflow (Google Brain). The model was trained with 200,000 steps and achieved high accuracies, yet required extensive labeling of ground truth clinical features for sufficient training. The current model employs an end-to-end approach that negates the need labor-intensive labeling of ground truth clinical features. Here we compared the results from the previous AI model to the current end-to-end AI model in a common task of distinguishing upper vs. lower respiratory diseases, and found the results to be nearly identical (**FIG. 8A-B**, Table 14A). When evaluating each model's precision in diagnosing common disease phenotypes, the accuracy of the end-to-end AI model was slightly higher than the traditional model using expert-annotated clinical features. Average diagnostic efficiency in diagnosing common pediatric upper respiratory diseases was 89.43% compared to the current model's 92.25% accuracy (**FIG. 8C-D**, Table 14B). Average diagnostic efficiency in diagnosing common pediatric lower respiratory diseases was 83.40% compared to the current model's

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84.85% accuracy (**FIG. 8E-F**, Table 14C). This suggested that given sufficient data, the end-to-end AI model may learn clinical features implicitly without extensive labeling efforts.

[0207] Table 14A | Traditional Schema vs. Current End-To-End Approach in Classifying Upper and Lower Respiratory Diseases

Upper vs. Lower Respiratory Systems: Traditional Schema vs. Current End-To-End Approach	Previous Schema Model	Current End-To-End Approach
Upper Respiratory	88.00%	88.00%
Lower Respiratory	87.00%	86.00%

[0208] Table 14B | Traditional Schema vs. Current End-To-End Approach in Diagnosing Common Upper Respiratory Diseases

Common Pediatric Upper Respiratory Diseases: Traditional Schema vs. Current End-To-End Approach	Previous Schema Model	Current End-To-End Approach
Acute Upper Respiratory Infection	93.20%	93.90%
Sinusitis	93.50%	96.30%
Acute Laryngitis	84.10%	88.10%
Upper Tract Cough Syndrome	86.90%	90.70%
Overall Accuracy	**89.43%**	**92.25%**

[0209] Table 14C | Traditional Schema vs. Current End-To-End Approach in Diagnosing Common Lower Respiratory Diseases

Common Lower Respiratory Diseases: Traditional Schema vs. Current End-To-End Approach	Previous Schema Model	Current End-To-End Approach
Bronchitis	83.70%	81.30%
Pneumonia	74.20%	76.80%
Tracheitis	89.20%	90.40%
Asthma	86.50%	90.90%
Overall Accuracy:	**83.40%**	**84.85%**

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[0210] Performance comparison between AI and human physicians

[0211] We further compared the diagnostic efficiencies between the AI model and physicians with variable levels of experience. The same internal validation test for adult patients (GMU1) consisting of 10,009 records was divided between a total of ten physicians and surgeons (three residents, four junior physicians; three chief physicians). Physicians reviewed corresponding medical records and proposed diagnoses that were then compared to original ground-truth diagnoses. These results were compared with the AI's performance in adult diseases. The physicians achieved an overall F-score average of 88.13% (range: 86.08% to 92.40%). Residents and Junior physicians achieved an overall F-score average of 86.66%; chief surgeons achieved an overall F-score average of 91.59 %; the AI model achieved an overall F-score average of 95.98% (Table 15). Across the twelve major disease classification categories, the AI model outperformed physicians in every disease category with the exception of ophthalmological diseases; physicians correctly classified ophthalmological disease 98.17% of the time compared to the AI model's 97.60% accuracy. When evaluating 11,926 pediatric records, model performance was comparable to pediatricians. Junior physicians achieved an overall F-score average of 83.9%; chief surgeons achieved an overall F-score average of 91.6%; the AI model achieved an overall F-score average of 87.2%. Thus, the AI model outperformed junior physicians across the twelve disease classifications.

[0212] **Table 15A** | Physician vs. AI Model Comparison. We used F1-score to evaluate the diagnosis performance across different diagnosis groups (rows) between our model, and three resident physician groups, four junior physician groups and three senior physician groups (columns, see method section for description). We observed that our model performed better than all physician groups.

Adult Disease category	AI Model	Junior Physician #1	Junior Physician #2	Junior Physician #3	Junior Physician #4	Senior Physician #1	Senior Physician #2	Senior Physician #3	Resident Physician #1	Resident Physician #2	Resident Physician #3	Overall Physician
Tumor or cancer disease	93.29%	81.73%	85.23%	83.67%	82.78%	88.65%	87.36%	87.67%	86.43%	81.37%	85.16%	85.01%
Respiratory disease	97.84%	82.56%	83.33%	82.61%	86.87%	93.42%	91.95%	86.59%	82.46%	84.81%	89.54%	86.41%
Cardiovascular disease	97.36%	86.53%	84.76%	89.19%	85.53%	94.59%	94.90%	86.41%	88.89%	95.89%	85.53%	89.22%

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Gynecological and Obstetric disease	93.01%	96.32%	94.00%	92.42%	88.10%	92.86%	98.70%	96.39%	91.67%	80.65%	86.67%	91.78%
Gastrointestinal disease	97.00%	82.98%	91.36%	87.50%	85.06%	91.43%	94.74%	89.42%	91.30%	91.30%	93.33%	89.84%
Neuropsychiatric disease	93.17%	85.09%	84.86%	85.71%	81.78%	85.78%	87.09%	86.89%	83.56%	83/54%	83.78%	84.95%
Urological disease	97.84%	83.33%	83.33%	98.00%	85.13%	89.78%	92.32%	91.67%	89.67%	87.55%	89.19%	89.00%
Orthopedic disease	97.24%	87.50%	91.65%	91.03%	83.34%	92.65%	93.46%	92.33%	89.33%	82.67%	73.91%	87.79%
Endocrinologic and metabolic disease	96.16%	83.45%	81.37%	82.58%	83.46%	89.82%	90.21%	89.37%	84.29%	83.36%	81.97%	84.99%
Ear-Nose-Throat disease	97.12%	87.25%	83.16%	82.36%	83.45%	92.34%	91.78%	92.08%	81.67%	79.79%	83.98%	85.79%
Nephrological disease	94.12%	81.68%	82.69%	84.08%	82.67%	91.25%	89.25%	88.98%	80.43%	81.58%	83.65%	84.63%
Ophthalmological disease	97.60%	97.50%	99.17%	99.00%	98.00%	99.26%	97.00%	98.76%	97.00%	97.96%	98.01%	98.17%
Average F-score	95.98%	86.33%	87.08%	88.18%	85.51%	91.82%	92.40%	90.55%	87.32%	86.08%	86.23%	88.13%

[0213] Table 15B | Illustration of diagnostic performance between our AI model and pediatricians We used F1-score to evaluate the diagnosis performance across different diagnosis groups (rows) between our model, and two junior physician groups and three senior physician groups (columns, see method section for description). We observed that our model performed better than junior physician groups but slightly worse than three experienced physician groups.

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	AI model	Physicians				
		Junior Physician group #1	Junior Physician group #2	Senior Physician group #3	Senior Physician group #4	Senior Physician group #5
Asthma	84.0%	80.1%	83.7%	90.4%	89.0%	93.5%
Encephalitis	81.0%	94.7%	96.1%	95.0%	95.9%	96.5%
GI	86.5%	81.8%	87.2%	85.4%	89.6%	89.3%
Group: "Acute laryngitis"	78.6%	80.8%	73.0%	87.9%	94.0%	94.3%
Group: "Pneumonia"	88.8%	82.9%	76.7%	94.6%	95.2%	97.2%
Group: "Sinusitis"	93.2%	83.9%	79.7%	89.6%	87.3%	87.0%
Lower Respiratory	80.3%	80.3%	81.5%	91.0%	90.3%	93.5%
Mouth-related Diseases	89.7%	81.8%	87.2%	85.4%	89.6%	89.3%
Neuro-Psych	94.0%	92.5%	96.3%	96.0%	96.2%	90.6%

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Respiratory	89.4%	80.8%	76.9%	89.0%	90.7%	91.7%
Systemic-Generalized	91.2%	87.9%	90.7%	95.2%	90.7%	94.4%
Upper respiratory	89.1%	81.7%	75.4%	88.4%	91.6%	91.6%
Average F-score	**87.2%**	**84.1%**	**83.7%**	**90.7%**	**91.7%**	**92.3%**

[0214] AI can provide Improvement of hospital management

[0215] We next conducted a study to address hospital management efficiency. We compared times of visits, costs, and admission rate between two groups where AI and physician diagnoses were concordant versus AI and physician diagnoses were discordant among top frequent disease categories. We showed there are marked differences in these two groups. In general, patients in the discordant groups have more visits, higher costs, and higher admission rates (Table 16), indicating beneficial effect of AI in assisting hospital management.

[0216] **Table 16** | AI can improve hospital management efficiencies. We analyzed 7 diseases categories which constituted the most frequent hospital visit. Match: diagnosis is concordant between AI and pediatricians; Mismatch, diagnosis is discordant between AI and pediatricians.

Disease category	**Group**	**Number of records**	**Visit times**		**Cost in outpatient visit (RMB)**		**Number of inpatient Admissions**	**admission rate**	**Concordance Rate**
			Mean	**STD**	**Mean**	**STD**			
Infectious mononucleosis	Match	328	4.05	2.02	1313.29	847.12	48	14.63%	76.64%
	Mismatch	100	4.85	2.43	1502.79	1129.8	36	36.00%	
Mycoplasma infection	Match	296	2.84	1.92	837.42	658.15	2	0.68%	64.91%
	Mismatch	160	3.13	2.23	1024.04	853.71	1	0.63%	

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Acute tonsillitis,	Match	1297	2.23	1.81	495.78	480.09	31	2.39%	
	Mismatch	377	2.57	1.92	637.09	543.24	13	3.45%	77.48%
Acute laryngitis	Match	2134	2.4	1.95	530	474.78	110	5.15%	
	Mismatch	691	3.88	2.74	949.25	761.84	53	7.67%	75.54%
Influenza flu	Match	401	1.97	1.47	416.48	430.48	24	5.99%	
	Mismatch	126	2.29	1.5	615.23	562.56	19	15.08%	76.09%
Enteroviral vesicular stomatitis with exanthem	Match	1440	2.28	1.67	478.45	425.52	50	3.47%	
	Mismatch	189	2.67	2.17	586.02	436.96	15	7.94%	88.40%
asthmatic bronchitis	Match	1047	2.64	1.87	792.41	652.22	13	1.24%	
	Mismatch	489	3.11	2.13	976.13	824.16	28	5.73%	68.16%

[0217] Identification of common features driving diagnostic prediction

[0218] In an effort to build a system that guides patients towards a diagnosis, the key driving words and the coding parameters (i.e. binary or categorical classification) that lead to an accurate diagnosis prediction were identified.

[0219] First, it was determined that a short chief complaint statement is sufficient for the framework to accurately identify the diagnosis of a patient, suggesting that the framework can potentially be built into a text-based automatic triage system that can provide initial evaluation of these common diseases.

[0220] Given the keywords identified from the word segmentation method applied to the available clinical documents, the term-frequency-inverse-term-frequency (TF-IDF) scores for each keyword was evaluated within documents of each common condition diagnosis and across all conditions. The evaluation was done independently of the diagnosis model and its diagnosis. A total of 3,679 keywords were evaluated (Table 13). Among those keywords with top TF-IDF scores, a physician manually selected an average of 13.83 keywords for each of the 12 common adult conditions that are uniquely distinctive in each of the common conditions (Table 13).

[0221] From these selected keywords, we analyzed the misclassified clinical documents by our end-to-end AI model by a set of inclusion criteria to check if they contain sufficient information regarding ground-truth condition compared to the model diagnosed condition. A document was marked as containing insufficient or ambiguous information for the diagnosis if they satisfy one of the inclusion criteria (see Methods). 91.78% (335/365) of the misclassified documents were marked. The analysis shows that misclassified EHRs by the

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framework are mostly due to either ambiguous or missing information related to ground-truth diagnosis conditions.

[0222] Discussion

[0223] Supervised machine learning is highly applicable and currently under-utilized in the medical field. Whereas previous learning systems required training parameters in a monotonous, step-by-step order, end-to-end learning trains parameters in a simultaneous manner that automatically maps the relationship between inputs and outputs. As shown, our end-to-end approach achieved comparable results to the traditional model in diagnosing specific respiratory diseases without requiring labor-intensive annotation of ground truth clinical features. As a means to access a multitude of variables provided in the physician consultation notes, we used an end-to-end approach to link free text from EHRs to accurately predict primary disease diagnosis via a NLP-based deep learning hybrid. For training purposes, annotations from expert physicians and informatics researchers were processed through an AI model as a means to extract important clinical features. This AI model was then applied to physician notes from over 2.61 million encounters across several major referral hospitals in China to extract meaningful clinical features into a deep learning classifier. Our model achieved a high level of accuracy in disease classification and predicting disease diagnosis across all common adult and pediatric conditions when compared to the original assessment and covers a wide range of disease categories. Furthermore, error analysis showed that records misclassified by our AI system were mostly due to missing or ambiguous information from the records. Therefore, discrepancies between AI and final diagnosis may suggest the need to improve the reporting quality of records in EHR.

[0224] One of the major challenges in healthcare across the globe is the increasing patient population and limited medical resources. In the top 18 countries serving 50% of the world's population, the mean consultation time is five minutes. In Bangladesh, for instance, the average consultation time is 48 seconds. Research has shown that a human's processing capacity often plateaus around four variables, therefore to obtain the relevant clinical ifnormation from the patient and deduce a diagnosis based on a number of variables within a few minutes is error prone. Deep learning can easily extract relationships between hundreds of variables across multiple dimensions within a relatively short time frame. When comparing average diagnostic efficiencies between our model and physicians, our model outperformed disease classifications in all categories with the exception of ophthalmological cases. In classifying diseases such as endocrinology and nephrology, model was able to better

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identify these conditions compared to physicians with accuracies of 38.75% and 41.06% respectively, demonstrating its efficacy as a diagnostic tool in clinical evaluation. Furthermore, our AI model showed high efficiency in diagnosing specific common diseases across a range of disease categories which may better serve hospital management by accurately triaging patients. For instance, by implementing an AI-assisted triaging system, patients who are diagnosed with more urgent or life-threatening conditions could be prioritized over those with relatively benign conditions. Under these circumstances, more hospital time and/or resources could be allocated to patients with greater or more urgent medical need compared to those who could bypass urgent physician evaluation and be referred for routine outpatient assessment.

[0225] Error analysis showed that records misclassified by the AI system are mostly due to missing or ambiguous information from the records. Therefore, discrepancies between AI and final diagnosis may suggest the need to improve the reporting quality of records in EHR. By comparing visits, costs, and admission rate, hospital stay duration, admission rate between AI and physician diagnosis-concordant group versus AI and physician diagnosis-discordant group among top disease categories, it was shown that the AI system can provide beneficial effect of AI in assisting hospital management, and reducing complications.

[0226] AI implementation, however, should not negate medicine's need for a compassionate hand, but rather augment the services provided to our patients. Disease is not biased, so neither should healthcare. However, often times past experiences may cause a physician to inaccurately place more emphasis on certain features than others leading to misdiagnosis, especially those pertaining to rare diseases. AI utilizes data from millions of patients across the globe and is trained on a wide array of outcomes that many physicians may not experience in their relative expertise. AI could serve the physician as a knowledgeable, unbiased assistant in diagnosing diseases they may often be overlooked. Furthermore, AI can take into account features that may be considered insignificant in clinical settings, such as certain socioeconomic factors, race, etc., which could make AI particularly useful in the applications of epidemiology.

[0227] In conclusion, the hybrid NLP deep learning model was able to accurately assess primary disease diagnosis across a range of organ systems and subsystems. The potential benefits of the model's application to hospital management efficiencies by reducing costs and hospital stay was shown. This system shows great potential in triaging patients in areas where healthcare providers are in relative shortage compared to the overall population, such as

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China or Bangladesh, and in providing clinical aide to patients in rural environments where physicians are not as easily accessible.

[0228] For example, our NLP deep learning model was able to accurately classify presenting diseases into adult and pediatric ICD-10 categories, with the ability to further diagnose specific disease conditions. The model outperformed physicians in almost all categories in terms of diagnostic efficiency, therefore demonstrating its potential utility as a diagnostic aide that could be used to triage patients in areas of healthcare resource shortage or provide a resource for patients in environments where access to care may be limited.

[0229] Methods

[0230] Data collection

[0231] A retrospective study was conducted on 2,612,114 EHRs (380,665 adult; 2,231,449 pediatric) from 1,085,795 patients (223,907 adult, 861,888 pediatric). The First Affiliated Hospital of Guangzhou Medical University (GMU 1), a major academic tertiary medical referral center, provided 186,745 adult patients with 333,672 EHRs for training and internal validation purposes. Guangzhou Women and Children's Medical Center (GWCMC1), a major academic pediatric medical referral center, provided 552,789 outpatient and inpatient pediatric visits consisting of 1,516,458 EHRs for training and internal validation purposes. The Second Affiliated Hospital of Guangzhou Medical University (GMU 2), provided 37,162 patients consisting of 46,993 EHRs for external validation purposes in adults. A separate cohort of pediatric data from Guangzhou Women and Children's Medical Center (GWCMC2) was collected over later time points which did not overlap with those used in the machine learning. This data provided 339,099 patients with 714,991 EHRs for external validation in pediatrics. These records encompassed physician encounters for pediatric and adult patients presenting to these medical institutions from January 2016 to October 2018. The study was approved by the First Affiliated Hospital of Guangzhou Medical University, the Second affiliated Hospital of Guangzhou Medical University, and Guangzhou Women and Children's Medical Center. This study complied with the Declaration of Helsinki and institutional review board and ethics committee. For all encounters, physicians classified primary diagnosis through the use of the International Classification of Disease ICD-10 codes. Twelve ICD 10 codes encompassed adult diseases while 6 ICD 10 codes encompassed common pediatric diseases. Certain disease categories, such as gynecological/obstetric and cardiovascular diseases, were considered inapplicable to include for pediatric analysis and were therefore excluded. All disease categories provide a wide range of pathology across adult and pediatric cohorts.

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[0232] The end-to-end AI model framework

[0233] The diagnostic model utilized free-text descriptions available in EHRs generated from Zesing Electronic Medical Records. The model reviewed the following three parameters per patient visit; chief complaints, history of present illness, and picture archiving and communication system (PACS) reports. Given that all EHRs were obtained from Chinese cohorts, text segmentation was essential in Chinese NLP due to the lack of spaces that separate meaningful units of text. As such, a comprehensive Chinese medical dictionary10 and Jieba, a widely used open-source general-purpose Chinese word/phrase segmentation software, were customized and applied to each record as a means to extract text containing relevant medical information (Supplementary Fig. 1). These extracted words were then fed into a word embedding layer to convert text into 1X100 vector dimensions. Vectors were then fed into a bi-directional long-short term memory (LSTM) recurrent neural network using PyTorch's default configuration that comprises 256 hidden units for each of the two layers. The model learns word embedding vectors for all 552,700 words and phrases in the vocabulary and all the weights in the bidirectional LSTM. The learning rate was set to default 0.001 in all of our model training processes. The output vectors of LSTM of each direction are concatenated and fed into a fully-connected SoftMax layer that computes a score for each diagnostic class. The class with the highest score is considered the model's diagnosis (Fig. 1). The model was trained end-to-end to obtain optimal model parameters for all layers without any feature engineering other than the initial word segmentation. No labor-intensive labeling of clinical features was necessary to train the model.

[0234] Error analysis

[0235] The 365 adult clinical records that were misclassified into an incorrect diagnosis among one of the twelve adult common conditions were considered. The records with the keywords that were identified for each condition were compared. A record was considered to contain missing information or ambiguous if it satisfies one of the following inclusion criteria:

[0236] No ground truth condition keywords.

[0237] More keywords for the predicted condition than keywords for the ground-truth condition.

[0238] Less than five keywords for the ground-truth condition.

[0239] Less than ten keywords from either the ground-truth or predicted conditions.

[0240] More than one chief complaint section.

[0241] More than one history of present illness section.

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[0242] Next, a similar error analysis was performed for the 1,095 adult clinical records that were misclassified when the model took only the chief complaints as the input. Since a chief complaint is short, only the first two criteria were considered in this case.

[0243] Comparative performance between our AI system and human physicians

[0244] We conducted a comparison study between our AI system versus human physicians. Free text, patient ID, and date of evaluation from 10,008 EHRs from GMU 1 internal validation test set were randomly sorted and equally divided between ten family medicine/general practitioners and chief physicians to manually label disease diagnosis. Two resident physicians and one resident surgeon with 1-2 years of practice experience, three junior physicians and one junior surgeon with 5-7 years of practice experience, and three chief surgeons with 8-10 years of practice experience made up the conglomerate of the practitioners. We evaluated the diagnostic performance of each physician group in each of top 12 diagnosis categories using an F1-score.

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CLAIMS

We Claim:

1. A method for providing a medical diagnosis, comprising:
   a) obtaining medical data;
   b) using a natural language processing (NLP) information extraction model to extract and annotate clinical features from the medical data; and
   c) analyzing at least one of the clinical features with a disease prediction classifier to generate a classification of a disease or disorder, the classification having a sensitivity of at least 80%.
2. The method of claim 1, wherein the NLP information extraction model comprises a deep learning procedure.
3. The method of claim 1, wherein the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes.
4. The method of claims 1, wherein the NLP information extraction model utilizes a plurality of schema, each schema comprising a feature name, anatomical location, and value.
5. The method of claim 4, wherein the plurality of schema comprises at least one of history of present illness, physical examination, laboratory test, radiology report, and chief complaint.
6. The method of claim 1, further comprising tokenizing the medical data for processing by the NLP information extraction model.
7. The method of claim 1, wherein the medical data comprises an electronic health record (EHR).
8. The method of claim 1, wherein the classification has a specificity of at least 80%.
9. The method of claim 1, wherein the classification has an F1 score of at least 80%.
10. The method of claim 1, wherein the clinical features are extracted in a structured format comprising data in query-answer pairs.
11. The method of claim 1, wherein the disease prediction classifier comprises a logistic regression classifier.
12. The method of claim 1, wherein the disease prediction classifier comprises a decision tree.
13. The method of claim 1, wherein the classification differentiates between a serious and a non-serious condition.

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14. The method of claim 1, wherein the classification comprises at least two levels of categorization.
15. The method of claim 1, wherein the classification comprises a first level category indicative of an organ system.
16. The method of claims 15, wherein the classification comprises a second level indicative of a subcategory of the organ system.
17. The method of claim 1, wherein the classification comprises a diagnostic hierarchy that categorizes the disease or disorder into a series of narrower categories.
18. The method of claim 17, wherein the classification comprises a categorization selected from the group consisting of respiratory diseases, genitourinary diseases, gastrointestinal diseases, neuropsychiatric diseases, and systemic generalized diseases.
19. The method of claim 18, wherein the classification further comprises a subcategorization of respiratory diseases into upper respiratory diseases and lower respiratory diseases.
20. The method of claim 19, wherein the classification further comprises a subcategorization of upper respiratory disease into acute upper respiratory disease, sinusitis, or acute laryngitis.
21. The method of claim 19, wherein the classification further comprises a subcategorization of lower respiratory disease into bronchitis, pneumonia, asthma, or acute tracheitis.
22. The method of claim 18, wherein the classification further comprises a subcategorization of gastrointestinal diseases into diarrhea, mouth-related diseases, or acute pharyngitis.
23. The method of claim 18, wherein the classification further comprises a subcategorization of neuropsychiatric diseases into tic disorder, attention-deficit hyperactivity disorder, bacterial meningitis, encephalitis, or convulsions.
24. The method of claim 18, wherein the classification further comprises a subcategorization of systemic generalized diseases into hand, foot and mouth disease, varicella without complication, influenza, infectious mononucleosis, sepsis, or exanthema subitum.
25. The method of claim 1, further comprising making a medical treatment recommendation based on the classification.

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26. The method of claim 1, wherein the disease prediction classifier is trained using end-to-end deep learning.

27. A computer-implemented system comprising: a digital processing device comprising: at least one processor, an operating system configured to perform executable instructions, a memory, and a computer program including instructions executable by the digital processing device to create an application for providing a medical diagnosis, the application comprising:

a) a software module obtaining medical data;

b) a software module using a natural language processing (NLP) information extraction model to extract and annotate clinical features from the medical data; and

c) a software module analyzing at least one of the clinical features with a disease prediction classifier to generate the classification of a disease or disorder, the classification having a sensitivity of at least 80%.

28. The system of claim 27, wherein the NLP information extraction model comprises a deep learning procedure.

29. The system of claim 27, wherein the NLP information extraction model utilizes a standard lexicon comprising keywords representative of assertion classes.

30. A computer-implemented system comprising: a digital processing device comprising: at least one processor, an operating system configured to perform executable instructions, a memory, and a computer program including instructions executable by the digital processing device to create an application for generating a disease prediction classifier for providing a medical diagnosis, the application comprising:

a) a software module for providing a lexicon constructed based on medical texts, wherein the lexicon comprises keywords relating to clinical information;

b) a software module for obtaining medical data comprising electronic health records (EHRs);

c) a software module for extracting clinical features from the medical data using an NLP information extraction model;

d) a software module for mapping the clinical features to hypothetical clinical queries to generate question-answer pairs; and

e) a software module for training the NLP classifier using the question-answer pairs, wherein the NLP classifier is configured to generate classifications having a

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sensitivity of at least 80% when tested against an independent dataset of at least 100 EHRs.

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FIG. 1

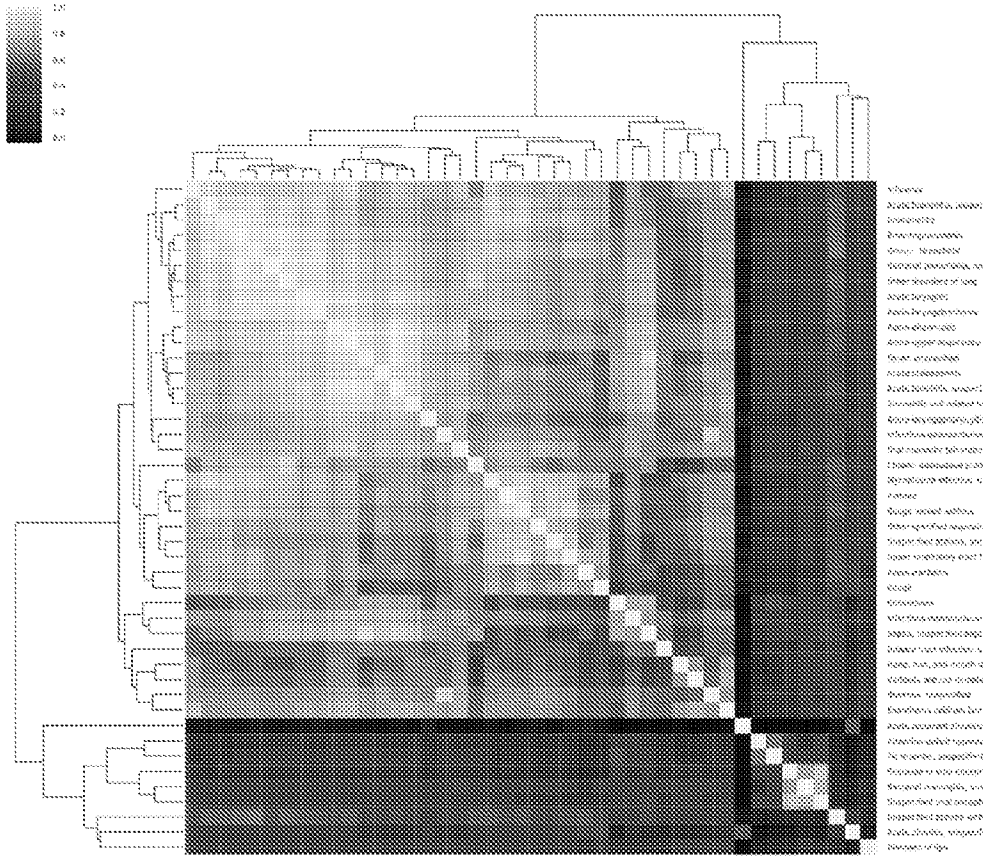

FIG. 2

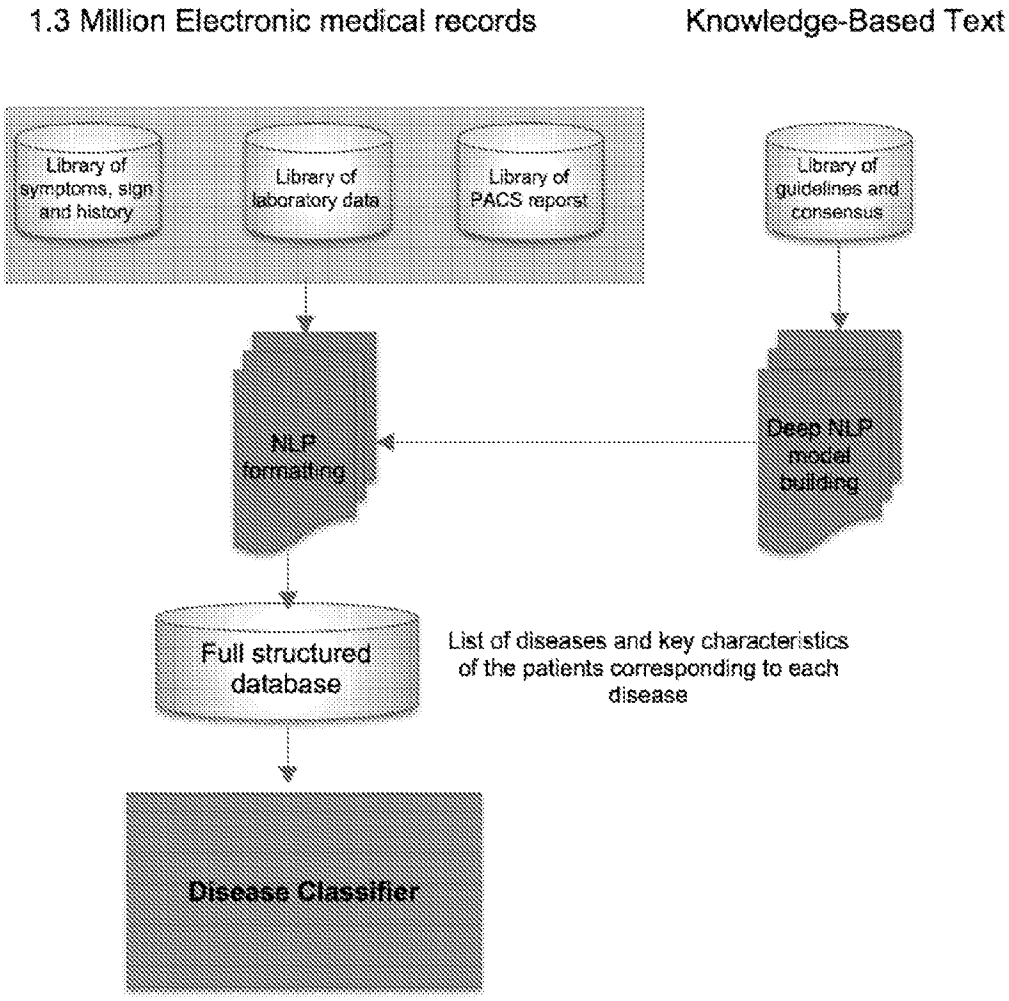
1.3 Million Electronic medical records
Knowledge-Based Text
Library of symptoms, sign and history
Library of laboratory data
Library of PACS report
Library of guidelines and consensus
NLP formatting
Deep NLP model building
Full structured database
List of diseases and key characteristics of the patients corresponding to each disease
Disease Classifier

FIG. 3

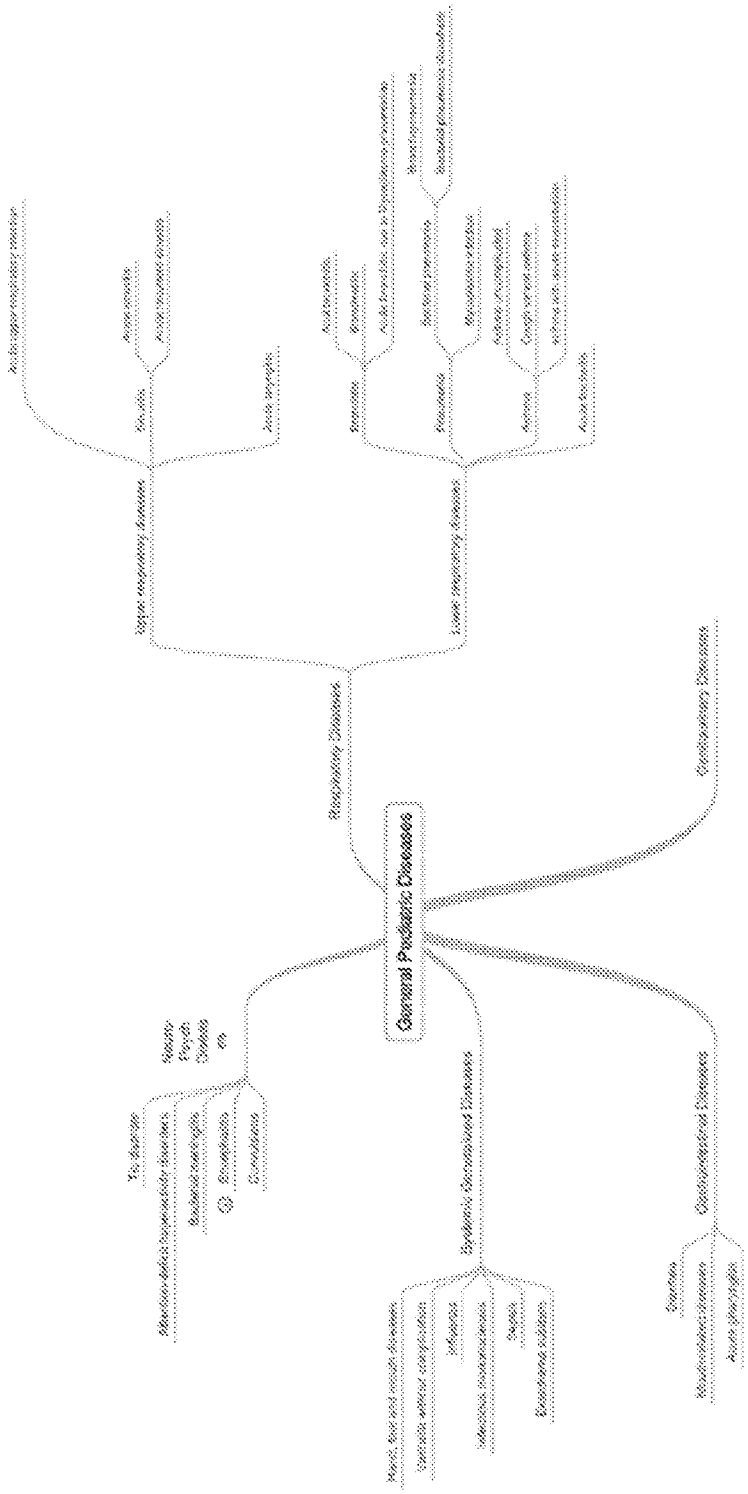
General Pediatric Diseases
Respiratory Diseases
Upper respiratory diseases
Lower respiratory diseases
Gastrointestinal Diseases
Systemic Genetic/Inherited Diseases
Neuro-Psych Diseases
Cardiovascular Diseases

FIG. 4

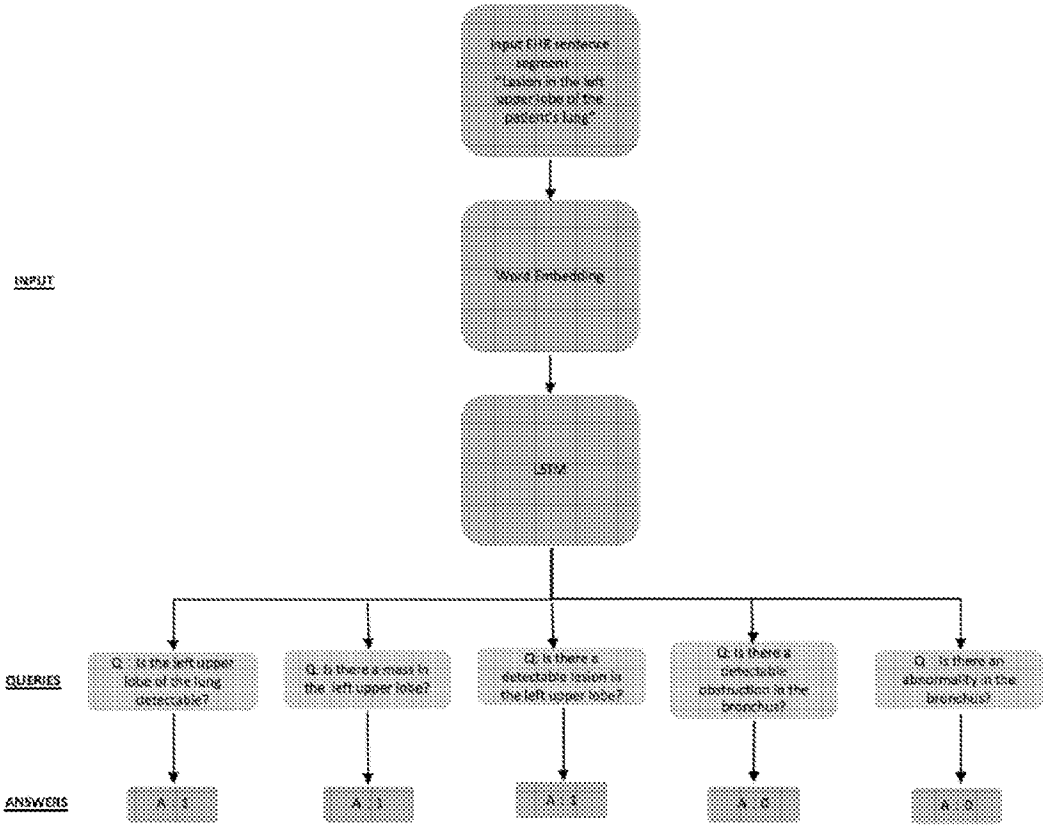
Input EHR sentence segment: "Lesion in the left upper lobe of the patient's lung"
Word Embedding
LSTM
INPUT
QUERIES
ANSWERS
Q: Is the left upper lobe of the lung resectable?
Q: Is there a mass in the left upper lobe?
Q: Is there a resectable lesion in the left upper lobe?
Q: Is there a resectable obstruction in the bronchus?
Q: Is there an abnormality in the bronchus?
A: 1
A: 1
A: 1
A: 0
A: 0

FIG. 5

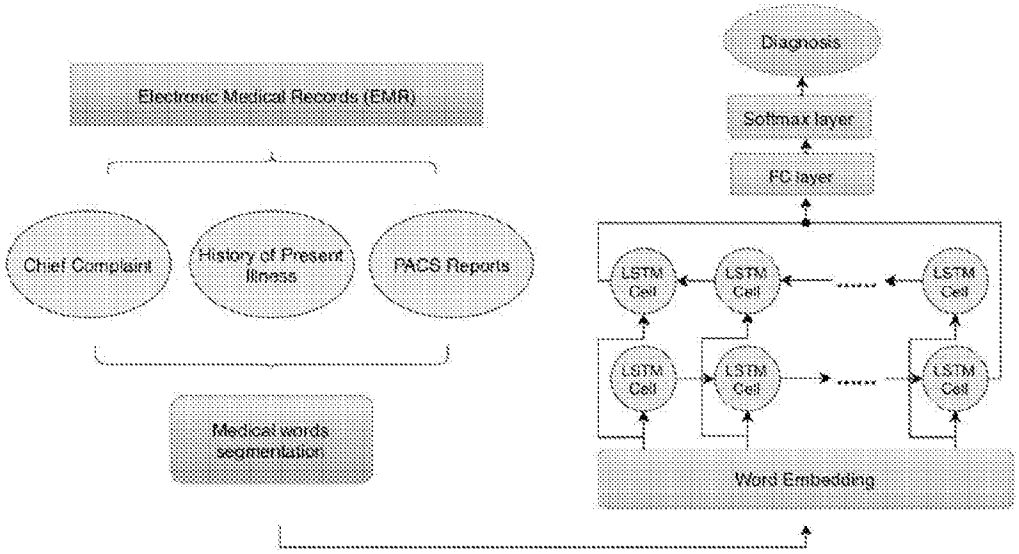
Electronic Medical Records (EMR)
Chief Complaint
History of Present Illness
PACS Reports
Medical words segmentation
Diagnosis
Softmax layer
FC layer
LSTM Cell
LSTM Cell
LSTM Cell
LSTM Cell
LSTM Cell
LSTM Cell
Word Embedding

FIG. 6A

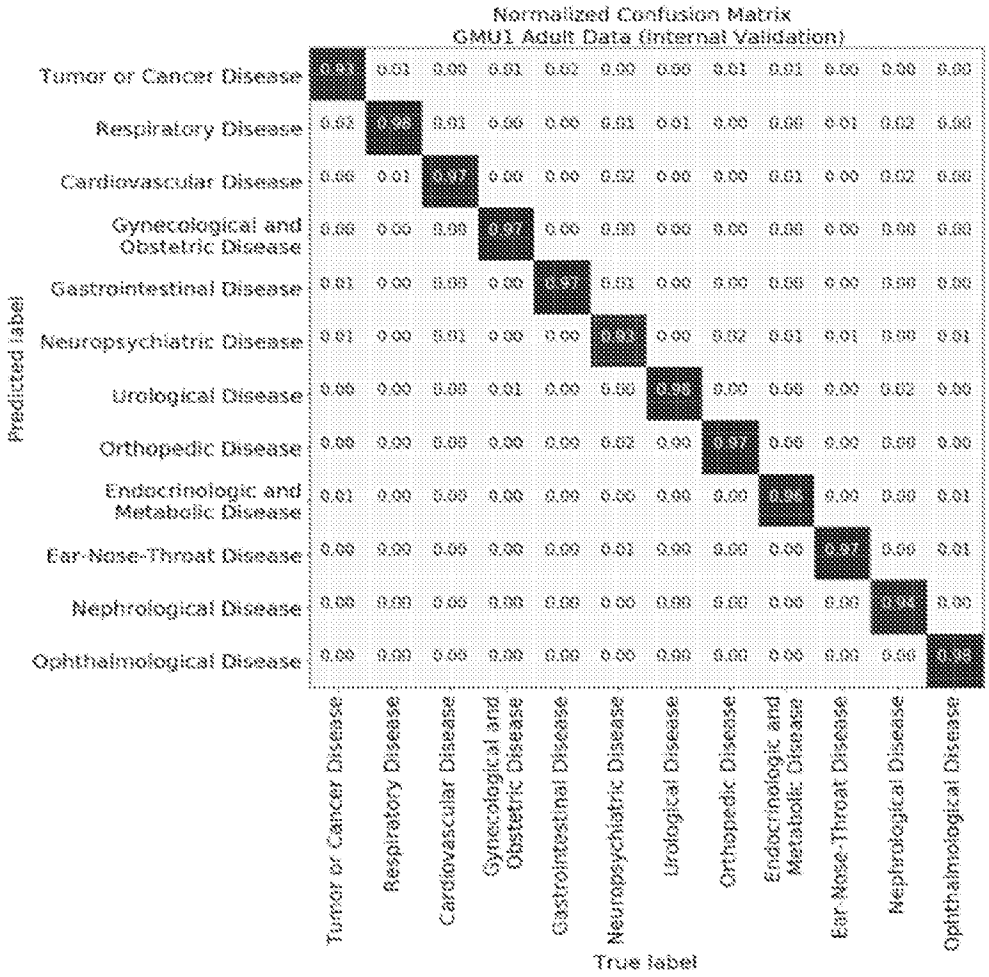
Normalized Confusion Matrix
GMU1 Adult Data (internal Validation)
Predicted label
True label
Tumor or Cancer Disease
Respiratory Disease
Cardiovascular Disease
Gynecological and Obstetric Disease
Gastrointestinal Disease
Neuropsychiatric Disease
Urological Disease
Orthopedic Disease
Endocrinologic and Metabolic Disease
Ear-Nose-Throat Disease
Nephrological Disease
Ophthalmological Disease

FIG. 6B

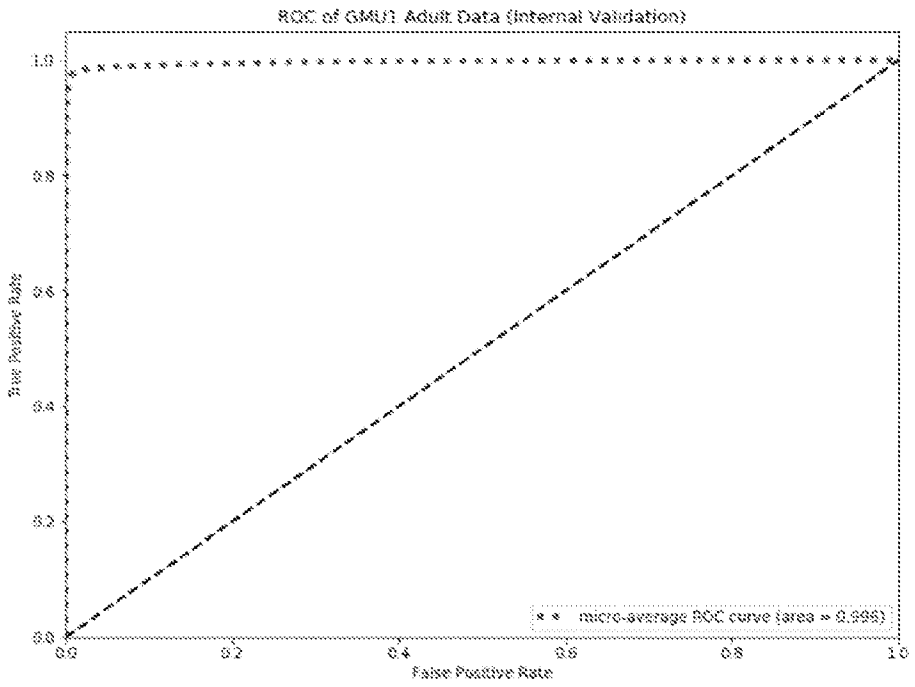
ROC of GMU1 Adult Data (Internal Validation)
True Positive Rate
False Positive Rate
micro-average ROC curve (area = 0.998)
0.0
0.2
0.4
0.6
0.8
1.0

FIG. 6C

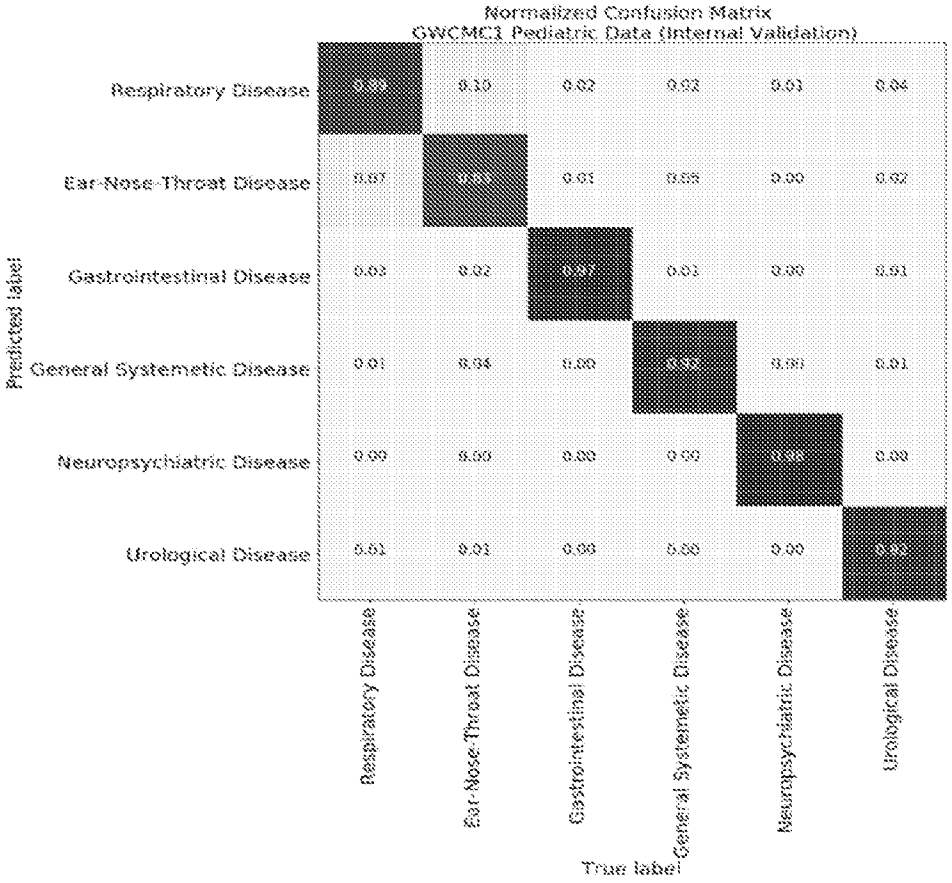
Normalized Confusion Matrix
GWCMC1 Pediatric Data (Internal Validation)
Predicted label
Respiratory Disease
Ear-Nose-Throat Disease
Gastrointestinal Disease
General Systemetic Disease
Neuropsychiatric Disease
Urological Disease
True label
Respiratory Disease
Ear-Nose-Throat Disease
Gastrointestinal Disease
General Systemetic Disease
Neuropsychiatric Disease
Urological Disease

FIG. 6D

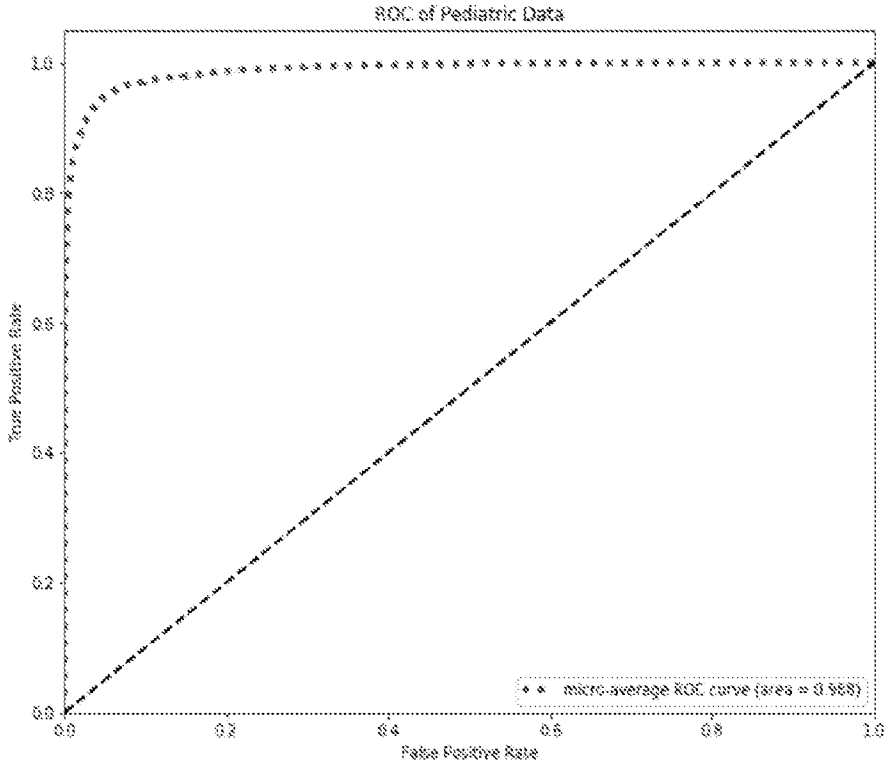
ROC of Pediatric Data
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
micro-average ROC curve (area = 0.988)

FIG. 7A

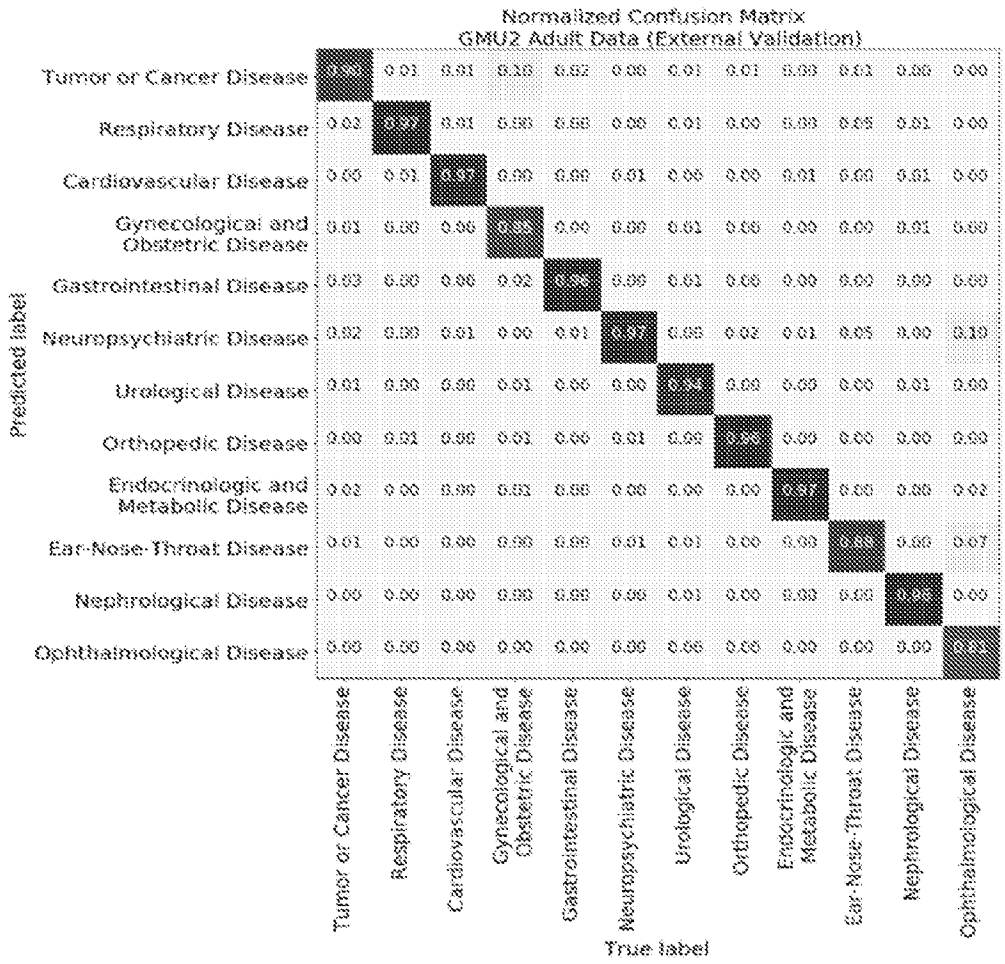
Normalized Confusion Matrix
GMU2 Adult Data (External Validation)
Predicted label
True label
Tumor or Cancer Disease
Respiratory Disease
Cardiovascular Disease
Gynecological and Obstetric Disease
Gastrointestinal Disease
Neuropsychiatric Disease
Urological Disease
Orthopedic Disease
Endocrinologic and Metabolic Disease
Ear-Nose-Throat Disease
Nephrological Disease
Ophthalmological Disease

FIG. 7B

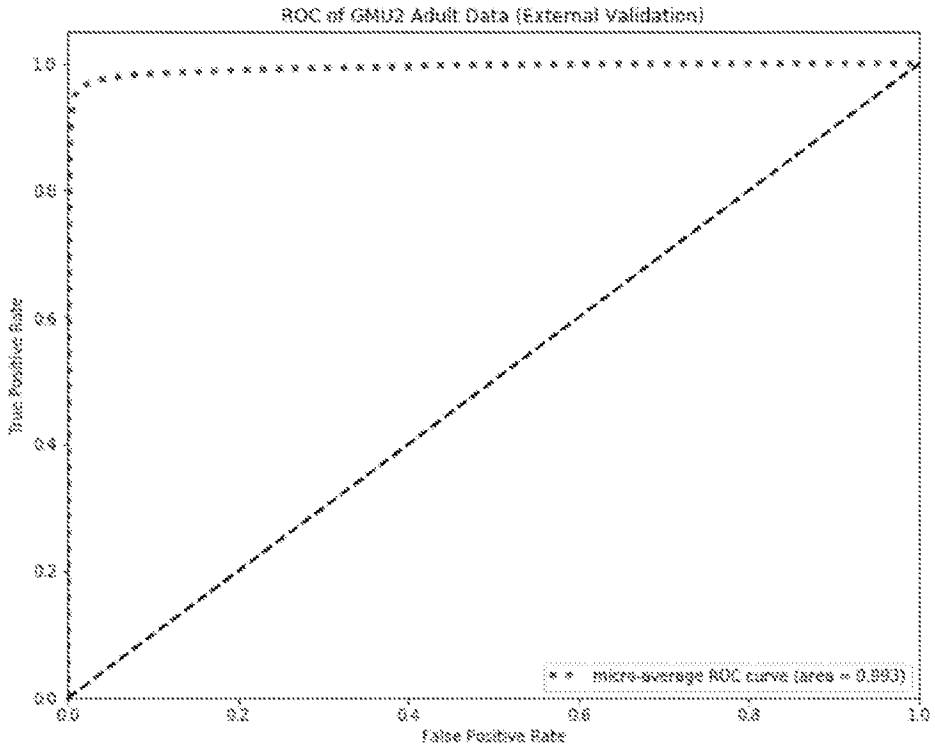
ROC of GMU2 Adult Data (External Validation)
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
micro-average ROC curve (area = 0.993)

FIG. 7C

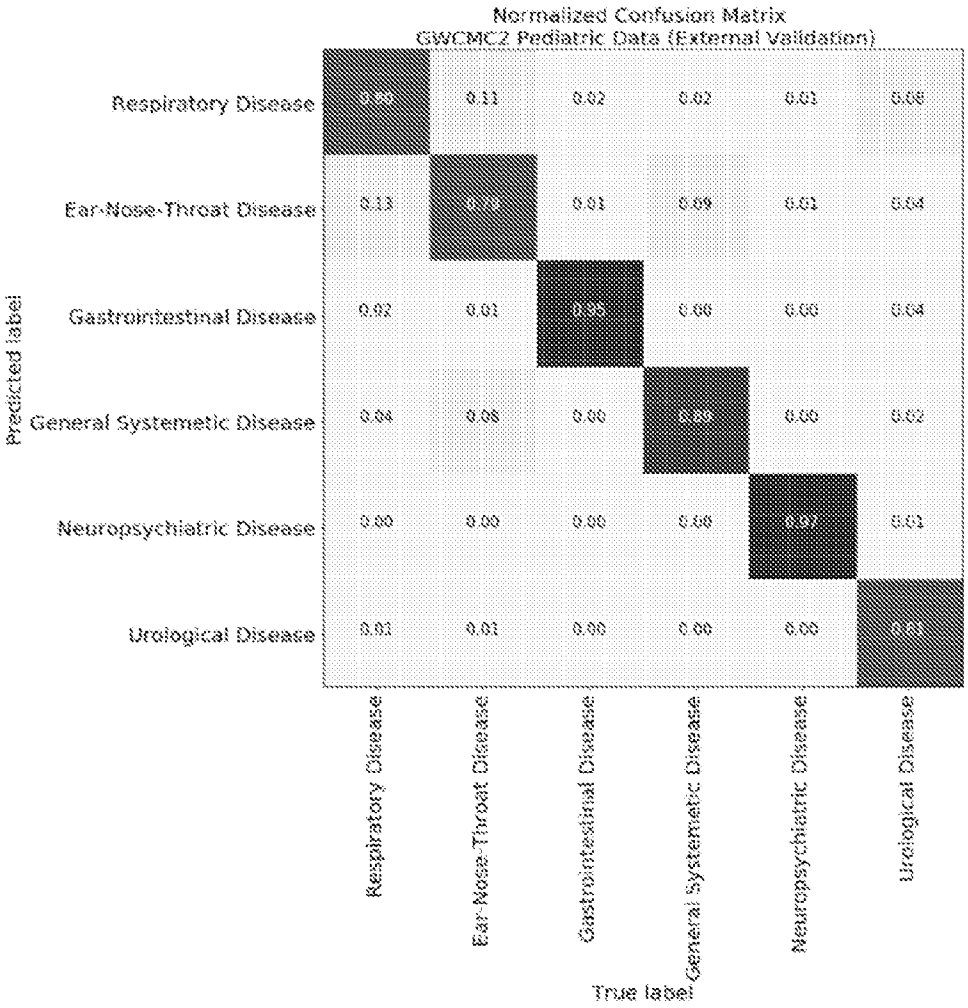

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FIG. 7D

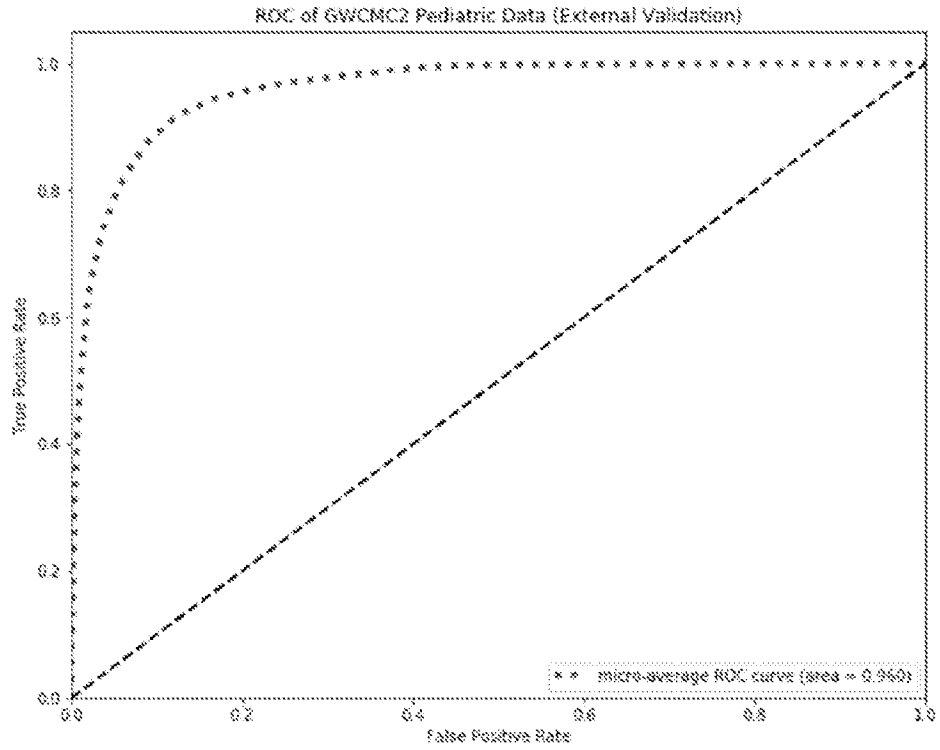
ROC of GWCNC2 Pediatric Data (External Validation)
True Positive Rate
False Positive Rate
0.0
0.2
0.4
0.6
0.8
1.0
micro-average ROC curve (area = 0.960)

FIG. 8A

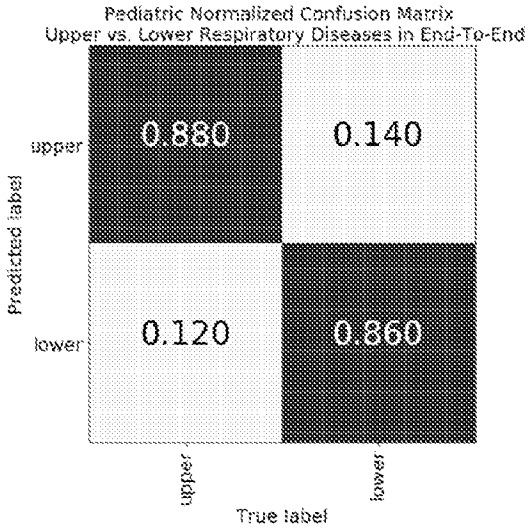

FIG. 8B

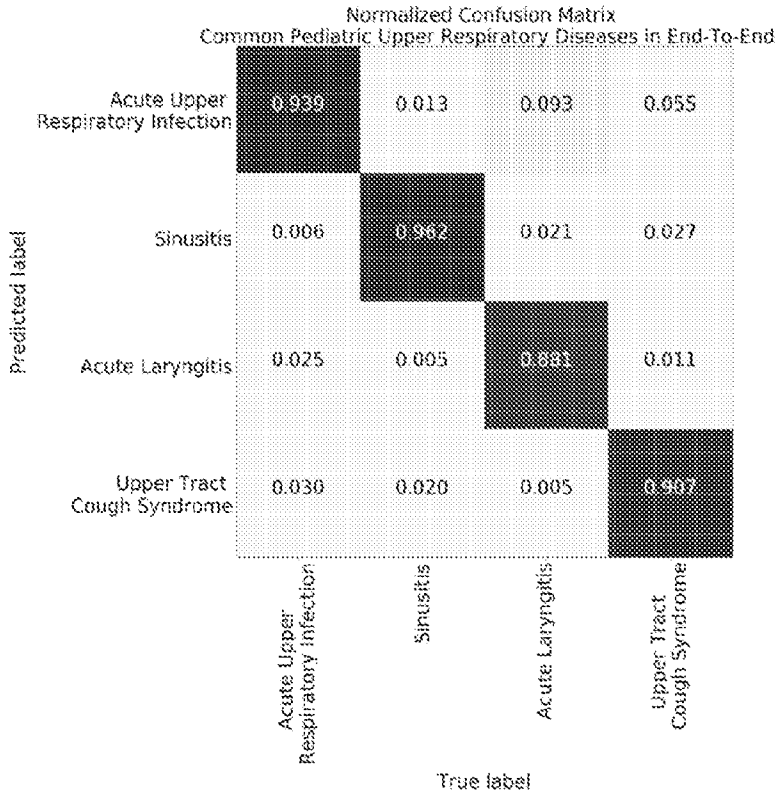

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FIG. 8C

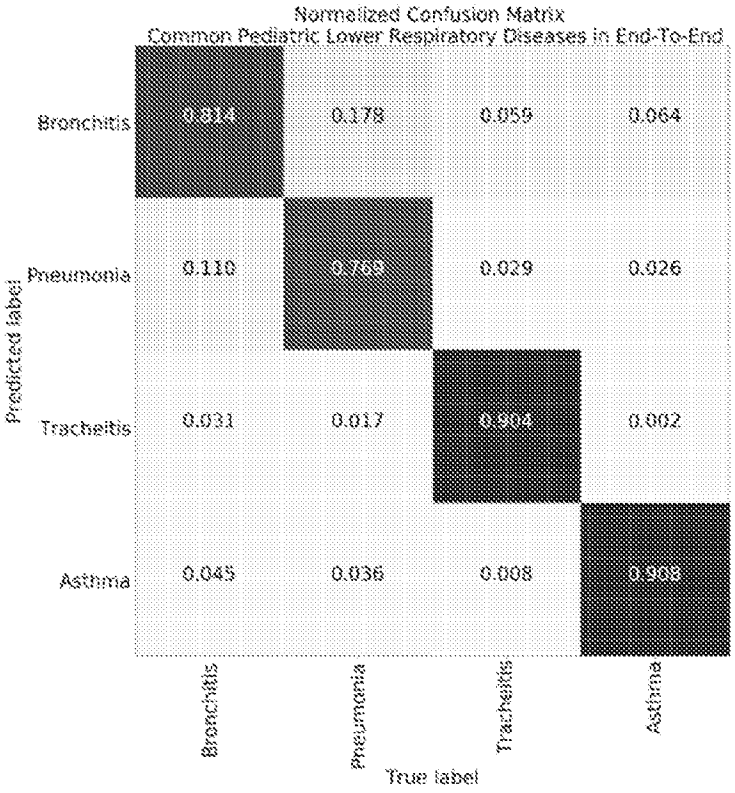
Normalized Confusion Matrix
Common Pediatric Lower Respiratory Diseases in End-To-End
Bronchitis
Pneumonia
Tracheitis
Asthma
Predicted label
0.814
0.178
0.059
0.064
0.110
0.769
0.029
0.026
0.031
0.017
0.904
0.002
0.045
0.036
0.008
0.908
Bronchitis
Pneumonia
Tracheitis
Asthma
True label

FIG. 8D

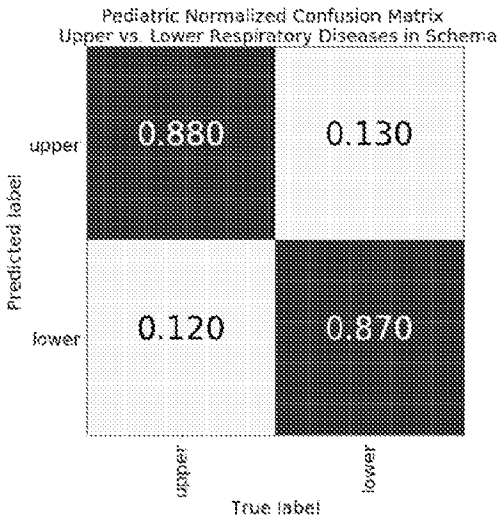

FIG. 8E

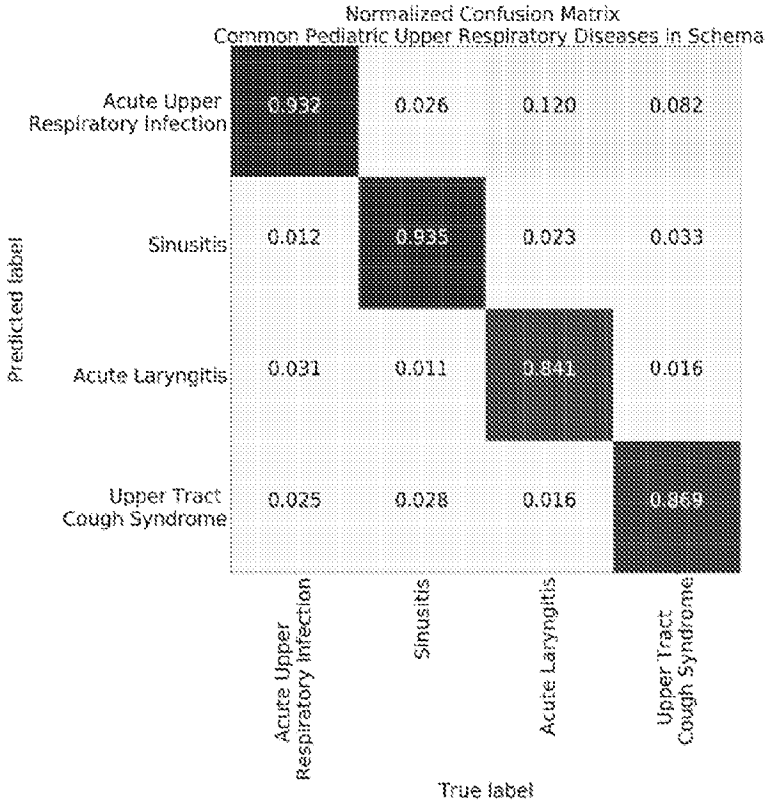

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FIG. 8F

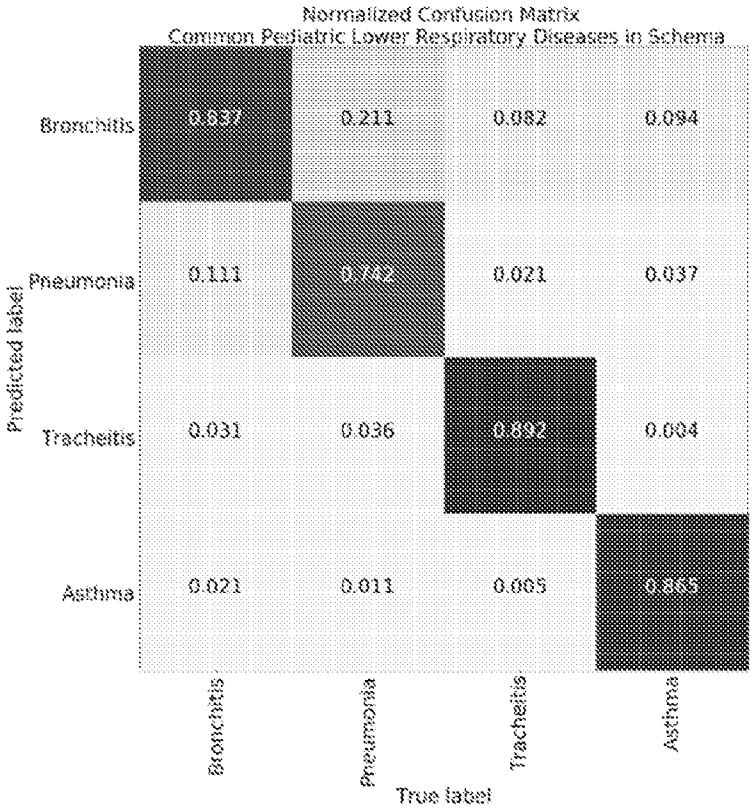
Normalized Confusion Matrix
Common Pediatric Lower Respiratory Diseases in Schema
Bronchitis
Pneumonia
Tracheitis
Asthma
Predicted label
0.937
0.211
0.082
0.094
0.111
0.742
0.021
0.037
0.031
0.036
0.892
0.004
0.021
0.011
0.005
0.865
Bronchitis
Pneumonia
Tracheitis
Asthma
True label

FIG. 9

现病史:患者于3个月前在外院体检时发现左侧甲状腺小结节，未予特殊处理。今家人为求进一步诊治至我院就医，门诊拟"甲状腺结节查因"收住我院。患者无发热盗汗，无咳嗽咳痰，无多饮多食，无胸闷气促、无恶心呕吐。精神、睡眠、胃纳尚可，大小二便正常，体重无明显下降。。**主诉:** 体检发现左侧甲状腺小结节3月余。 **PACS:** 1、甲状腺显像未见明显异常显像征。 2、甲状腺摄锝功能未见明显增高。 3、甲状腺计重为18.1g。	**History of present illness:** The patient found a small nodule in the left thyroid gland at the physical examination in another hospital 3 months ago without special treatment. Today, the family seeks further medical treatment in our hospital. The outpatient clinic plans to provide "thyroid nodule examination" and accept the patient to our hospital. The patient had no fever or night sweats, no cough, no mucus, no excess thirst or increased appetite, no chest tightness or shortness of breath, no nausea or vomiting. Spirit, sleep, and appetite are still normal. Stools and urine are normal and no significant weight loss. **Chief Complaint:** Physical examination revealed a small nodule in the left thyroid more than 3 months ago. **PACS:** 1. There was no obvious abnormal sign in thyroid imaging. 2. There was no significant increase in thyroid iodine uptake. 3. The thyroid weight is 18.1g.

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FIG. 10A

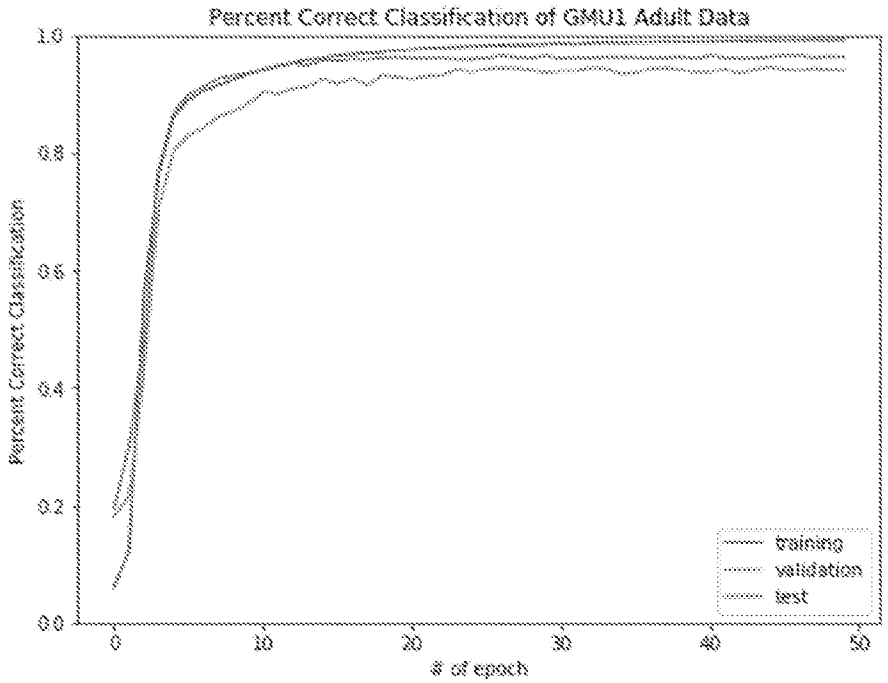


FIG. 10B

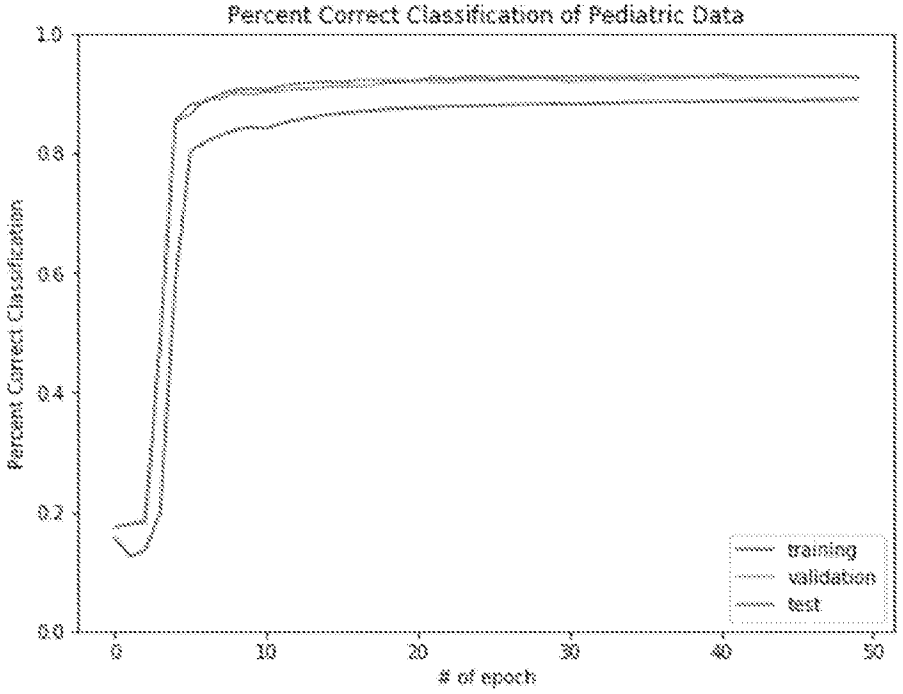


FIG. 10C

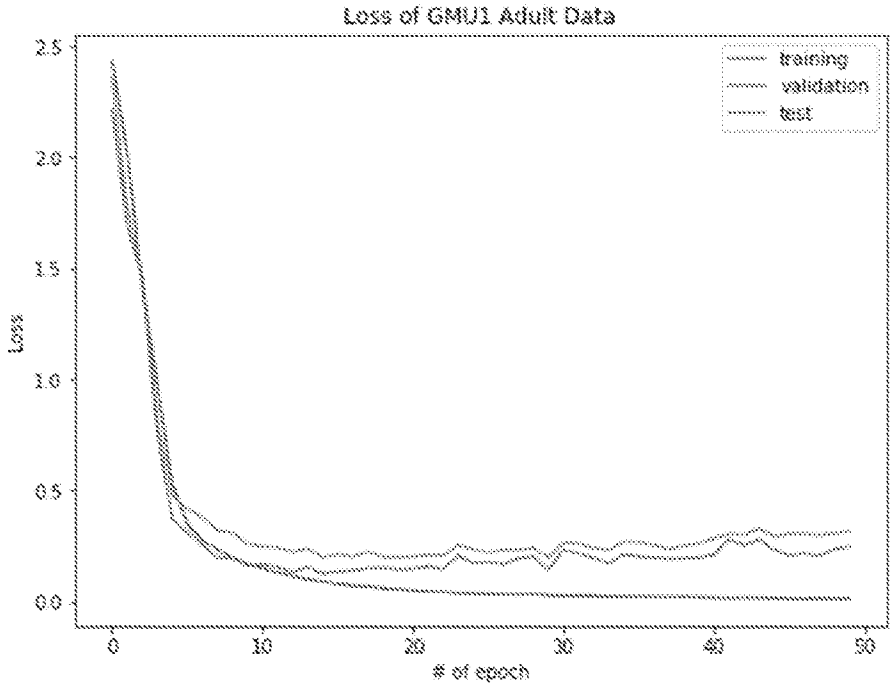
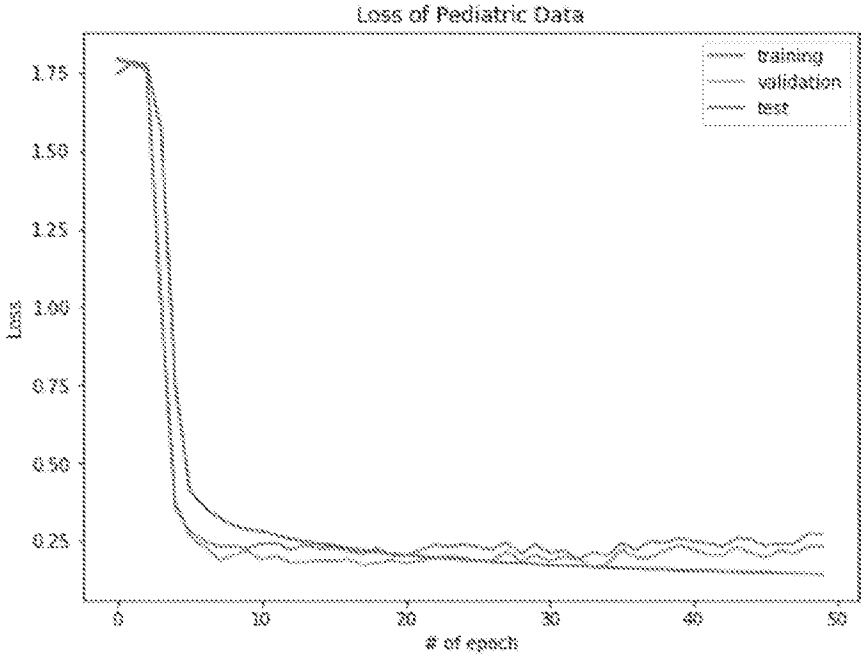


FIG. 10D



INTERNATIONAL SEARCH REPORT

International application No.
PCT/US19/39955

A. CLASSIFICATION OF SUBJECT MATTER

IPC - G06F 17/28; G16H 50/70 (2019.01)

CPC - G06F 17/28, 16/30; G16H 50/70

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
See Search History document

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014/0006013 A1 (THE NATIONAL INSTITUTE OF HEALTH et al.) 2 January 2014; para [0023]-[0025], [0033]-[0036], [0048], [0086], [0093]	1-30
A	US 2015/0066539 A1 (A-LIFE MEDICAL, LLC) 5 March 2015; entire document	1-30
A	US 2016/0350919 A1 (VIRTUAL RADIOLOGIC CORPORATION) 1 December 2016; entire document	1-30

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"D" document cited by the applicant in the international application
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 August 2019 (29.08.2019)	27 SEP 2019
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Shane Thomas Telephone No. PCT Helpdesk: 571-272-4300

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(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
20 September 2001 (20.09.2001)

PCT

(10) International Publication Number
WO 01/069513 A3

(51) International Patent Classification[7]: G06F 19/00

(21) International Application Number: PCT/US01/07339

(22) International Filing Date: 7 March 2001 (07.03.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
09/522,792 10 March 2000 (10.03.2000) US

(71) Applicant and
(72) Inventor: ZAKIM, David, S. [US/US]; 323 Melrose Avenue, Mill Valey, CA 94941-3437 (US).

(74) Agents: KENNARD, Wayne, M. et al.; Hale and Dorr LLP, 60 State Street, Boston, MA 02109 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

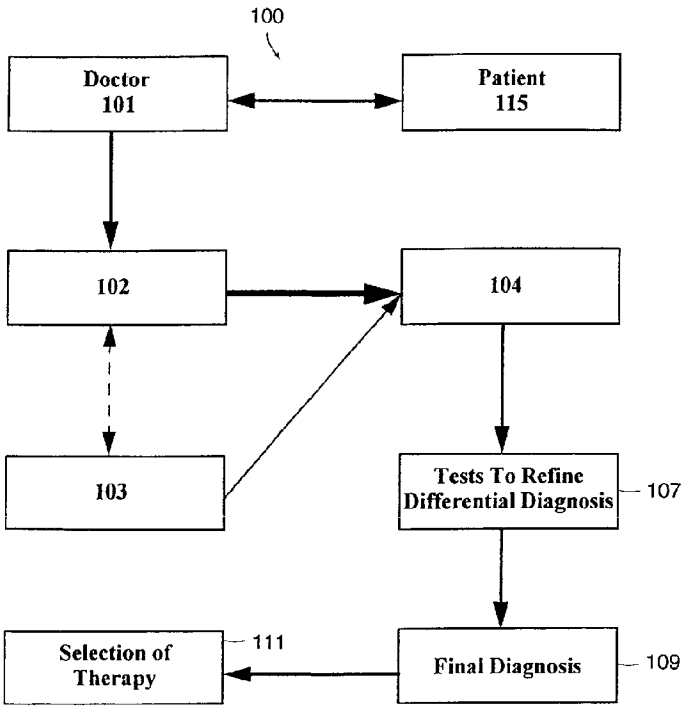
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(88) Date of publication of the international search report:
3 October 2002

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A SYSTEM AND METHOD FOR OBTAINING, PROCESSING AND EVALUATING PATIENT INFORMATION FOR DIAGNOSING DISEASE AND SELECTING TREATMENT



(57) Abstract: A computer-based system and method is disclosed which constructs medical histories by direct interactions between the patient and system that acquires pertinent and relevant medical information covering the complete life of a given patient. The system and method insure that a complete life long medical history is acquired from every patient interacting with the health care system. Once acquired, the facts of the patient's life long and family medical history are analyzed automatically by databases to generate a set of the most reasonable diagnostic possibilities (the differential diagnosis) for each medical problem identified and for each risk factor for disease that is uncovered in the historical database. Further, the automatically analyzed database of historical medical information is used as the search tool for bringing to bear, on the diagnosis and treatment of each medical problem identified in each patient, the entirety of medical knowledge that relates to and can be useful for the correct and efficient diagnosis and treatment of each of every patient's medical problems. This collection of information is analyzed to generate a final diagnosis and treatment regimen.

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INTERNATIONAL SEARCH REPORT

In ational Application No
PCT/US 01/07339

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06F19/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06F A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

WPI Data, EPO-Internal, PAJ, COMPENDEX, BIOSIS, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 021 404 A (MOUKHEIBIR NABIL W) 1 February 2000 (2000-02-01) column 18, line 6 - line 19 claims 10-14 ---	1-18
X	WO 98 02836 A (ILIFF EDWIN C) 22 January 1998 (1998-01-22) the whole document --- -/--	1-18

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 July 2002	29/07/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Muñoz, M

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

In tional Application No
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TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

by Inventors:

BATE et al.

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application No. 18/446,954 (Attorney docket No. RCVRP002C1), filed August 9, 2023, entitled "Translation of Medical Evidence into Computational Evidence and Applications Thereof," which in turn is a continuation of U.S. patent application No. 18/135,026, filed April 14, 2023, entitled "Translation of Medical Evidence into Computational Evidence and Applications Thereof" (now U.S. Patent No. 11,869,674), which claims priority of U.S. provisional patent application No. 63/331,526, filed April 15, 2022, entitled "System and Method for Computational Evidence," which are all hereby incorporated by reference. This application also incorporates by reference U.S. Patent No. 11,437,145.

FIELD OF THE INVENTION

[0002] The present invention relates generally to automating access to medical evidence. More specifically, the present invention relates to a computational evidence platform allowing any application to query and use the medical evidence.

BACKGROUND OF THE INVENTION

[0003] Currently, U.S. healthcare waste is estimated at $1.5T, and a number of reasons are evident. For one, bias and misdiagnosis are omnipresent, with each of us likely to be misdiagnosed in our lifetime and disproportionately impacted groups due to bias, and the timeframe for new research to be put into practice is 5-17 years. Further, there is already more knowledge than is humanly possible to stay current on and apply, and only 20% of clinical guidelines are backed by high-quality evidence.

[0004] Unfortunately, the burden to be more efficient falls on clinicians, who have reached a ~50% burnout rate. Even though evidence is the fundamental unit of diagnosis,

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treatment, payer economics, research and regulation, current scientific practice and operational medical knowledge is primarily represented as documents in guidelines and computable if-then rules in workflows. This severely limits diffusion, feedback and scalability. And, while powerful, AI architectures based on text alone are not sufficient to represent, process or reason on this knowledge controllably or reliably. And yet further, mapping standard ontologies to documents, for example, as done by existing clinical decision support systems, does not enable controllable use of the information by AI systems. They only provide meta-data to the narrative form.

[0005] Physician and healthcare needs for evidence are at an inflection point. Solving this problem is critical to improved (and improving) health outcomes and sustainable healthcare. Current content providers, i.e. publishers, such as DynaMed, BMJ, UpToDate, etc., provide encyclopedia-style medical content look-up for clinicians covering diagnosis, and management of diseases. They assemble the published evidence through expert, human-centric activity—looking at published papers and published society guidelines, sometimes supported by tooling to help human-led assembly activity. These papers are supporting references only. Current best practice takes what are essentially narrative paper documents, even if they are in a digital form, and boils them down to other paper documents, again in narrative form, that require human beings to interpret their contents. This process is slow, inefficient and generalized, although it is the best available, until now.

[0006] Another dynamic that puts pressure on traditional referential evidence suppliers is the ability to scale as care evolves to precision medicine. Current referential evidence provides insight at a population level, and will not be able to support individualized assessments and context. Utility of these products to key customers, if remaining unchanged, will decline. For example, future decisions will involve more and more factors: the type of coverage, co-morbidities, individual laboratory values and trends, etc. Current technology is unable to scale within the world of precision medicine. One of the key challenges today is that there is limited post-clinical trial evidence based on the real-world complexity of patient clinical context and response. This in turn perpetuates generalized guidelines, or guidelines that may be harmful.

[0007] Medical evidence is the fundamental form of knowledge underpinning the science and practice of medicine. It is used in the understanding, prevention and diagnosis of disease. There is no effective way, however, to diffuse, gain feedback or strengthen evidence

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across the system. Today, evidence is predominantly narrative and document-based for dissemination. This creates significant problems including: delay—there is a 3- to19-year lag from bench to bedside; ineffective at scale—manual search is a time-sink in practice; alert fatigue—documents become hard coded rules out of context; and minimal feedback—there is sparse feedback from practice back to research.

[0008] Accordingly, a new platform and techniques are needed to address the above deficiencies.

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SUMMARY OF THE INVENTION

[0009] To achieve the foregoing, and in accordance with the purpose of the present invention, a platform and associated techniques are disclosed that facilitate the science and practice of medicine, medicine being the understanding, diagnosis and prevention of disease.

[0010] The present invention relates generally to making medical evidence computational and usable in a way that can be referenced by any application. In one embodiment, a computational evidence platform allows the extraction of medical evidence or related clinical guidelines from any source and places it into a structured, computational representation system making it useful by any application to query the evidence and to map it to external data inputs such as a patient chart.

[0011] In one particular embodiment, a database that includes medical evidence in the form of computational elements may be used by any application useful to the science and practice of medicine, such as clinical decision support, diagnosis, administrative processes (such as prior authorization, scheduling or other), as well as for research purposes. This database may include interlinked computational elements for conditions, diagnostic factors, risk factors and investigations. Prior art techniques place medical evidence into separate silos which cannot be used for reasoning for any medical application.

[0012] Embodiments of the invention provide: 1) representing clinical concepts as elemental factors and investigations that are computational useful (i.e., can be shared across conditions) and linking them in a database; 2) determination of the patient's clinical state using these elemental factors and investigations; and 3) determination of the next-best action to recommend for a particular patient based upon his or her state using these elemental factors and investigations. Representing clinical concepts as elemental factors and investigations allows one to compare the electronic health record of the patient to any number of medical evidence sources because the elemental factors and investigations provide a common language for comparison, thus providing an end-to-end link between medical science and the practice of medicine.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0013] The invention, together with further advantages thereof, may best be understood by reference to the following description taken in conjunction with the accompanying drawings in which:

[0014] FIG. 1 illustrates a computation evidence platform able to evaluate and diagnose a patient's condition, and recommend a next-best action or actions for that patient, all based upon medical evidence which has been made computational.

[0015] FIG. 2 is a block diagram of further detail of Figure 1 showing translation of medical evidence into computational elements.

[0016] FIG. 3 is a flow diagram describing how medical evidence is translated into computational elements.

[0017] FIG. 4A is an example of a visualization of the graph database after any number of iterations of the flow of Figure 3.

[0018] FIG. 4B provides more detail on the content of condition, factor group, demographics and EDF nodes.

[0019] FIG. 4C provides more detail on the content of condition, investigations group, EDI Result and EDI nodes.

[0020] FIG. 5 is a flow diagram describing how the state of a patient may be determined.

[0021] FIG. 6 is a flow diagram describing how the next-best actions per condition are determined based upon the patient's state.

[0022] FIG. 7 is a flow diagram describing how the next-best actions across conditions are determined based upon the patient's state.

[0023] FIG. 8A illustrates a display of ranked conditions and also next-best actions per condition.

[0024] FIG. 8B illustrates a display of ranked conditions and also next-best actions per condition.

[0025] FIG. 8C illustrates a display of next-best actions across conditions.

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[0026] FIGS. 9A-9E are an example illustrating how a portion of an evidence source is translated into computational elements.

[0027] FIG. 10 is an example transformation of evidence-based text to computational data.

[0028] FIGS. 11A and 11B illustrate a computer system suitable for implementing embodiments of the present invention.

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DETAILED DESCRIPTION OF THE INVENTION

[0029] While standards exist enabling interoperable exchange of patient data (e.g., FHIR), these standards by themselves do not solve the above problems because they merely abstract sets of queries that can be asked about a patient's state. They do not translate a medical evidence narrative into a structured form of data that is computational.

[0030] Some clinical decision support services are available but are less than optimal. By way of example, Stanson Health provides tools, but the difference, and shortcoming, is that at their core they use a rules engine that is limited by the knowledge encoded explicitly in its rules. This is in direct contrast to our approach which is to construct the relationships (via our graph database) between entities which allow for more generalized engines to make broader inferences from the data.

[0031] Artificial intelligence (AI) applications are generally separated from the systems in which they are being used in the course of real-time diagnosis by a clinician. This can delay authorizations for testing due to the lack of prerequisite information.

[0032] It is realized that multiple clinical ontologies exist, including SNOMED-CT, but that these by themselves do not provide the end-to-end computational representation necessary to make evidence and associated administrative guidelines operational. And although SNOMED-CT provides taxonomies of clinical terms (e.g., fever, heart valve replacements, etc.) it can only perform limited reasoning; while one taxonomy provides a hierarchy of diagnostic factors and another taxonomy provides a hierarchy of conditions, it provides no information as to how particular factors relate to a condition, or how a diagnosis of a patient may be derived using these hierarchies. These are hierarchies of concepts, not relationships, and cannot be used to perform reasoning in order to link a condition to particular diagnostic factors, for example.

[0033] By way of example, the condition "ectopic pregnancy" in SNOMED-CT may be described in narrative form as "complications of pregnancy," but it is not connected to a particular factor such as "vaginal bleeding" which would allow inferential reasoning to produce a diagnosis. Further, even if SNOMED-CT could make an inference of presence or absence using certain concepts, a) this only works for defined terms, and b) the coverage in the situation hierarchy is quite sparse in comparison to the concepts covered in the finding/disorder hierarchies.

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[0034] We disclose converting medical evidence, the "raw material," into computational evidence (or elements) that is application (e.g., artificial intelligence or AI) ready, computational, diffusible and deployable at unprecedented scale and associated functionality utility across healthcare stakeholders. Computational means that elements of medical evidence, relating to the understanding of, and diagnosis of medical conditions, is processable by software applications (including artificial intelligence and other computational models), and combinable with other healthcare data (including patient data and other real-world data), in context and in real time.

[0035] Embodiments of the invention are able to combine any number of ontologies and medical evidence sources into one common ground. The underlying database provides computational elements (e.g., factors, investigations) found in medical evidence sources in narrative form (often requiring human interpretation), and the linking of these computational elements with respective conditions (such linking not found in ontologies) allows for computation using the database to provide answers to medical questions.

[0036] We believe that the only way to scale the delivery of quality healthcare within the world of precision medicine is to make medical evidence computational by converting it into computational elements. Such computational elements can be used in real time and within the technical and cognitive workflow of the clinician. It will also be able to integrate with, and consider, other sources of information beyond the specialty at hand. Further, feedback loops are able to be much more timely (not simply based upon studies that have been conducted and then published) and can be based on both trials and observational evidence (real-world evidence).

[0037] Therefore, we disclose converting medical evidence into computational elements for use in the understanding of, and diagnosis of medical conditions that will have the following advantages. Any medical evidence (such as text or any evidence source) assembled by humans into encyclopedia-style published content may be turned into computational elements, thus effectively turning unstructured content into structured data. This process has limitless extensibility; over time it may scale to include billions of evidence data points and will outpace any referential lookup capability. In particular embodiments the process uses a clinical terminology ontology with pre-coordinated and post-coordinated expressions from SNOMED-CT, uses logical observation identifiers names and codes

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(LOINC) that gives us reasoning for laboratory tests, and uses RxNORM that gives us reasoning for pharmaceuticals.

Computation Evidence Platform

[0038] Figure 1 illustrates a computation evidence platform 10 able to evaluate and diagnose a patient's condition, and recommend a next-best action or actions for that patient, all based upon medical evidence which has been made computational. Generally, platform 10 may be viewed as having a health system (the user environment) and backend systems, shown separated by vertical dashed line 4. The health system is that hardware and software generally located on customer premises (such as in hospital, clinic, doctor's office, etc.), while the backend systems are generally that hardware and software located at offices and locations owned by or under order control of the provider of platform 10, such as locations controlled by Recovery Exploration Technologies, Inc. or in cloud services such as AWS, Azure, Paperspace, etc. Nevertheless, certain components of the health system (such as the EMR database, not shown) may be located remotely from the clinician (e.g., in the cloud) and in one embodiment the diagnostic glass software application 24 is also cloud based and accessed by a clinician using a Web browser on a computer in his or her office. Other components of the health system may also be cloud based. Note that "clinician" used herein refers to medical doctors, physicians, physician assistants, nurse practitioners and other medical professionals qualified to diagnose, treat and care for patients.

[0039] An EMR (electronic medical record) system of record (not shown) is an external database providing the EMR-stored medical data related to the patient and the diagnostic process, including but not limited to patient demographics, symptoms, investigations, examinations, laboratory test results, signs, diagnoses, and history. Data may be accessed in both real time and asynchronously pre-encounter or post-encounter. Data is accessed via various methods including but not limited to FHIR (Fast Healthcare Interoperability Resources) standards.

[0040] EMR UI 20 is the user interface of the EMR system; the diagnostic glass application 24 is a stand-alone application that runs on the clinician's computer (e.g., it is a browser application), although it is capable of being launched from that EMR UI 20 environment with a single sign-on authorization including but not limited to SMART on FHIR and other relevant standards. EMR Agent 26 is an event detector that detects user actions on his or her computer. It sends messages via the diagnostic glass 24 to 40 the DX

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Glass API which in turn is responsible for retrieving the relevant information from the EMR, automatically detects any new relevant data, including but not limited to new data added to the EMR system (for example, a new patient record or state change of patient data such as diagnostic data both in real-time and asynchronous modes of operation), and provides that data to diagnostic glass 24, i.e., data that is typically added by a clinician. EMR APIs 28 is a collection of APIs such as FHIR, USCDI (United States Core Data for Interoperability), CDS Hooks, and vendor-specific APIs which allow EMR agent 26, user interface 20 and other components to communicate with the EMR system. Shown at 22 is a standard SOAP note 22 by which a clinician may enter observations of a patient during an encounter; other data entry techniques may also be used.

[0041] Diagnostic glass 24 is a real-time, fully-automated, possibly hands-free software application and user interface, designed specifically to be the system of interaction by which a clinician may enter patient data, and explores diagnoses of a patient either during a patient encounter or when the patient is not present. For example, diagnostic glass 24 is used by a clinician in real time during a patient encounter (live, by telephone, online, chat, video call, etc.) or may be used by a clinician before or after a patient encounter. Diagnostic glass 24 is an interface to the next-best action (NBA) engine 70 which runs in parallel with the clinician's actions and does not require any additional input from the clinician. Diagnostic glass 24 may be used as an overlay or as a window tab.

[0042] Diagnostic glass 24 accepts manual clinician entries and selections (e.g., typed input, mouse input, etc.,) and may use speech recognition technology (microphone and speech recognition software not shown) as well as live note capture technology to collect real-time patient encounter information; it also is able to display pertinent positive and negative history from the patient's medical chart in the EMR system that has been extracted by NLP 74 or reasoning service 72. This verbatim text (either from manual data entry, speech recognition, live notes, from the EMR medical chart, etc.) is then converted in real time into diagnostic factors and investigations, and prior conditions all matched to nodes in the graph database 50 by the NLP engine for later use by the NBA engine 70 and classifier 78 to determine potential patient conditions and next-best actions.

[0043] In one embodiment, diagnostic glass 24 is an application integrated into the EMR environment via relevant standards such as a SMART (Substitutable Medical Applications, Reusable Technologies) on FHIR application for EHRs (such as Epic and

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Cerner), and is integrated into the clinical workflow. In another embodiment, diagnostic glass 24 is a standalone system, integrated with relevant external data sources. The suggestions from the diagnostic glass 24 are provided for expert consideration and not as a replacement for the clinician. Thus, the diagnostic glass 24 provides real-time, in-context differential diagnosis and next-best-action suggestions to validate and expand clinical consideration.

[0044] Communications channel 6 is a software layer that communicates information between diagnostic glass API 40 (and components 42, 44 and 48) with patient state service 60. Patient State Service 60 is a caching layer that serves to enhance real-time operation for already-analyzed patients and to control access to the various functions provided by the platform. OCR Service 42 provides mechanisms to convert images of text to digital text strings for further analysis. Data Integration Service 44 mediates access to external EHR services including the translation from the abstract data model used by the CEP to the specific data models of the EHRs. Data Scheduler Service 48 provides a mechanism that enables patient charts to be analyzed and cached prior to a patient's visit thus facilitating better real-time performance.

[0045] Evidence extraction 82 is performed to extract textual medical evidence from any of a variety of sources for representation within graph database 50. Any of a wide variety of medical evidence sources 86 may be used and include: National Library of Medicine, JAMA Rational Clinical Evidence, BMJ Best Practice (or other British Medical Journal databases), SNOMED-CT (Systemized Nomenclature of Medicine – Clinical Terms), LOINC (Logical Observation Identifiers, Names, and Codes) database, CPT (Current Procedural Terminology) codes, StatPearls content, and laboratory test reference ranges, drug interactions (drug-drug, drug-condition, drug-food), clinical dictionaries, content on rare diseases, and other online sources such as Merck Manuals, WebMD, NORD (rarediseases.org), the CDC (for endemic information), the WHO, etc. The evidence extractor can extract clinical items from any textual data source; it maps extracted concepts to these code systems or ontologies.

[0046] Typically, the sources used are in electronic form, such as a JSON file, XML file, or other electronic format representing textual information. If they are Web sites then they may be marked up in HTML. The textual information may be free-form text, may be in

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narrative form, may be semi-structured text (e.g., text within flow diagrams, decision trees, etc.).

[0047] In addition, evidence-based medicine sources are used and include a collection of external data, such as datasets of clinical support reference content for healthcare professionals which contain best practices, evidence-based research relevant for clinical decision support including diagnosis and prognosis.

[0048] An evidence extractor 84 is a system which extracts relevant text from an evidence source and delivers it to NLP engine 74 for recognition of the clinical concepts within the text. It can be implemented in forms such as a stand-alone application or a Web browser plug-in function. It facilitates the selection, extraction, and delivery of relevant text to the NLP engine 74. The Extractor also facilitates the workflows associated with adding the extracted concepts and relationships into a knowledge management system, in our specific case, the graph database 50. The Extractor itself facilitates the workflow necessary for sending the relevant text, or portion of text, to the NLP for the extraction of domain specific concepts. In the current invention, the NLP is trained in the domain of medical concepts. By way of example, when text related to a particular medical condition is input the extractor extracts the condition, its diagnostic factors, risk factors, investigations, and any differential diagnoses if possible, as well as rankings, etc. The extractor 84 also extracts a citation or citations 88 associated with the extracted text.

[0049] NBA engine 70, reasoning engine 72 and content classifier 78 are software modules whose purpose is described below. NLP (natural language processing) engine 74 may include any number of NLP processes (such as an NLP pipeline), each may use a model or not, and each may choose to store information in a wall cache. The NLP processes that may be used include but are not limited to: Word Segmenter, Sentence Segmenter, Negation Cues, Negation Scopes, NER (Named Entity Recognition), Relationship Prediction, NEL (Named Entity Linking), Phrase Extractor, Composite Matcher, Embedding Matcher, Graph Matcher, NLI and Long-to-Long Matcher. The NLP engine may also include models or functions for extracting temporality cues and scopes, experiencer cues and scopes, sex cues and scopes, and age cues and scopes.

[0050] NLP engine 74 is used not only for extracting clinical concepts from medical evidence sources, but also for interpreting a patient's chart and outputting factors and results

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of investigations and in the form of elemental diagnostic factors and elemental diagnostic investigations (EDFs and EDIs).

[0051] Graph database 50 is a database that will store the extracted information from the medical evidence sources after that information has been translated into computational elements. Any of a wide variety of other types of databases may be used to store this information such as a relational database or object store or object-oriented database.

[0052] In one particular implementation a JanusGraph graph database is used having nodes and arcs, the nodes containing medical evidence of different types (i.e., conditions, differential diagnoses, diagnostic factors, risk factors, investigations,) and the arcs indicating linkages or causality between the nodes. In addition, a citation (or citations) of a scientific publication is extracted per condition and also per factor group, if present. Database 50 may also be referred to as a computational database, a knowledge base, an evidence base, an inferential database, or an inferential database of computational elements.

[0053] Console user interface 80 is used by a person 81 and includes a graph editor by which the person views graph database 50 and reviews clinical concepts extracted from the medical evidence, corrects errors (i.e., quality control), adds factors, perform groupings, etc., thus changing and improving the extracted evidence before it is stored into the database 50. It can also be used to update or remove the information once it has been stored in the database. It employs full CRUD capabilities: Create, Replace, Update, Delete.

[0054] During determination of the next-best action for a particular patient, patient state service software module 60 keeps track of the patient's state, basically the diagnostic factors and investigations that the patient has presented with (whether from the patient's electronic health record, presented by the patient during the encounter, observed by the clinician, etc.), which may change over time. During determination of the patient state, module 60 will take the factors and investigations extracted from the patient chart and send those to the reasoning service 72 in order to infer other factors and investigations. By way of example, given that the patient has "acute fever" we may also infer that the patient has the factors "fever" and "change in body temperature." For example, it does this using the SNOMED ontology polyhierarchy and walking the relevant ancestor-descendant chains. Note that this can also be done in RxNORM for drugs as well. The reasoning service 72 also contains a component that understands the ancestor-descendant relationships of clinical tests,

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e.g. CBC with differential is a parent of CBC (complete blood count) is a parent of Hematocrit and White Blood Count.

[0055] Not all conditions are described in the literature with the same level of specificity, and similarly, patients may be very specific in their description of symptoms, e.g. a patient suffering from the effects of Botulism might report very specific left upper quadrant abdominal pain, whereas the evidence for Botulism does not localize the abdominal pain to a specific area. Without the inference from LUQ abdominal pain to UQ abdominal pain to abdominal pain a diagnostic factor for Botulism would be missed.

[0056] Patient state service 60 may also send the patient state (including any inferred factors from the reasoning service) to the content classifier 78 (or a diagnostic classifier) which performs a straight classification using condition scoring.

[0057] Once factors and investigations have been extracted from the patient chart and any inferred factors have been added, the NBA engine 70 executes using as input the patient's current factors and investigations and produces the likely, ranked conditions of the patient, along with for each, unknown factors that should be queried and investigations that should be performed, by referencing conditions, factors and investigations in graph database 50 as will be explained in greater detail below. Thus, the next-best actions for a particular condition may be a question to ask the patient about a specific diagnostic or risk factor, or a specific laboratory test or examination to be performed upon the patient.

Computational Data

[0058] In general, the system distinguishes between clinical factors and investigations (including laboratory tests and examinations). A diagnostic factor is a factor that the physician can observe, detect or measure quickly or have the patient describe to him during an office visit (traditional signs and symptoms), while an investigation is a laboratory test or an examination performed by a specialist; both are more sophisticated and take more time. By way of example, diagnostic factors include: "patient has a headache," "patient skin appears yellow," "patient reflexes appear normal," etc. Thus, the value of a particular diagnostic factor may be a simple yes or no, a numerical value, a numerical range, the presence or absence of the diagnostic factor, an observation (e.g., "appears normal"), or other results such as a specific physiological description like “the nasopharynx is symmetric.” For

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purposes of discussion, the system distinguishes between diagnostic factors and risk factors such as gender, age, family history, and medications, e.g., "sex is male" and "family has a history of colon cancer" in order to more accurately output a diagnosis or other goal of the system.

[0059] Depending upon the implementation, vital signs, e.g. heart rate, blood pressure, oxygen saturation, etc. may also be considered as investigations. They can be performed quickly, by clinicians with a lower level of education or training, and for little to no cost. Generally, although not always, investigations will be the ones with numbers or numeric ranges whereas diagnostic factors indicate the presence or absence of something.

[0060] Typically, investigations require either the collection and processing of some sort of biological sample (a laboratory test) or a physiological analysis using some sort of device (an examination). Laboratory tests may include fluid analysis (e.g., blood panel, urine, semen, and CSF), and examinations may include diagnostic imaging (CT, MRI, X-ray, PET, ultrasound, endoscopy) and pathology analysis among others. By way of example, the result of a laboratory test is "CBC blood test shows reduced hemoglobin level" and the results of an examination is "MRI of the pelvis appears normal." Thus, the result of a particular laboratory test or examination may be a simple yes or no, a numerical value, a numerical range, the presence or absence of a particular item, an observation (e.g., "appears normal"), or other results.

[0061] Our design uses EDFs (elemental diagnostic factors) to represent factors, which is a computational element resulting from transforming human-readable evidence into computational elements. Clinical factors described by evidence-based medicine and medical guidelines are translated into EDFs disambiguated across conditions. Specifically, an EDF is a clinical factor that may be evident in a number of conditions, either as caused by a condition (e.g., signs, symptoms, vital signs) or as a risk factor that may contribute to the cause of a condition. Evidence-based medicine typically considers diagnostic factors on a condition-by-condition basis; EDFs enable these factors to be disambiguated across conditions by the system. In cases where the same factor applies to multiple conditions (but may be referred to by different terminology), EDFs enable those like factors to be understood as having the same meaning.

[0062] As an example, EDFs may disambiguate clinical factors where one human-readable form relates to "neck stiffness" in one condition and "nuchal rigidity" in another,

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with the EDF = “stiff neck”. An example relates to a fever, possibly described in different sources as "being feverish" or "high temperature," but all meaning the same concept. EDFs may also describe higher level factors then the atomic elements, for example “GI symptoms” may be defined as EDFs “nausea”, “abdominal pain” and “vomiting”. Another example is “constitutional symptoms”, with EDFs being “fever”, “malaise”, and “weakness”. Another example is a reference that lists the diagnostic factor "pelvic pain" under the condition "ectopic pregnancy." But, the factor "pelvic pain" is quite broad and we able to extract from the narrative in the reference the very specific EDFs of "acute pelvic pain," "right-lower quadrant pain," "lower abdominal pain," and "pelvic pain." Once "pelvic pain" has been made an EDF, it may be used as a factor for other conditions (e.g., BPH, benign prostatic hyperplasia) which is a male condition).

[0063] The graph database, for example, contains the following EDFs that are related to pelvic pain: acute pp, burning pp, chronic female pp, chronic pp without obvious pathology, constant pp, cyclic pp, dull pp, female pp, hx (history) of chronic female pp, hx of cyclic pp, intermittent pp, no female pp, no pp, pp on penetration, sharp pp, throbbing pp, which are all distinct concepts used in various conditions.

[0064] These EDFs are part of a computational evidence ontology, which includes other relevant concepts related to conditions and investigations. EDFs are defined in a way that can be applicable across any condition and may be used in any type of consultation such as diagnosis, determination of a next-best action or actions, preauthorization, etc.

[0065] The EDFs may also be connected to other ontologies, including but not limited to SNOMED-CT, for example to provide standardized synonyms. A particular EDF may be found in a one-to-one relationship with another clinical concept in a taxonomy such as SNOMED-CT, although many EDFs are created anew and do not exist in other taxonomies.

[0066] Each EDF may also have associated a variety of attributes associated with particular conditions such as: age and sex restriction (i.e., if the factor is only applicable to persons of a particular age and only to male or female patients).These condition-specific attributes are held in a demographics node (as shown below) unique to the condition and the EDF, but separate from the EDF. Other conditions having that EDF may have different demographics nodes that are unique to that condition. Thus, EDFs remain elemental, independent, and can be used computationally across conditions.

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[0067] The EDFs also have attributes defined such as temporality of the factor (historic or present), experiencer of the factor (patient or family member) and negation, whether for a given condition the clinical factor did not occur or is not present. Synonyms defined in an EDF allow the EDF to be recognized across different sources that use different terms. We train the NLP models with the synonyms and they are stored in the database.

[0068] Each EDF is also be linked to a taxonomy of clinical concepts (e.g., SNOMED) in order to perform inferential reasoning, such as by reasoning service 72. Inferential reasoning is performed after the initial set of clinical concepts are extracted from any input text or structured data. The NLP process feeds into the inferential reasoning although they may be combined if desired.

[0069] Clinical findings in the EHR or other input source are also translated into the relevant EDF. This then enables the clinical state of the patient to be assessed across all conditions in the ontology, and for next-best-actions to be computed, all in the same state-action space.

[0070] EDFs are made elemental and independent by placing various attributes that pertain to different conditions into a different data structure linked to both a particular EDF and a particular condition. In this manner, an EDF remains independent and may be used computational across different conditions, yet within the context of a particular condition these attributes are taken into consideration. In one particular embodiment, attributes for a particular EDF relevant for a specific condition are held in a factor group linked to that specific condition and the EDF. By way of example, attributes held in a factor group pertaining to EDFs of a specific condition include: a rank (how likely it is that the condition produces that factor); whether the factor is a risk factor or a diagnostic factor (diagnostic factors are caused by a condition, whereas risk factors tend to cause the condition); and criteria such as whether the condition must exhibit that factor or cannot exhibit that factor. The notion of rank can be further expanded to include sensitivity, specificity, likelihood ratios, incidence, and prevalence among other elements. These all may be combined together to provide an ultimate weight value for the factor group, the weighting being a function calculated outside of a factor group, although the ultimate weight from that function may be stored in the factor group if desired.

[0071] One attribute is the ranking of the factor group with respect to its associated condition, i.e., how likely is it that the particular factors of the factor group have been caused

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by the potential medical condition (in the case of diagnostic factors), or how likely is it that the factor group of risk factors has caused the potential medical condition (in the case of a risk factor). Rank may be expressed in a source using numerical values, or words and phrases to refer to the likelihood that group of factors is caused by particular condition, etc. Other attributes related to rank may include sensitivity, specificity, or a likelihood ratio that may be directly extracted from an evidence source regarding factors of the condition (or that may be added by person 81 reviewing that source). A weight value may be calculated and represented in a wide variety of manners. One technique is to use the ranking only; another technique is to use specificity and sensitivity to calculate the likelihood ratio (the probabilities of people with the factor having or not having the condition). A weighting function calculates the weight value based upon these attributes present within the factor group. Further, demographics that link the factor to a specific condition (e.g., age, sex,) may be held separate from the EDF in a demographics node, thus also ensuring that the EDF remains independent and applicable to any of a number of conditions.

[0072] In a similar manner, the design uses elemental diagnostic investigations (EDIs) to represent elemental and independent laboratory tests and examinations which may be used for computation across all conditions. Similar to EDFs, certain attributes of a laboratory test (e.g., a result, units, range, etc.) that are specific to a particular condition are not held within the EDI itself (thus ensuring its independence) but are held separately yet still linked to a specific condition. Further, an investigation group which holds any number of laboratory tests or examinations will have its own attributes defined upon it as well. Further details are below.

Translation of Medical Evidence into Computational Elements

[0073] Figure 2 is a block diagram of further detail of Figure 1 showing translation of medical evidence into computational elements. Shown is an evidence source 86 from which a portion of input text 87 can be selected and input into NLP engine 74 using evidence extractor 84 as described above. Preferably, NLP engine 74 is initialized using a lexicon such as an ontology (or ontologies) 73 relevant to terms, phrases and concepts in the input text that will be extracted by the NLP engine. By way of example, a lexicon such as SNOMED-CT may be used when the evidence source describes conditions and its factors, an ontology for diseases may be used if the evidence source mainly describes diseases, a specific ontology for

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a particular disease (e.g., cancer) may be used, or an ontology such as RXNorm may be used if the source describes drugs. Multiple ontologies may also be used. In practice, the NLP engine may make use of nodes in the graph database 50 when recognizing concepts in an evidence source or patient chart.

[0074] In one example, the evidence source lists conditions, each with relevant factors and investigations; the clinical concepts 89 extracted are thus the diagnostic and risk factors relevant to a particular condition which are organized into factor groups 92 groups and stored into the graph database 50. To the extent that there are laboratory test results and examinations associate with the condition, these organized into investigation groups 94 and also stored. Using the lexicon or ontology 73 the NLP engine extracts, for example, the most granular descriptions of a particular diagnostic factor that it finds is supported in the input text. By way of example, given a diagnostic factor of "abdominal pain" for a particular condition, in which the narrative describes three specific types of pain such as "lower abdominal pain," "lower right abdominal pain," and "lower left abdominal pain," the NLP engine will extract those three specific types as additional elemental diagnostic factors in addition to the diagnostic factor of "abdominal pain."

[0075] Clinical concepts 89, thus, include conditions, factors, investigations, and drugs (trade names and generics). Also extracted from the selected input text is a citation (or citations) 90. We extract also the URL of the source and a hash function which allows us to detect when the contents of the citation have changed in the future. As described above, person 81 uses console 80 in order to review and edit clinical concepts 89 which will be grouped by type and then input into graph database 50. Having person 81 reviewing the clinical concepts output from the NLP engine helps to ensure that the elements of the graph database 50 are sensical and coherent, thus leading to better diagnosis, etc.

[0076] Figure 3 is a flow diagram describing how medical evidence is translated into computational elements.

[0077] Figures 9A-9E are an example illustrating how a portion of an evidence source is translated into computational elements. These figures will be referred to during the discussion of Figure 3.

[0078] In step 110 a portion of text from medical evidence source is extracted and input into NLP engine 74. In one embodiment, a user may manually choose a portion by highlighting that text, copying the text, or in a similar manner. Or, a portion or portions of

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text from the source is extracted automatically from the source using evidence extractor 84. Preferably, the source is a respected, clinically-relevant source known to provide accurate medical information. Typically, whether manually or automatically selected, the portion may be a paragraph, section or pages covering a particular condition and its associated diagnostic and risk factors, as well as investigations useful in diagnosing the condition such as laboratory tests and examinations. Or, the portion is a paragraph, section or pages including clinical concepts from any document. Another example is a document including the preauthorization guidelines for an expensive diagnostic test such as an MRI.

[0079] Figure 9A shows a web browser 800 being used by person 81 who is accessing a particular Web page of a Web site 804 in order to input text for a particular condition 828. The source may be any electronically available Web site, database, archive, file, etc. In this example, the person is reviewing any number of factors 810-816, some listing only a single diagnostic factor, others describing a number of diagnostic factors under each factor. For example, factor 814 lists a number of diagnostic factors which have been selected by the person using box 820. The person may also select the entire narrative for a particular factor, such as by using box 828. The person may also select any number of factors, or investigations, and may also select the entire text pertaining to this condition.

[0080] In addition, for each factor a ranking is extracted from the evidence source indicating how likely it is that a factor is indicative of the particular condition, e.g., a positive PCR COVID test is highly indicative that the patient has COVID-19 and such a result will have a high ranking, whereas a patient presenting with a fever is less indicative of COVID-19 and will have a lower ranking. Rankings may be later translated into a weight as will be explained in greater detail below. Although a rank is extracted automatically (if available), the rank is reviewed by person 81 who may change it, add a rank to a factor group, re-order ranks of factor groups, etc., thus improving accuracy. Other attributes related to rank that may be extracted for a factor group include sensitivity, specificity, or a likelihood ratio. Again, if these attributes are not extracted automatically the person 81 will review the source text and add these attributes to factor groups, i.e., will order the factor groups by giving them ranks, and may provide sensitivity, specificity or likelihood ratio if that information is present in the source text and has not been extracted automatically.

[0081] Rankings are also relevant for investigations as well. Investigations are ordered in how they should be performed, e.g. first line tests - that should be done initially,

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second line tests that should be done for additional confirmation, and emerging tests that have not yet been fully assessed for broad applicability and/or accuracy. Again, the NLP engine may extract these rankings for investigations but they are also reviewed by person 81 to adjust, change or add a ranking for an investigation group.

[0082] Some evidence sources will have explicit rankings, some rankings will be numerical, some will be implicit in the order of factors and investigations for a particular condition, some sources may have no rankings, and some sources may rank differently. Person 81 sets the final ranking of factors and investigations by adjusting rank of a factor group or first line, second line, etc. of an investigation group.

[0083] Also extracted for each factor of a condition is a description of the relationship between the factor and its condition (if present in the evidence source). This description does not necessarily define the factor, but rather explains, e.g., how a fever might occur for a specific condition, how common fever is for that condition, or how strong a factor it might be. A condition may be any medical condition, a disease, an orthopedic anomaly, an adverse drug reaction, or a drug-to-drug interaction.

[0084] At step 114 the citation (or citations) associated with the input portion is also extracted. Figure 9B shows that the user has selected option 830, bringing up citation 832, which he or she then extracts using evidence extractor 844 by way of selection 834. Typically, an extracted citation will include: its URL, authors, publisher, title, publication date, any update date, and the full citation.

[0085] In step 116 the text input portion is processed using NLP engine 74 initialized with a particular ontology or ontologies tailored for the evidence source as described above. Figure 9B also shows a selection 836 by which the person may input the selected text into the NLP engine.

[0086] In step 120 the NLP engine outputs clinical concepts 89. Depending upon the evidence source used, these clinical concepts may be conditions with their respective diagnostic and risk factors, along with their respective laboratory tests and examinations. Figure 9C shows that based upon the input text, output are five diagnostic factors 840. Note that these five factors are the finest level of granularity of information that can be extracted from input text, that is, no other factors can be extracted and five is the greatest number of factors that can be extracted based upon this text.

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[0087] In step 120 NLP engine 74 is also capable of generating elemental diagnostic factors as well. By way of example, if a clinical concept is "abdominal pain" for a particular condition and the text supports sharp pain in the lower left or lower right abdomen, then the NLP engine may generate the EDFs "sharp, lower right abdominal pain" and "sharp lower left abdominal pain." In another example, if a narrative in a source describes "vaginal bleeding" as a sign of an "ectopic pregnancy" and also describes "light bleeding" and "heavy bleeding" as signs, NLP engine 74 is able to produce the new EDFs "vaginal bleeding," "light bleeding" and "heavy bleeding" (along with a ranking for each if available) which will be better able to match a patient's specific signs and symptoms thus leading to a better diagnosis.

[0088] Another example is a risk factor for a particular condition that indicates travel to an endemic area along with a description of some of those endemic areas. The general risk factor would be "travel to an endemic area" and the NLP engine would generate a risk factor of "travel to Cuba" assuming that is supported by the text. Another example of extraction is text listing "red eyes and nose" as a diagnostic factor for a particular condition. This text is extracted into "red eyes" and "red nose" in which case red is a part of both factors. Translation of these clinical concepts into EDFs provide highly granular factors and investigations that are truly independent of one another and lead to less confusion and greater accuracy when the graph database 50 is applied to patient information.

[0089] Generally, NLP engine 74 is able to extract from the evidence source the most granular factors and investigations supported by the text for a particular condition, e.g., "travel to Cuba" rather than "travel to an endemic area" thus creating computational data. In another example, in a narrative regarding the presence or absence of a fever or history of fever for a particular condition, the NLP engine may extract the clinical concepts "history of fever," "fever," and "no fever," all being separate factors that will be translated into EDFs. The level of detail of the EDF is only limited by the level of detail in the extracted text and what the person 81 may add. In addition to diagnostic and risk factors, clinical concepts 89 produced by NLP engine 74 also include results of investigations such as from laboratory tests or examinations. Clinical concepts may also include drugs, such as the risk factors of "misuse of opioids" or "cocaine addiction."

[0090] At step 120 the clinical concepts have been output but are not yet in a computational form, i.e., are not yet all elemental diagnostic factors (EDFs). Typically, the output will be a list of heterogeneous objects, each type of clinical concept having its own

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data structure, i.e., factors have a different data structure from a condition which is different from the data structure of a laboratory test, drug, etc. These clinical concepts output by NLP engine 74 may also exist within graph database 50, if not, then a new clinical concept may be created to add to the database. Further, a clinical concept need not be a known condition nor a condition already existing within graph database 50; it may be a new condition that will be added as a new node to the database. By way of example, a newly discovered, very rare genetic condition for which some evidence exists may be output as a clinical concept. Typically, the evidence source and input text being processed at a particular time may be limited to particular type of clinical concept (such as factors, laboratory tests, examinations, drugs, etc.) and so the ontology or ontologies used may be specific to the type of clinical concept being processed at that time.

[0091] In step 124, the clinical concepts are reviewed by a person 81 using console 80. The person may review the underlying data structures of the clinical concepts or preferably uses a graphical user interface representing the clinical concepts in a more user-friendly form. This person creates groups of factors, groups of investigations, etc., depending upon the clinical concepts extracted from the input text. He or she also decides whether a particular clinical concept remains as a factor group or should become an EDF, or whether a clinical concept remains as an investigation group (e.g., a broad laboratory test or examination group) or should become an EDI.

[0092] Figure 9C also shows that person 81 has created factor group 842 in order to group diagnostic factors 840 together and to indicate to the graph database than a factor group node should be created that will hold five different elemental diagnostic factors. Person 81 also makes corrections, confirms ranks for factors, orders investigations by line, adds new factors or investigations based upon the text, etc. By way of example, if the extraction produces four diagnostic factors from a group of five in the source text, the person 81 upon viewing that text may add the fifth diagnostic factor manually to form a group of five diagnostic factors grouped under one factor group.

[0093] Another reason to use a person to review the clinical concepts extracted from an evident source is to correct errors in that source. By way of example, a condition causes a diagnostic factor (e.g., a sign or symptom) but a risk factor contributes to a condition (or even to a symptom); sometimes the two are not classified correctly. The person may change a diagnostic factor to a risk factor or vice versa. The person may also add an EDF for a

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complex situation, e.g., where the factor is caused by a particular condition which may not already be in a taxonomy such as SNOMED. By way of example, if "pelvic pain" is specifically due to "chlamydia" then the person may create an EDF basically listing the diagnostic factor of "pelvic pain" as being linked to the condition chlamydia.

[0094] Person 81 further has ability to add factors for a particular condition based upon different sources. For instance, considering the condition "systemic mastocytosis," one source may list spicy food and acidic foods as being exacerbating factors, while a second source further lists "alcohol" as an exacerbating factor. Person 81 may add "alcohol" as a factor to that condition based upon the second source. Person 81 may also add synonyms for a particular factor or investigation or review and verify synonyms that have automatically been added by the NLP engine. Person 81 corrects errors and classifies the factors correctly so that the causality is clear. Person 81 will also review clinical concepts that include investigations such as laboratory tests or examinations. For example, the person may review ESR or CRP (C-reactive protein) blood tests to make corrections, and information, etc. (e.g., ensure that the test is referring correctly to CRP, plasma CRP or serum CRP). Person 81 may also augment a particular clinical concept in order to add a code or link to a known concept in an established taxonomy of clinical concepts such as SNOMED-CT, thus establishing a cross-link into one or more hierarchies that permit inferential reasoning.

[0095] Person 81 also has the ability to rearrange the order of factors and investigations for a particular condition, for example if a particular evidence source is believed to have more or better information. In one example, the input section of text describes the condition "systemic mastocytosis," provides a general diagnostic factor such as "gastrointestinal complaints" and goes on to describe in narrative form some specific factors such as "nausea," "diarrhea" and "abdominal pain." The clinical concepts 89 output then include these three specific factors as factors of that particular condition. Person 81 may then edit any of these factors.

[0096] Assuming that the input text was a list of diagnostic and risk factors for a particular condition, the person then selects a group descriptor of "factor groups," decides upon a name for a particular group, and then places those factors that belong to that particular group into that group which may include grouping it some of the factors under one of the factors.

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[0097] A factor group will be created for each grouping of diagnostic factors. E.g., there will be a factor group for gastrointestinal symptoms, a factor group for headaches, a factor group for fever symptoms, etc. The person will create or confirm these factor groups. He or she may also do the same for investigation groups for laboratory tests and examinations for a particular condition, etc., in the same manner as described above. Thus, factor groups include collections of EDFs, and investigation groups include collections of EDIs. In addition to reviewing or adding the rank for a particular factor group, the person may also review, add to, or change the other condition dependent attributes in a factor groups such as: sensitivity, specificity, likelihood ratio, risk factor or diagnostic factor, must have or cannot have criteria (i.e., for the condition to be present one or more of the subsumed diagnostic factors must be present or cannot be present).

[0098] In a preferred embodiment a person does review the clinical concepts, corrects errors, adds factors, perform groupings, etc., thus changing and improving the extracted evidence before it is stored into the database 50. It is important that a person actually reviews and improves some of the clinical concepts. Person 81 will also review any differential diagnoses, make corrections if needed, or add a differential diagnosis from one condition to another if present in the source text, thus resulting in differential link 341, for example.

[0099] Further, person 81 also has ability to review, change, adjust, add or confirm demographics information associated with a particular diagnostic factor that will be stored in a demographics node (e.g., node 308 or 374) separate from the EDF. Although the NLP may automatically extract demographics information and separate it from the extracted diagnostic factors, it is helpful to have the person review the demographics information before it is stored into a demographics node associated with an EDF. The demographics information is displayed to the person who may correct it, add information, confirm the information, etc., in the context of reviewing the medical source. Once reviewed, the person saves the demographics information in the appropriate demographics node associated with the EDF. Similarly, although EDI results are also extracted from a medical source along with their corresponding laboratory test or examination, the person will also review the EDI results before storing that information into the appropriate EDI Result node associated with the EDI node.

[00100] The person 81 uses the Graph Editor in order to view these clinical concepts in the graph database or may use a different visual editor in order to perform correction and

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grouping before these concepts are placed into the graph database. These elemental components (elemental diagnostic factors, elemental diagnostic investigations) can often be mapped directly to clinical concepts found in the international taxonomy SNOMED-CT.

[00101] Next, in step 128 a rank or other condition-dependent attributes may be added to each factor or investigation group, either by person 81, automatically from the text portion, or reviewed, adjusted or confirmed by person 81. As mentioned earlier, the rank indicates the likelihood that the factor (for example) is caused by the particular condition. The rank may be inherent in the text and be added automatically (e.g., a ranking, term, phrase, percentage, etc. or the text may indicate for each factor the likelihood that it was caused by the condition), or may be added by person 81 based upon their expertise, or may be confirmed or adjusted by the person. In addition, other condition-dependent attributes may be added depending upon the type of each group.

[00102] Figure 9D shows that person 81 is editing the newly-created factor group "corneal manifestations" 950 and may choose to add any of the attributes 952 as shown.

[00103] In step 132 the particular condition of the input text is assigned to each of the groups. Each factor group or investigation group will be linked to, or associated with, the condition. Assignment may occur in many different ways, the condition may be part of another data structure which is linked indirectly to each EDF or EDI, or may be performed in other manners. Figure 9C shows that person 81 has assigned condition 848 to this factor group; this assignment may also occur automatically based upon the context of the input text.

[00104] In step 136 the condition, and extracted and possibly modified EDFs and EDIs are stored as nodes in the graph database 50, factors being stored as elemental diagnostic factors in the graph, and investigations being stored as elemental diagnostic investigations in the graph, thus not all the nodes in the graph are EDFs or EDIs. Figure 9C shows that a new factor group and factors 844 are ready to be stored into the graph database as a factor group and five new elemental diagnostic factors once the person selects 846.

[00105] In step 140 links are created between the recently added nodes to the graph database 50. These links (or arcs) show the linkages (or parent-child relationship) between two nodes and may be used to traverse the nodes of the database.

[00106] Creation of nodes in the database 50 and creation of links between these nodes may be performed in a wide variety of manners depending upon which graph database is

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used. Although a visualization of a particular graph database is shown in Figure 1 (in this example, a property-value graph), other graph databases may be used which are typically implemented using nodes and arcs. Further, a variety of visualizers may be used to view the underlying database and may appear different forms. And, the conditions, factor groups, EDFs, investigation groups, and EDIs, need not necessarily be implemented in a particular data structure shown or as nodes; each may be implemented using the representation of the underlying database. Further, links between nodes need not be implemented using arcs, but may be implemented using any suitable linkage, pointer, reference, etc., according to the underlying database as well.

[00107] Figure 9E illustrates how the recently extracted factor group and diagnostic factors are represented 960 in the graph database as nodes. Shown is the factor group corneal manifestations 962 having five EDFs 965-969, each EDF having a unique demographics node. The condition node 970 ocular sarcoidosis is shown having the factor group 962. Factor group 962 also links to a citation node 963 holding a citation with support for the factor group 962 and its factors 965-969 indicating condition 970. As mentioned, each citation may be held in its own node, and other nodes reference that node in order to link back to the citation.

[00108] After step 140 the flow may iterate 144 over and over again in order to add other portions of the evidence source, or to add portions from a different evidence source.

Database Example

[00109] Figure 4A is an example of a visualization of the graph database after any number of iterations of the flow of Figure 3. Shown are specific conditions 300, 340 and 360, each having any number of factor groups or investigation groups. In this example conditions 300, 340 and 360 are specific medical conditions that are not named for purposes of the example. Condition 300 has a factor group 304 including two EDFs, fever 310 and nausea 312, each of those associated with a particular demographics node 306 or 308. The demographics nodes are inserted automatically by the system and there is a single demographics node for each EDF node. Linkages between condition 300, factor group 304, demographics and EDF nodes are provided based upon information gleaned from the steps of Figure 3. In this simple example, the input text revealed that the factors fever and nausea are diagnostic factors for condition 300.

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[00110] Condition 340 has a factor group 344 including two EDFs, double quotidian fever 356 and fever 310, each of those associated with a particular demographics node 348 or 352. In this simple example, input text revealed that the factors double quotidian fever and just plain fever are diagnostic factors for condition 340. Note also that the EDF fever 310 is a diagnostic factor for two conditions. Condition 360 has a factor group 264 including one EDF nausea 312 having a demographics node 366 and a demographics node 368; an EDF node may link to multiple demographics nodes. For example, there may be two demographics nodes for nausea node 312 because for this particular condition the factor is only present for the very young (node 368) or the very old (node 366). Other conditions may require two or more demographics nodes for a single EDF or EDI. Note that the EDF nausea 312 is a diagnostic factor for two conditions. In another example, for the condition, abnormal uterine bleeding, there will be two demographics nodes for the factor "women at extremes of reproductive age." One demographic node will have "females 12-19" and the other will have "females 40-60."

[00111] Condition 340 also has a related differential diagnosis indicated via link 341 of condition 300. This means that if condition 340 is determined to be present in the patient (as described below) that a differential diagnosis is also condition 300. But, there is no corresponding differential diagnosis link from condition 300 to condition 340, thus indicating that, for this example, condition 340 is not a differential diagnosis of condition 300. Link 341 is added by the person 81 based upon extracting factors and investigations for a particular condition, e.g., the text may say "condition A is often mistaken for condition B." For example, influenza may be confused with RSV because they have the same signs and symptoms. Person 81 using the console will add link 341 if condition 340 might also be condition 300, but will only add a similar link from 300 to 340 if condition 340 might also be mistaken for condition 300.

[00112] Condition 300 also has two investigation groups, CBC blood culture 316 and urinalysis 320, both also produced by portions of an evidence source being input into the flow of Figure 3. Similar to factors, the single laboratory test EDI urine dipstick for white cells 332, is at the end of the linkage, with its possible result, EDI Result low 326, being between nodes 320 and 332. The EDI Result type of node is similar to the demographics nodes in that an EDI Result node provides a result specific to its indicated condition, and is

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indicative of the condition only when the result has a particular value, such as "low" in node 326.

[00113] The other investigation group of condition 300 is CBC blood culture 316 and is an example of an investigation group which may include many specific tests, each having a particular value which is indicative of the condition, if that value is present. Although a CBC blood culture may include many results, only shown are the specific tests EDI hematocrit 328 and EDI hemoglobin 330, each having a particular result 322 and 324. Again, the specific laboratory tests 328 and 330 are only indicative of condition 300 if the results 322 and 324 are as shown.

[00114] Advantageously, each EDF has a single (typically) demographics node associated with it that holds condition-dependent attributes that further define how and when a particular factor is present for a specific condition as well as the rank indicating the likelihood that the factor is caused by the specific condition. For instance, if the EDF fever 310 only occurs because of condition 300 in children under 12 years of age, that information is present within demographics 306.

[00115] For each EDF the attributes of temporality, negation, and experiencer are also used. Temporality refers to whether or not the patient is experiencing the factor now, negation means the factor is or is not present and experiencer refers to whether the factor is experienced by the patient or there is a family history.

[00116] Further, each factor group node holds a ranking as discussed above, e.g., a ranking within factor group node 304 indicates the likelihood that fever 310 is caused by condition 300. Separating out specific demographics and the ranking from an EDF node in this manner allows each EDF node to be truly elemental, independent and atomic in the sense that each EDF node can be referenced and used by any condition; the specifics as to how factor manifests because of a particular condition and its ranking are held in the factor group and demographics nodes, not in EDF node. By way of example, if fever 310 presents itself in a different way for different ages depending upon whether the patient has condition 300 or condition 340, these details are held in demographics nodes 306 and 352 rather than within EDF node 310. And, because fever 310 may be ranked differently for condition 300 and condition 340, these rankings are held in nodes 304 and 344 as well. Thus, a fever 310 in the context of condition 300 is a definition of fever 310 within that node plus its attributes within demographics node 306 and node 304. For certain conditions with bimodal distributions they

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will be two demographics nodes between fever, for example, and condition 300 (e.g., when the fever only occurs in very young children and in very old people).

[00117] The condition-dependent attributes within a factor group node may be added in a variety of manners. Some of the attributes may be automatically added when the factor groups are added to the graph database in step 136 based upon output from the NLP engine when it recognizes the input text. Or, other attributes may be automatically determined by using external taxonomies. Or, person 81 may add attributes to a particular factor when reviewing the clinical concepts in step 124.

[00118] In another example, a patient with condition 340 may exhibit double quotidian fever 356 as well as plain fever 310, each being a separate EDF node with its own particular demographics and ranking. This separation of different fevers into different EDF nodes, each having different demographics and ranking allows more accurate diagnosis and reasoning. Because a person with condition 340 may exhibit double quotidian fever and a patient with condition 300 will not, it is important to keep these two elemental factors separate, yet still allow the factor "fever" to be shared by both conditions are shown.

[00119] Each EDF node (e.g., such as fever 310) includes a variety of information useful in allowing the node to be elemental and independent as herein described. A node includes its name (e.g., fever), synonyms (e.g., elevated temperature, pyrexia, febrile, feverish, etc.), and a unique identifier that links back to a medical taxonomy (e.g., SNOMED, SNOMED-X, LOINC, RxNorm, ICD, CPT, etc.) and identifies a unique factor within that taxonomy. In the case of SNOMED, the unique identifier may be a SNOMED code or an expression that combines a number of SNOMED codes. The unique identifier to a medical taxonomy allows the system to perform inferential reasoning from the EDF node using the medical taxonomy.

[00120] In one example, consider a patient who complains of lower-right abdominal pain but nothing else. If condition X has a diagnostic factor of lower right abdominal pain only and condition Y has a factor of abdominal pain only it will be important to consider both conditions because there may have been miscommunication between the patient and clinician, the evidence source may not be clear, or for some other reason. Accordingly, by using the factor lower-right abdominal pain as an index into the medical taxonomy, one may traverse the hierarchy in order to retrieve abdominal pain as a parent of lower-right abdominal pain and thus assume that the patient also has abdominal pain which may lead to a

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diagnosis of condition Y. Without that linkage, the clinician or system would only consider condition X.

[00121] Figure 4B provides more detail on the content of condition, factor group, demographics and EDF nodes. As shown, condition node 370 may include attributes for that particular condition such as age (e.g., the condition can only occur in individuals having an age between 12 and 55), sex (e.g., the condition may only pertain to males or females), etc. Factor group 372 may include a rank (applicable to each of the EDFs to which it is linked), a weight value (which may be used instead of the rank) which may incorporate sensitivity, specificity and the likelihood ratio, a type which indicates whether the EDFs linked below the factor group are diagnostic factors or risk factors, and "must have" and "cannot have" criteria indicating whether or not the EDFs of this factor group must be present for the condition to occur or must not be present. Other criteria may also be present indicating that a certain number of the linked EDFs must be present for the condition to occur (e.g., "at least two of the below diagnostic factors must be present"), or a points system may be used, each of the below factors receiving a number of points and a minimum must be reached before the condition is known to occur. Also included is a link to a citation 378 providing support in a medical evidence source for the use of the factors of the factor group in indicating the condition. Each factor group will also have a name (e.g., gastrointestinal symptoms) and a brief description taken from the evidence source.

[00122] Demographics node 374 includes demographics of EDF node 376 which must be true for that factor in the context of condition 370. By way of example, if the factor of EDF node 376 is only present in certain genders, or only below or above certain ages in the context of condition 370 (i.e., the factor can only indicate the condition if the patient meets the demographics) and that information is held in node 374.

[00123] EDF node 376 includes only the basic information needed to represent a particular factor (e.g., fever, headache, nausea) such that node 376 is elemental and independent and may be used as a factor in other conditions. By only holding the essential information in node 376, and by holding attributes for that factor that are only relevant to condition 370 in nodes 372 and 374, node 376 can be used as a factor for many conditions. Included are its synonyms (derived from the evidence source or from input by person 81), temporality (T, a binary value indicating whether the factor was experienced in the past or now), negation (N, a binary value indicating whether the factor is present or not present), and

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experiencer (E, a binary value indicating whether the factor is experienced by the patient or family member). These values for TNE may be stored within node 376 or in a separate node linked to node 376. Further, given that there are three binary values, there may be as many as eight EDF nodes 376, each having a different value using the combination of these three values. Each of these eight EDF nodes is also independent and each may be used by many different conditions. By way of example, an EDF node for fever may list temporality is now, fever is present, and experiencer is the patient. A second EDF node fever may list temporality is now, fever is not present, and experiencer is the patient. The other six nodes vary the other two attributes T or E. A link to at least one ontology using a unique code references that same factor within the known ontology providing the ability to traverse the hierarchy of that ontology either up or down.

[00124] Figure 4C provides more detail on the content of condition 370, investigations group, EDI Result and EDI nodes. As shown, condition node 370 includes the same attributes as above. Investigations group 382 may include a ranking (applicable to each of the EDIs to which it is linked), and also includes a name and description as above. Each investigation group also includes the ranking, i.e., whether the group is first line, second line or emerging, etc., thus ordering the various investigation groups, which ordering may be adjusted by person 81.

[00125] Each EDI Result node 384 includes the actual result from the laboratory test or examination (e.g., "low," 32, greater than 100, in-between 50 and 100, yellowish, etc.) to indicate the condition 370, and the type of the result: a value, range, a binary, and ordinal, nominal, etc. Each EDI node 386 includes the test or examination name, its synonyms, a link to one more ontologies using a unique code for that particular test or examination, and all possible result types for that test or examination. Note that the types listed for a particular EDI Result 384 are likely a smaller subset then the result types listed in node 386.

[00126] Returning now to a discussion of the investigation groups of condition 300, note that these groups do not have demographics nodes, but each has one or more EDI Result nodes below them which are similar to demographics nodes in that they hold results of tests or examinations that are specific to a particular condition. Nodes 322-326 hold the specific results of a test that indicates when condition 300 is present and EDI nodes 328-332 contain a description of the actual test itself. Similar to EDF nodes, each EDI node include a name of a test (e.g., hemoglobin), synonyms, a link to an ontology.

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[00127] EDI Result nodes include the result of the test (described using terms such as "high" or "low", using ranges, using binary values, using ordinal types, etc.), units of the result, reference range values, the particular coding, etc., all condition-dependent attributes indicating what is a valid result to indicate the associated condition. Thus, each individual EDI node 328-332 (whether for a laboratory test or examination) remains elemental, independent and may be used computationally across various conditions.

[00128] It is realized that because some laboratory tests have different reference range values (and certain machines may have different values), it is advantageous to keep these particular attributes and their values within an EDI Result node rather than within the EDI node itself, thus ensuring that an EDI node (such as EDI hematocrit 328) is truly independent and elemental, and may be used for computation for any condition, not only with condition 300. Other investigations such as examinations are handled in the same manner.

[00129] Similar to the relationship between EDFs nodes and demographics notes, while an EDI nodes such as 328 holds the elemental laboratory test that may be shared between many different conditions, its corresponding EDI Result node such as 328 holds the particular result of that test which indicates that the particular condition 300 is present. EDI node 328 may very well have a different parent EDI Result node having a different result which links to a different condition.

Flow Diagram for Determine Patient State

[00130] Figure 5 is a flow diagram describing how the state of a patient may be determined. In a first step 404 a patient presents for a medical visit with a clinician, e.g., an in-person visit or the client participates remotely by telephone, computer, or any other suitable telemedicine scenario. Alternatively, the patient has presented in the past and the clinician is reviewing the patient's chart without the patient being present.

[00131] In a next step 408 the clinician uses the EHR system user interface 20 (or other suitable user interface such as diagnostic glass 24) to open the patient's electronic chart in the EHR system. The EHR system detects the clinician's context, the patient context (e.g., a medical record number) and sends this information to the backend systems of platform 10.

[00132] Next, in step 412 platform 10 via the diagnostic glass 24 (which may be integrated with the EHR system) downloads the patient's medical history from his or her

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chart and transmits the textual information to the NLP engine 74 via patient state service 60. Included within this medical history are any clinical notes that a clinician had entered previously or has just entered, including simple notes, SOAP notes, structured column notes, consultant notes, etc. Further, any transcriptions may be included as well as transcriptions transcribed from a microphone using speech recognition software.

[00133] Next, in step 416 patient state service 60 calls NLP engine 74 in order to extract the diagnostic factors, risk factors and investigation results (including laboratory test results and examination results) from the patient's medical history. Preferably, the NLP engine is initialized with the EDF and EDI nodes from the graph database in order to facilitate finding those same concepts within the patient chart. NLP engine 74 may also use embedding service 76 in order to extract the relevant factors and investigations from the patient's medical history, resulting in factors and investigations that are either known to be present or known to be absent.

[00134] Similar to how the NLP engine produced various clinical concepts such as diagnostic factors, risk factors investigations from text from evidence sources, the NLP engine extracts factors and investigations from the patient's medical record and provides them. For instance, if the diagnostic factor "high fever" was extracted from an evidence source as being indicative of a particular condition, and a patient diagnostic factor of "high fever" is extracted from the patient's medical record, both of these factors will be in the same format or data structure thus allowing comparison and a determination that the patient's diagnostic factor matches that same diagnostic factor in the graph database.

[00135] The NLP engine produces a patient diagnostic factor (or investigation) that is the same as an EDF (or EDI) in the graph database by matching extracted names with EDF and EDI names and synonyms, and by using the graph database and its links with which it has been initialized. By way of example, the NLP engine may use the ontology link for a particular EDF or EDI in order to explore and match the factors and investigations from the patient's medical record. This is useful when two concepts have the same name but exist in different hierarchies in an ontology (i.e., the same name referring to a condition and the factor). By way of example, given the phrases "cold" or "feeling cold" or "feeling a little cold," these phrases can be ambiguous about whether the patient is describing a condition or a symptom. The engine will use the ontology link in an EDF to understand whether "cold" is a finding (i.e., a factor) or is a condition in the context of the patient's chart. Thus, the engine

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is able to distinguish between "cold" a condition, and "feeling cold" a patient symptom. During this extraction from the patient chart, the person 81 is not used to extract factors and investigations; it is automatically performed by the platform 10. Basically, the NLP engine is looking for the clinical concepts it extracts from the patient's chart within the graph database that it has built up previously. Further, the NLP engine uses the full context of the patient chart and can distinguish between "patient examination," "pulmonary embolism," and "peripheral edema," all having the acronym PE. Thus, not only is the NLP engine initialized with nodes from the graph database to identify concepts in the patient chart, but also it uses ontology links in particular EDFs in order to disambiguate concepts. Given a concept from a chart, an ontology link from an EDF may also be used by the NLP engine to traverse up a hierarchy of concepts in order to find a concept that it already knows about in the graph in order to match the chart to the graph. All of these techniques provide greater accuracy for the platform.

[00136] In step 420 reasoning service 72 uses inferential reasoning in order to expand the diagnostic/risk factors and investigations that were extracted from the EHR data in step 416. The reasoning service 72 may use an internal or external taxonomy or any other suitable medical hierarchy in order to perform this inferential reasoning. By way of example, if one diagnostic factor is "double quotidian fever" the service finds the parent of that which is "fever" and then infers that another diagnostic factor of the patient is "fever." The service will traverse upward in the taxonomy adding all other relevant diagnostic factors that are parents of "fever." In addition, if a negation is present, e.g., a diagnostic factor is "no fever," then the service traverses down the taxonomy to infer that the patient does not have "chronic fever" nor "intermittent fever," and other possible children. In another example of inferential reasoning, if the patient is taking amoxicillin the service also infers that the patient is taking an antifungal medication by traversing up the taxonomy. Investigations may also be expanded. For instance, if the patient did a white blood cell test it may be inferred that this test was part of a CBC blood culture. Preferably, both the EDI node itself and the EDI Result node are expanded.

[00137] In step 424 all of the expanded factors and investigations present in the patient are matched to corresponding nodes in the graph database. When we match a patient diagnostic factor of "fever" to the graph database we are matching the patient's factor to the EDF fever node 310 not to its demographics node 306 or 352. The reason being that it is

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unknown at this time what the patient's condition or conditions might be and by matching only to the EDF fever node it leaves open the option of concluding that any of various conditions linked to fever might be possible. Attempting to match not only to fever node 310 as well as to demographics node 306 might preclude a match if the demographics do not match. By allowing a match irrespective of any of the demographics nodes we can later conclude any potential conditions linked to the fever node, assuming that the demographics match during the analysis. Similar matching occurs with respect to EDI nodes; we match extracted patient laboratory tests and examinations to EDI nodes (e.g. 328-332) irrespective of their EDI Result nodes (e.g., 322-326).

[00138] Even though matching only matches EDF nodes, the demographics nodes corresponding to matched EDF nodes are taken into account when reasoning occurs to determine if the patient has the particular condition related to that EDF node. For example, if the patient's factor matches EDF fever node 310, but demographics node 306 indicates that it is only found in women, then a male patient would not be diagnosed with condition 300. Similarly, if demographics node 352 indicates that its associated fever is common in men over 50 years old and the patient is a male over 50, then it is certainly possible that the patient will be diagnosed with condition 340. In a similar manner, EDI Result nodes will be used to determine if matched EDI nodes are relevant for their associated conditions when performing step 424.

[00139] In one embodiment, partial matching is performed during step 420. By way of example, as extracted factors and investigation results are each in turn considered for expansion using inferential reasoning, the system will match each to a corresponding node in the graph database in order to find the link to an appropriate taxonomy or hierarchy for expansion. As expansion occurs (either by traversing up or down the hierarchy) the system can match inferred patient diagnostic factors to the corresponding node in the graph database, e.g., inferring that the patient has "fever" from a patient factor of "double quotidian fever" means that the system can also match the "fever" node in the graph database. Matching may occur in other manners, such as by matching all expanded factors and investigations in step 424 rather than during the expansion of step 424.

[00140] In step 428 the system computes rankings of the likely conditions of the patient in order to present differential diagnoses. As mentioned above, each factor group or investigation group includes a rank indicating how likely it is that the particular group will

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manifest given its condition. In addition, each EDF node or EDI node includes a noise value representing how much relevant information content in node has relative to other information. For example, fever node 310 provides a certain amount of information whereas double quotidian fever node 356 is more specific and provides even more information, thus having a greater noise value. Thus, the noise value for fever 310 will be the same for condition 300 as well as condition 340, although the rank of factor groups 304 and 344 will be different.

[00141] Step 428 looks at the factor group nodes and investigation group nodes for each matched EDF node and EDI node to determine a ranking of its associated condition. A parameterized weighting function then combines the rank of a group optionally with its noise values (or uses sensitivity, specificity, and a likelihood ratio) in order to compute a weight value for each factor group and investigation group which are then combined to compute a final weight value for a particular condition in order to rank that condition against the other conditions, a higher final value meaning that it is more likely that the patient has that condition.

[00142] As mentioned above, even though an EDF node or EDI node is matched, it will carry no weight and the associated condition will not be considered if the patient does not meet the demographics specified in a demographics node in between the EDF node and the condition, or does not meet the specific results in an EDI Result node in between the EDI node and the condition. Further, a matched EDF node will carry no weight and its associated condition will not be considered if the condition-specific criteria in the factor group corresponding to that EDF node are not also satisfied. For instance, if a factor group lists certain "must-have" diagnostic factors then the associated condition will not be considered if those diagnostic factors are not present; similarly, if certain "cannot have" diagnostic factors are listed then the associated condition will not be considered if those diagnostic factors are present in the patient.

[00143] Other techniques for assessing the relative importance of EDFs, EDIs, factor groups and investigation groups may also be used. A rank may only reside in the factor group and investigation group nodes, and the sum of all these ranks of all matched nodes is the ranking of the associated condition. Or, we can compute a two- or three-dimensional sensitivity, specificity and likelihood ratio for each group and then compute a total weight for each condition based upon those ratios. In any case, the sum of the likelihoods of matched

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factors and investigations being present for a given condition informs the final ranking value for a particular condition. The top N conditions may be considered the differential diagnoses for that patient, N being a design choice and being a suitable number for consideration, further calculation or display, such as 3, 5, 10, etc.

[00144] In step 432 these top N conditions are output for display upon diagnostic glass 24 for viewing by the clinician, may be output in any suitable data structure for further processing by another software application, may be used as input to determine a next-best action as described immediately below, or may be output for any other purpose. These output conditions may simply be listed in order of their ranking without further information, may each be listed along with a ranking value, may each be listed along with a probability value of being present, etc.

Flow Diagram for Determine Next-Best Actions Per Condition

[00145] Figure 6 is a flow diagram describing how the next-best actions per condition are determined based upon the patient's state. Use of the graph database 50 allows the patient's current clinical state to be compared to a body of medical evidence that has been extracted from evidence sources in order to determine next-best actions.

[00146] Preferably, the flow diagram of Figure 5 has been executed and the patient's current clinical state is known, i.e., his or her likely conditions, and the patient's current diagnostic and risk factors as well as results from laboratory tests and examinations that have been performed. These factors and investigations have also been expanded as discussed in step 420 to include other factors and investigations not specifically disclosed by the patient. Alternatively, it is also possible to input a current patient clinical state (i.e., likely conditions, current factors and investigation results) using other techniques in order to match and identify nodes within the graph database 50.

[00147] In step 504 a loop begins for each current condition of the patient with a greater than de minimis probability (identified in step 428 or otherwise), e.g., the top N conditions. Typically, any condition with a probability greater than about 10% will be processed. This minimum is configurable.

[00148] In step 508 the NBA engine 70 identifies the set of all of the expanded diagnostic factors known to be present or absent and all expanded investigations known to

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have been performed, i.e., those identified in step 420--all EDF and EDI nodes in the graph database 50. As mentioned above, these nodes may be identified using an alternative technique and not necessarily from step 420. For example, if the patient presented with a fever and fever node 310 was matched in step 424, then this node is now identified in step 508. Similarly, if the patient had a test performed for hemoglobin, then EDI node 330 is also identified. Step 508 thus produces an identification of all EDF and EDI nodes in the graph database that correspond to the likely current condition.

[00149] In step 512 the NBA engine identifies the set of all diagnostic factors and risk factors not yet known to be present or absent in the patient. As step 508 has identified all of the nodes within the graph database that are present within the patient, it is straightforward to identify all of those nodes that are currently unknown. For example, assuming the current condition is condition 300, the engine traverses downward to all factor groups and identifies all of those EDF nodes that have not been matched; if the patient presented with fever but no information is provided regarding nausea, it is unknown whether nausea is present or absent and therefore EDF node 312 will be identified in this step.

[00150] Similarly, in step 516 the NBA engine identifies the set of all laboratory tests and examinations that have not yet been performed. Assuming the current condition is condition 300, the engine traverses downward to all investigation groups and identifies all of those EDI nodes that have not been matched; if the patient had performed hematocrit and hemoglobin tests but nothing else, then EDI node 332 will be identified in this step.

[00151] Next, in step 520 the NBA engine returns both sets of unknown factors and not-yet-performed investigations for the current condition and holds these results until the loop ends. In step 524 after all patient conditions have been processed the loop ends and the NBA engine may return both sets for all conditions to diagnostic glass 24 for display, may provide both sets to patient state service 60 for storage or later processing by another application, or may retain both sets from all conditions for further processing in Figure 7 below.

[00152] In step 528 the diagnostic glass displays to the clinician these top N conditions each with a set of factors not yet known to be present or absent in the set of investigations not yet performed as the next-best actions. Preferably, the listing of the next-best actions (whether factors or laboratory tests for examinations) are listed in the order of their importance to a particular condition, such as by using their calculated weight or ranking from

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a factor group or investigation group. This weight or ranking may be listed explicitly alongside each factor group or investigation group when displayed or may be implicit in that factors and investigations are listed from top to bottom in order of decreasing weight or rank. For example, the rank of EDF fever node 310 is found within factor group 304 and the rank of EDI hemoglobin node 330 is found within investigation group 316.

[00153] Other techniques for displaying this information may also be used. For example, the number of conditions presented may be configured in a variety of ways including but not limited to a specific number of conditions or by using a specified weight threshold. Or, the conditions may be ordered by their weights as established by NBA engine 70. The information may be displayed within diagnostic glass 24, within a similar standalone product, or integrated with the EHR system. The present, not present and unknown clinical factors associated with a particular condition may be displayed with an indication as to their particular state. The unperformed laboratory tests and examinations may also be listed with their current state (i.e., unperformed). The next-best actions may be presented either per condition or in the aggregate. The presentation of the information by the diagnostic glass user interface may be textual, graphical, audio, video, a combination of the above or in another appropriate format.

[00154] Further, while in one embodiment the output next-best-action factors to query are ranked against one another while the output next-best-action investigations are similarly only ranked against themselves, in other embodiment both may be ranked against one another, e.g., the first next-best action may be an unknown factor while the second next-best action may be a recommended test or examination.

Flow Diagram for Determine Next-Best Actions Across Conditions

[00155] Above is described a technique for determining the next-best actions per condition, the below flow diagram describes a technique for determining the next-best action across all the conditions that the patient may have, or list of the top N next-best-actions. In other words, these next-best actions are the best action or actions that a clinician can take (e.g., the best diagnostic or risk factor the clinician should ask about, or the best laboratory test or examination to perform) in order to most quickly diagnose the patient's condition. Using the example of Figure 4, if the patient presents only with a fever this means that the patient has condition 300 or condition 340. The next-best-action will be to ask if the patient

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has nausea (matching to EDF node 312) and if so, this means that the patient has condition 300, and if not, it is likely the patient has condition 340. Another possibility is to ask the patient to perform a hemoglobin test (assuming EDI node 330 is currently unknown), and if positive, this means that the patient likely has condition 300, while if negative, means the patient likely has condition 340. Of course, an actual graph database will be much more complex and contain many hundreds of thousands of nodes or more, meaning that an automated search algorithm is used.

[00156] In a first step 604 the current unknown factors (i.e., not known to be present or absent) and investigations (i.e., those not yet performed),corresponding to the patient's current state are identified. In addition, their corresponding nodes in the graph database are also identified, i.e., the unknown EDF and EDI nodes. Preferably, this step is performed using the results from step 504-520 of Figure 6, i.e., those sets of unknown factors and investigations.

[00157] And, although step 604 appears outside of the search algorithm loop in this flow diagram, it is also possible to identify these unknown nodes during the search algorithm loop while the algorithm is traversing nodes of the graph database. In other words, as the patient's state is known (i.e., the NBA engine knows which factors are known, and which investigations have been performed), it is also known which nodes are unknown and these may be identified as needed in step 612, 616 and 628.

[00158] In step 608 the search algorithm is begun using the graph database and knowing the patient state (i.e., which nodes are known and which are unknown). Any of a wide variety of search algorithms may be used, especially tree search algorithms, and one that has been found to work well is the Monte Carlo tree search. Even a brute force search may work but will take more time and resources.

[00159] Next in step 612 one of the unknown nodes is chosen to begin, the "next node." For example, if it is unknown whether or not the patient has nausea, then EDF node 312 may be chosen to be the first node with which to begin.

[00160] In step 616 given the patient's current state, the search algorithm assumes that this next node is now known (e.g., "patient does have nausea") and new condition rankings are generated based upon this new information. This step may be implemented as in steps 420-432 in which the new, now known factor is expanded, these are matched to nodes in the graph database and new rankings of the likely conditions are generated based upon the

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original patient state plus this new information. Further, this step is also able to take into account the probability that a patient would respond "yes, I have nausea."

[00161] This step also generates a new score, effectively evaluating how beneficial it is in assuming that the next node is now known in terms of determining the patient's condition; the score represents how effective that assumption is in distinguishing the conditions from one another. In one embodiment, the score represents how much the differential diagnoses have changed relative to one another. For instance, if in the patient's original state one diagnosis had a probability of 70% and a second diagnosis had a probability of 75%, but, once the assumption of "patient does have nausea" is made the first diagnosis has a probability of 95% and the second diagnosis now has a probability of 60%, the score for that assumption will be quite high. If both diagnoses are now at 70% then the score will be lower. In addition, the search algorithm will also generate a search branch and a corresponding score where the assumption for that next node is the opposite, i.e., "patient does not have nausea."

[00162] The score may also be interpreted as an attempt to maximize the confidence in a potential patient condition using the minimum number of actions (e.g., questions, laboratory tests, etc.). Typically, the score per action is a combination of the dollar cost of performing the action (asking about a diagnostic factor, performing a laboratory test or examination), the time involved in performing the action, and the risk of performing the action. How these are combined to yield a particular score will depend upon the implementation. By way of example, asking about diagnostic or risk factors typically has no cost, little time and no risk, while laboratory tests may have minor costs, sometime involved and low risk. More complex examinations (such as an MRI) may have high cost, significant time involved, and greater risk. These score factors may be held within individual EDFs or EDIs, may be held in association with these via a link, may be held in a separate database cross-referenced to the individual EDFs and EDIs, or in similar manners.

[00163] In step 620 this generated new score will be stored with reference to unknown node about which an assumption was made and may be compared to previous scores for previous assumptions made for other unknown nodes. As is known in the art of search algorithms, and especially recursive algorithms such as the Monte Carlo tree search, the search will continue down these two paths, one assuming nausea and one not, generating new condition rankings and new scores as it goes. Further, a search algorithm such as the Monte Carlo tree search will also trim (or prune) nodes for which an assumption would be

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irrelevant, may discard the current search path, and may eventually return to a state where EDF node 312 is again unknown and will make an assumption for another node.

[00164] Accordingly, in step 624 a decision may be made to terminate the algorithm. The algorithm may be terminated based upon user input indicating that only a certain number of seconds or fraction thereof should be used in performing the search, based upon only a certain number of levels of recursion should be used, may be terminated once a particular score threshold has been reached, may be terminated once a particular score is a certain quantity greater than the next largest score, etc. If not terminated, then in step 628 the algorithm chooses a new next node from among the unknown nodes identified in step 604 and recursively continues its search by returning to step 616. As known in the art of search algorithms, this next node may rely upon assumptions made for other unknown nodes, or may revert to the original patient state and choose a different unknown node to make an assumption about it.

[00165] If the algorithm does terminate, then in step 632 a list is output of the top N unknown nodes having the highest scores from highest to lowest. The nodes may be listed inherently in order or may have the numerical score associated with each one. In other words, since the NBA engine keeps track of the score generated each time a particular unknown node becomes known in step 616, it is able to output this list which may be a single EDF or EDI node, or multiples of these nodes, thus representing the next-best action or actions across all possible conditions of the patient. Once output, the clinician is thus able to query the patient about an unknown diagnostic or risk factor, or order a particular laboratory test or examination to be performed which will result in the best way to reach a diagnosis at that time.

[00166] Further, once the patient has answered the question, or received laboratory or examination results back, this new information may be entered back into the system in order to execute the flows of Figure 5, 6 or 7 in order to generate new results.

Display Ranked Conditions and Next-Best Actions

[00167] Figure 8A illustrates a display of ranked conditions and also next-best actions per condition. Shown is a user interface of diagnostic glass application 24 having patient information 704, a selection 708 of whether to display differential diagnoses each with their

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next-best actions (factors) or the differential diagnoses each with their next-best actions (investigations). The clinician has selected differentials with factors 708. Shown are the differential diagnoses 712 and 716 for this patient listed in order of their likely probability; in this embodiment each condition is preceded by its probability (meniscal tear-67%, osteoarthritis-27%, etc.), although the probability or ranking need not be explicitly present. Although other information is present, the above shows the output of step 432 from Figure 5.

[00168] Also shown is other information relevant to the output of step 528 from Figure 6. Shown are factors from the patient's record 720 including pertinent positives and pertinent negatives (not shown, but the clinician can scroll down to see them). Here, the clinician has selected factors to be shown but may also select vital signs, laboratory results or other examinations. Shown at 724 and 728 are the pertinent positive and negative factors and investigations that pertain to condition 712; in other words, those known factors and investigations that most likely indicate the associated condition 712. These may be ordered alphabetically or by rank. Although not shown, if any of the other conditions 716 are expanded, their pertinent positives and negatives would also be shown.

[00169] The next-best actions 732 for condition 712 are shown below that condition and are those factors which are not yet known or have not yet been performed. These may be listed as a group of the top actions to ask about or perform next or may be listed in order of their likelihood of indicating the associated condition, with or without an explicit ranking. The clinician may review and perform one of these actions 732; once he or she inputs whether the factor is now present or not, then the platform may execute the steps of Figure 6 in order to display new conclusions based upon the new information in step 528.

[00170] At any time, a clinician reviewing this display may access the citations relied upon for the conclusions present. By way of example, by clicking upon a particular condition such as condition 712, a window is opened presenting a view of the graph database including that condition, such as a view shown in Figure 4A (another view is shown in Figure 4B). From here, the clinician can see the various factor groups with their names and may select one of these factor groups to understand why the factors of this group are indicative of the medical condition. Once selected, the factor group is displayed such as shown at 372, and the clinician may review the rank of the group, criteria, names of subsumed EDFs or diagnostic factors, and see the link to the citation, such as the link to citation 378. The clinician may then click upon this link to reveal the actual citation such as shown at 832 in Figure 9B. The

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clinician may then review the actual reference of the citation using the enclosed URL (or other unique identifier) in order to assure himself or herself that the conclusion of the condition 712 is accurate. Accordingly, citations are built into the graph database, are transparent, and may be accessed easily by a clinician when reviewing results in order to provide confidence in the conclusion. A citation may be accessed for an investigations group (such as citation 388) in a similar manner. Similarly, citations may also be accessed from any of the outputs of Figure 8B or Figure 8C.

[00171] Figure 8B illustrates a display of ranked conditions and also next-best actions per condition. Shown is the diagnostic glass 24 but this time the clinician has selected tests 740 in order to display the laboratory tests or examinations which are the next-best actions. Shown are conditions 712, 752 and 754 from before, except that in this view each condition is followed by the recommended laboratory tests or examinations which have not yet been performed and which are ordered by the likelihood that they will indicate or rule out the associated condition. By way of example, examinations 748 are recommended for condition 712, examinations and laboratory tests 756 are recommended for condition 752, and condition 754 is followed by its recommended tests and examinations. These investigations may be ordered by which most likely indicates or could rule out the associated condition, may or may not have an explicit ranking alongside each one, may be listed as a group with no explicit or implicit rankings, may be listed by overall cost which as explained below may include a combination of dollar cost, time to administer and risk to the patient.

[00172] Although not shown, the clinician may select both options 708 and 740 in which case the next-best actions of 732 and 748 for condition 712 will be listed together, and may be listed by rank of likelihood of indicating the particular condition (factors and investigations are mixed), grouped by factors or investigations, etc.

[00173] Figure 8C illustrates a display of next-best actions across conditions. Shown is the diagnostic glass 24 similar to that of Figure 8A. Shown is the patient's information 704, a selection of differential diagnoses 708, and the next-best actions specific to condition 712. In addition, in order to display the output of step 632 of Figure 7, shown are next-best actions 760 which are those next-best factors to ask about or next-best laboratory tests or examinations to be performed across all conditions 712 and 716. In other words, these are factors which are not yet known to be present or not present, and laboratory tests or examinations which have not yet been performed, and which if known or performed, would

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be the best at concluding which is the patient's most likely current condition. For example, if one or more these actions are performed and the results are input at 760, the platform will re-execute any of the flow diagrams of Figures 5, 6 or 7, and may conclude that osteoarthritis is more probable than a meniscal tear (depending upon the results of the actions 760. Or, condition 712 may be even more certain and will have a higher probability than 67%.

Example Transformation

[00174] Figure 10 is an example transformation of evidence-based text to computational data. Shown is a portion of a medical evidence source 980 for the condition hypertension. The portion lists the condition, various diagnostic factors such as retinopathy 981, and a brief description. Although not shown, the frequency of each diagnostic factor for this condition may also be listed indicating its rank. Once this portion for retinopathy is transformed 982 (or translated) as discussed above with reference to Figure 3 then the diagnostic factor retinopathy for hypertension may be represented as an elemental diagnostic factor (EDF) 983. This node includes its name 984, an ontology identifier 985, an ontology expression 986, any number of synonyms 987, and specific temporality, negation and experiencer attributes 988 having a binary value. This EDF 983 for retinopathy may then be represented and used for computational purposes in a graph database 990 having the retinopathy data 983 represented as a node 991. As shown, node 991 serves as an EDF for any number of conditions such as Marfan syndrome 992. These conditions may also have differential diagnoses links 993 and 994 between them as well. Accordingly, by virtue of retinopathy node 991 being elemental and independent, and not including condition-specific attributes, it may be used as a diagnostic factor node for any of a number of conditions as shown for computational purposes.

Computer System Embodiment

[00175] FIGS. 11A and 11B illustrate a computer system 900 suitable for implementing embodiments of the present invention. FIG. 11A shows one possible physical form of the computer system. Of course, the computer system may have many physical forms including an integrated circuit, a printed circuit board, a small handheld device (such as a mobile telephone or PDA), a personal computer or a super computer. Computer system

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900 includes a monitor 902, a display 904, a housing 906, a disk drive 908, a keyboard 910 and a mouse 912. Disk 914 is a computer-readable medium used to transfer data to and from computer system 900.

[00176] FIG. 11B is an example of a block diagram for computer system 900. Attached to system bus 920 are a wide variety of subsystems. Processor(s) 922 (also referred to as central processing units, or CPUs) are coupled to storage devices including memory 924. Memory 924 includes random access memory (RAM) and read-only memory (ROM). As is well known in the art, ROM acts to transfer data and instructions uni-directionally to the CPU and RAM is used typically to transfer data and instructions in a bi-directional manner. Both of these types of memories may include any suitable of the computer-readable media described below. A fixed disk 926 is also coupled bi-directionally to CPU 922; it provides additional data storage capacity and may also include any of the computer-readable media described below. Fixed disk 926 may be used to store programs, data and the like and is typically a secondary mass storage medium (such as a hard disk, a solid-state drive, a hybrid drive, flash memory, etc.) that can be slower than primary storage but persists data. It will be appreciated that the information retained within fixed disk 926, may, in appropriate cases, be incorporated in standard fashion as virtual memory in memory 924. Removable disk 914 may take the form of any of the computer-readable media described below.

[00177] CPU 922 is also coupled to a variety of input/output devices such as display 904, keyboard 910, mouse 912 and speakers 930. In general, an input/output device may be any of: video displays, track balls, mice, keyboards, microphones, touch-sensitive displays, transducer card readers, magnetic or paper tape readers, tablets, styluses, voice or handwriting recognizers, biometrics readers, or other computers. CPU 922 optionally may be coupled to another computer or telecommunications network using network interface 940. With such a network interface, it is contemplated that the CPU might receive information from the network, or might output information to the network in the course of performing the above-described method steps. Furthermore, method embodiments of the present invention may execute solely upon CPU 922 or may execute over a network such as the Internet in conjunction with a remote CPU that shares a portion of the processing.

[00178] In addition, embodiments of the present invention further relate to computer storage products with a computer-readable medium that have computer code thereon for performing various computer-implemented operations. The media and computer code may be

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those specially designed and constructed for the purposes of the present invention, or they may be of the kind well known and available to those having skill in the computer software arts. Examples of computer-readable media include, but are not limited to: magnetic media such as hard disks, floppy disks, and magnetic tape; optical media such as CD-ROMs and holographic devices; magneto-optical media such as floptical disks; and hardware devices that are specially configured to store and execute program code, such as application-specific integrated circuits (ASICs), programmable logic devices (PLDs) and ROM and RAM devices. Examples of computer code include machine code, such as produced by a compiler, and files containing higher-level code that are executed by a computer using an interpreter.

[00179] Although the foregoing invention has been described in some detail for purposes of clarity of understanding, it will be apparent that certain changes and modifications may be practiced within the scope of the appended claims. Therefore, the described embodiments should be taken as illustrative and not restrictive, and the invention should not be limited to the details given herein but should be defined by the following claims and their full scope of equivalents.

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CLAIMS

We Claim:

1. A computer system for translating medical evidence into computational elements, said computer system comprising:

one or more processors; and

memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to:

input a portion of electronic text pertaining to a medical condition from a medical evidence source;

process said electronic text to produce a plurality of clinical concepts indicative of said medical condition;

display said clinical concepts on a computing device;

receive input from said computing device indicating that said clinical concepts are relevant to said medical condition; and

store said medical condition and said clinical concepts each as a separate entry in a database, said medical condition being linked to each of said clinical concepts, wherein said entry of each of said clinical concepts in said database does not include information specific to said medical condition.

2. A computer system as recited in claim 1, wherein the instructions, when executed, further cause the one or more processors to:

display on said computing device a portion of said database which includes said medical condition entry, each of said diagnostic factor entries and the links between said medical condition entry and each of said diagnostic factor entries.

3. A computer system as recited in claim 1 wherein said database is a knowledge graph and said each separate entry is a node of said knowledge graph.

4. A computer system as recited in claim 1 wherein each clinical concept is a diagnostic factor and each diagnostic factor entry includes a unique identifier which links to an entry in a medical ontology representing said each diagnostic factor.

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5. A computer system as recited in claim 1, wherein one of said clinical concepts is a diagnostic factor, and wherein the instructions, when executed, further cause the one or more processors to:

receive input indicating demographics corresponding said diagnostic factor, said demographics indicating a type of person to which said diagnostic factor occurs in the context of said medical condition; and

store said demographics in a demographics entry linked between said medical condition entry and a diagnostic factor entry representing said diagnostic factor.

6. A computer system as recited in claim 1, wherein said clinical concepts are displayed on said computing device to a person, and wherein said input is received from said person via said computing device.

7. A computer system as recited in claim 1, wherein the instructions, when executed, further cause the one or more processors to:

receive a rank associated with said clinical concepts, said rank indicating how likely it is that said clinical concepts are indicative of said medical condition; and

store said rank in a database entry between said medical condition entry and said clinical concepts entries.

8. A computer system as recited in claim 1 wherein said clinical concepts are diagnostic factors caused by said medical condition, are risk factors that contribute to said medical condition, are laboratory tests that indicate said medical condition, are examinations that indicate said medical condition, or are drugs that contribute to said medical condition.

9. A computer system as recited in claim 1, wherein the instructions, when executed, further cause the one or more processors to:

receive input indicating a group that subsumes said clinical concepts; and

store said group as a separate entry in said database, said group including at least one condition-dependent attribute that depends upon said medical condition, said medical condition entry being linked to said group entry and said group entry being linked to each of said clinical factors entries.

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10. A computer system as recited in claim 1 wherein said one of said clinical concepts is a diagnostic factor, and wherein said diagnostic factor entry includes a temporality attribute indicating whether or not a patient is currently exhibiting said diagnostic factor, a negation attribute indicating whether not said diagnostic factor is present in said patient, or an experience attribute indicating whether not said patient experiences said diagnostic factor personally.

11. A computer system as recited in claim 1, wherein the instructions, when executed, further cause the one or more processors to:

extract from said electronic text a rank indicating how likely it is that one of said clinical concepts is indicative of said medical condition; and

add said rank to a location in said database between said medical condition entry and said clinical concepts entries.

12. A computer system for determining a state of a patient, said computer system comprising:

one or more processors; and

memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to:

extract from a medical evidence source a plurality of diagnostic factors each indicative of a medical condition and store each of said diagnostic factors and said medical condition as its own node in a database, said medical condition being linked to said diagnostic factors, wherein each of said diagnostic factor nodes do not include information specific to said medical condition;

for at least one of said diagnostic factors, store demographics that indicate said medical condition on the basis of said at least one diagnostic factor between said medical condition node and a node representing said at least one diagnostic factor;

extract from a medical evidence source a plurality of laboratory tests each indicative of said medical condition and store each of said laboratory tests in said database;

for at least one of said laboratory tests, store a test result in said database; and

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match patient data from a patient medical chart to at least one of said diagnostic factor nodes, said demographics, or said test result in order to display a result indicating a likelihood that said patient has said medical condition.

13. A computer system as recited in claim 12, wherein the instructions, when executed, further cause the one or more processors to:

determine a rank of said likelihood that said patient has said medical condition by reference to a node intermediate between said medical condition node and said diagnostic factor nodes that holds said rank of said diagnostic factors.

14. A computer system as recited in claim 12, wherein the instructions, when executed, further cause the one or more processors to:

determine a rank of said likelihood that said patient has said medical condition by reference to a node intermediate between said medical condition node and said laboratory test nodes that holds said rank of said laboratory tests.

15. A computer system as recited in claim 12, wherein the instructions, when executed, further cause the one or more processors to:

perform said extract said plurality of diagnostic factors and said extract said plurality of laboratory tests using natural language processing (NLP).

16. A computer system for determining a state of a patient, said computer system comprising:

one or more processors; and

memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to:

receive a plurality of diagnostic factors known to be present or absent in a patient;

match said diagnostic factors to factor nodes in a knowledge graph that includes a plurality of medical condition nodes, each of said factor nodes being linked to at least one of said medical condition nodes;

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for each of a plurality of said medical condition nodes, collect a rank value from along a path between said each medical condition node and each matched factor node to which said each medical condition node is linked, said rank value indicating how likely it is that the diagnostic factor matched to said each matched factor node is indicative of a medical condition represented by said each medical condition node;

sum all collected rank values for said each medical condition node to produce a final ranking value for said each medical condition node; and

output the medical condition representing said each medical condition node and said final ranking value of said each medical condition node.

17. A computer system as recited in claim 16, wherein the instructions, when executed, further cause the one or more processors to:

display in association with each of said output medical conditions its corresponding final ranking value.

18. A computer system as recited in claim 16 wherein said medical condition is a disease, an orthopedic anomaly, an adverse drug reaction, or a drug-to-drug interaction.

19. A computer system as recited in claim 16 wherein the instructions, when executed, further cause the one or more processors to:

display said output medical conditions in order of final ranking value.

20. A computer system as recited in claim 16 wherein the instructions, when executed, further cause the one or more processors to:

receive said plurality of diagnostic factors at said knowledge graph via an applications programming interface (API); and

output said medical conditions and said final ranking values via said API to a software application.

21. A computer system as recited in claim 16 wherein the instructions, when executed, further cause the one or more processors to:

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for at least one of said diagnostic factors known to be present, traversing upward in a medical ontology link found in one of said matched factor nodes corresponding to said at least one of said diagnostic factors known to be present in order to infer at least one other diagnostic factor present in said patient and matching this other diagnostic factor to a factor node in said knowledge graph.

22. A computer system as recited in claim 16 wherein a demographics node of said knowledge graph located between one of said matched factor nodes and its corresponding linked medical condition node includes demographics of people who exhibit said matched diagnostic factor in the context of said linked medical condition, and wherein the instructions, when executed, further cause the one or more processors to:

only collect a rank value from along a path between said matched factor node and said at least one linked medical condition node when information of said patient matches said demographics in said demographics node.

23. A computer system as recited in claim 16 wherein each of said factor nodes does not include information specific to a medical condition represented by said at least one medical condition node.

24. A computer system for determining next-best actions for a medical condition, said system comprising:

one or more processors; and

memory that stores instructions, wherein the instructions, when executed by the one or more processors, cause the one or more processors to perform the following for at least one medical condition of a patient:

identify all known factor nodes in a knowledge graph that each represent a diagnostic factor known to be present or absent in said patient, each known factor node being linked to a medical condition node in said knowledge graph representing said at least one medical condition;

identify all unknown factor nodes in said knowledge graph that each represent an unknown diagnostic factor not known to be present or absent in said patient, each unknown factor node being linked to said medical condition node;

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identify a rank of each unknown factor node that indicates a likelihood that said represented unknown diagnostic factor indicates said at least one medical condition, said rank being stored between said unknown factor node and said medical condition node; and

output said unknown diagnostic factors corresponding to said unknown factor nodes in association with said at least one medical condition in order of said rank of said each unknown factor node.

25. A computer system as recited in claim 24, wherein the instructions, when executed, further cause the one or more processors to:

identify said unknown factor nodes by traversing down through said knowledge graph from said at least one medical condition node and disregarding said known factor nodes.

26. A computer system as recited in claim 24 wherein said rank of said each unknown factor node is located between said at least one medical condition node and said each unknown factor node.

27. A computer system as recited in claim 24, wherein the instructions, when executed, further cause the one or more processors to:

for each known factor node, traverse upward in a medical ontology link found in said each known factor node in order to infer other diagnostic factors present in said patient.

28. A computer system as recited in claim 24 wherein traversing said knowledge graph from one of said unknown factor nodes to said at least one medical condition produces a first rank for said one of said unknown factor nodes in the context of said at least one medical condition which is different from a second rank produced by traversing from said one of said unknown factor nodes to a second medical condition.

29. A computer system as recited in claim 24 wherein the instructions, when executed, further cause the one or more processors to:

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input said diagnostic factors known to be present or absent in said patient to said knowledge graph via an applications programming interface (API); and

provide said unknown diagnostic factors in association with said at least one medical condition via said API to a software application.

30. A computer system as recited in claim 24 wherein said each known factor node does not include information specific to said at least one medical condition.

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TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

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ABSTRACT OF THE DISCLOSURE

A computational evidence platform extracts clinical concepts from medical evidence sources and creates a database of elemental diagnostic factors and elemental investigations links to medical conditions. Input from a person groups factors and investigations makes corrections and adds a ranking. Elemental factors and investigations do not include information specific to their associated conditions but include synonyms and a link to a medical ontology. A patient state is determined by extracting patient known diagnostic factors and investigation results from the patient chart. These known factors and results are matched to the database and a ranking of likely conditions are output. Next-best actions per condition are output by determining factors not yet known and investigations not yet performed. Next-best actions across conditions are determined by performing a recursive tree search of the database and assuming that unknown factors are now known to generate a score for each assumption.

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Application Number	Not yet assigned
Filing Date	Herewith
First Named Inventor	Carl BATE
Title	TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF
Art Unit	Unknown
Examiner Name	Unknown
Attorney Docket Number	RCVRP002C1C5

SIGNATURE of Applicant or Patent Practitioner

Signature	/Jonathan O. Scott/	Date	March 27, 2025
Name	Jonathan O. Scott	Telephone	650-842-1300
Registration Number	39,364		

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications.

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The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	CBS	Date (Optional)	3/6/24
Name	Carl Bate		
Title	Founder and CEO		

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Application or Patent No.: Not yet assigned	First Named Inventor: Carl BATE	Art Unit: Unknown
Filing Date: Herewith	Attorney Docket Number: RCVRP002C1C5	Examiner: Unknown

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Signature /Jonathan O. Scott/	Date March 27, 2025
Name (Print/Typed) Jonathan O. Scott	Practitioner Registration Number (if applicable) 39,364

■ * Total of _____ forms are submitted.

A Federal agency may not conduct or sponsor, and a person is not required to respond to, nor shall a person be subject to a penalty for failure to comply with an information collection subject to the requirements of the Paperwork Reduction Act of 1995, unless the information collection has a currently valid OMB Control Number. The OMB Control Number for this information collection is 0651-0070. Public burden for this form is estimated to average 2 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the information collection. Send comments regarding this burden estimate or any other aspect of this information collection, including suggestions for reducing this burden to the Office of the Chief Administrative Officer, United States Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450 or email InformationCollection@uspto.gov. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Instructions for Filling out the
"Information Disclosure Statement Size Fee – Written Assertion Under 37 CFR 1.98" Form
(Not to be Submitted to the USPTO)

Note: This form is to be used when applicant or patent owner files an Information Disclosure Statement (IDS) for consideration by the examiner. This form must be accompanied by PTO/SB/08a and/or PTO/SB/08b or equivalent.

Determining the cumulative number of applicant-provided or patent owner-provided items of information

The IDS size fee is based on the cumulative number of items of information provided by an applicant or patent owner during the pendency of the application or reexamination proceeding. It is the applicant's and patent owner's responsibility to track the cumulative number of items of information provided in the application or proceeding and provide a written assertion of any applicable IDS size fee due.

In determining the applicable written assertion for the cumulative number of applicant-provided or patent owner-provided items of information, "provided" refers to the items cited on an IDS under 37 CFR 1.98(a)(1) by an applicant or patent owner, whether or not an actual copy of the cited item is submitted by the applicant or patent owner to the USPTO. If a particular item provided by an applicant or patent owner on an IDS was not considered because the item was non-compliant and that particular item is provided on an IDS a second time in the same application or patent, it will not be counted again.

An item of information that an applicant cited in a parent application will not be counted in a child application (e.g., a continuation, continuation-in-part, or divisional application) for the purpose of the IDS size fees unless it is resubmitted, i.e., provided by the applicant on an IDS in the child application. Applicants who wish to avoid paying the IDS size fees in a child application for items of information considered in a parent application may do so by not resubmitting the items. An item of information must be resubmitted in the continuing application if the applicant desires the item of information to be printed on the patent. See MPEP 609.02, subsection II.A.2.

The cumulative count is determined for each application or patent separately. Continuing, CPA, and reissue applications and post-issuance proceedings will start with a count of zero. A request for continued examination (RCE) is not the filing of a new application, and thus the count will not reset when an RCE is filed.

Written Assertion

Check "[ ] No IDS size fee is required under 37 CFR 1.17(v) at this time" on the above PTO/SB/08c form when the IDS does not cause the cumulative number of applicant-provided or patent owner-provided items in this application or proceeding to:

- exceed 50, 100, or 200 items of information.

Check "[ ] The IDS is accompanied by the IDS size fee under 1.17(v)(1)" on the above PTO/SB/08c form when the IDS causes the cumulative number of applicant-provided or patent owner-provided items in this application or proceeding to:

- exceed 50 items of information but not exceed 100 items of information.

Check "[ ] The IDS is accompanied by the IDS size fee under 1.17(v)(2)" on the above PTO/SB/08c form when the IDS causes the cumulative number of applicant-provided or patent owner-provided items in this application or proceeding to:

- exceed 100 items of information but not exceed 200 items of information.

Note: If a fee under 1.17(v)(1) was previously paid, the fee currently due is the difference between the 1.17(v)(2) fee and the previously paid 1.17(v)(1) fee.

Doc Code: IDS.SIZEFEE
Document Description: Assertion of whether IDS Size Fee Due

Check "[ ] The IDS is accompanied by the IDS size fee under 1.17(v)(3)" on the above PTO/SB/08c form when the IDS causes the cumulative number of applicant-provided or patent owner-provided items in this application or proceeding to:

- exceed 200 items of information.

Note: If a fee under 1.17(v)(1) or (v)(2) was previously paid, the fee currently due is the difference between the 1.17(v)(3) fee and the previously paid 1.17(v)(1) or (v)(2) fee.

Select only one assertion on the PTO/SB/08c form above.

Note: the cumulative count of items of information includes all items of information already of record in a pending application or proceeding that were submitted via IDS(s) including those submitted prior to January 19, 2025.

Method of Payment

This section should only be filled out if the IDS size fee is due. Fees may be paid by check or money order (made payable to the Director of the United States Patent and Trademark Office), credit card (Form PTO-2038), or deposit account. When paying by deposit account, the amount of the IDS size fee to be charged to the deposit account must be specified to comply with 37 CFR 1.98(a)(4). General authorizations to charge fees to a deposit account are not compliant written assertions. When paying by credit card, to protect your credit card information, do not submit Form PTO-2038 electronically through USPTO's patent electronic filing system or any other USPTO Web site.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

Routine uses of the information in this record may include disclosure to:

1) law enforcement, in the event that the system of records indicates a violation or potential violation of law;

2) a federal, state, local, or international agency, in response to its request;

3) a contractor of the USPTO having need for the information in order to perform a contract;

4) the Department of Justice for determination of whether the Freedom of Information Act (FOIA) requires disclosure of the record;

5) a Member of Congress submitting a request involving an individual to whom the record pertains, when the individual has requested the Member's assistance with respect to the subject matter of the record;

6) a court, magistrate, or administrative tribunal, in the course of presenting evidence, including disclosures to opposing counsel in the course of settlement negotiations;

7) the Administrator, General Services Administration (GSA), or their designee, during an inspection of records conducted by GSA under authority of 44 U.S.C. 2904 and 2906, in accordance with the GSA regulations and any other relevant (i.e., GSA or Commerce) directive, where such disclosure shall not be used to make determinations about individuals;

8) another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c));

9) the Office of Personnel Management (OPM) for personnel research purposes; and

10) the Office of Management and Budget (OMB) for legislative coordination and clearance.

If you do not furnish the information requested on this form, the USPTO may not be able to process and/or examine your submission, which may result in termination of proceedings, abandonment of the application, and/or expiration of the patent.

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/092,400	**03/27/2025 02:48:32 PM Z ET**	**RCVRP002C1C5**

Title of Invention

TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	6474	FILED BY	ANDREASARAH DACANAY
PATENT CENTER #	69760428	FILING DATE	-
CUSTOMER #	58766	FIRST NAMED INVENTOR	Carl BATE
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	Jonathan Scott

Documents

TOTAL DOCUMENTS: 22

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
RCVRP002C1C5_ADS.pdf	11	Application Data Sheet	2175 KB
RCVRP002C1C5_POA.pdf	2	Power of Attorney	288 KB
RCVRP002_Declarations_SIGNED.pdf	9	Oath or Declaration filed	3610 KB
RCVRP002C1C5_Track_One_Request_TRACK1.REQ.pdf	2	Track One Request	153 KB
RCVRP002C1C5 Final-APP.TEXT.docx	57	Application body structured text document	85 KB

Warning: At least one claim appears to contain more than one sentence. Please review and revise if necessary. At least one claim appears to not end with a period. Please review and revise if necessary.

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

RCVRP002_Drawings_FINAL.pdf	24	Drawings-only black and white line drawings	555 KB
RCVRP002C1C5_IDS_Size_Fee_Assertation.pdf	4	Assertion regarding Information Disclosure Statement (IDS) Size Fee (SB/08C)	274 KB
RCVRP002C1C5_IDS.pdf	2	Transmittal Letter	23 KB
RCVRP002C1C5_1449.pdf	2	Information Disclosure Statement (IDS) Form (SB08)	34 KB

Warning: This is not a USPTO supplied IDS fillable form. Data in the form cannot be automatically loaded to other USPTO systems.

WO2001069513A3_FOR.pdf	4	Foreign Reference	368 KB
WO2012122198A1_FOR.pdf	50	Foreign Reference	1313 KB
WO2020006495A1D6_FOR.pdf	120	Foreign Reference	11564 KB
Boxwala_NPL.pdf	8	Non Patent Literature	508 KB
WHO_NPL.pdf	8	Non Patent Literature	2113 KB
Michaels_NPL.pdf	9	Non Patent Literature	410 KB
MBCK_NPL.pdf	10	Non Patent Literature	656 KB
MANIFESTO_NPL.pdf	7	Non Patent Literature	216 KB
Scott_NPL.pdf	6	Non Patent Literature	3712 KB
HL7_NPL.pdf	9	Non Patent Literature	508 KB
Solomon_NPL.pdf	4	Non Patent Literature	1130 KB
Rogers_NPL.pdf	5	Non Patent Literature	7877 KB
Wroe_NPL.pdf	9	Non Patent Literature	315 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (04-14)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	Carl BATE	Nonprovisional Application Number (if known):	
Title of Invention:	TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.

2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.

3. The applicable box is checked below:

I. ☑ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)

i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.

---OR---

(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, **or** the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)

i. A request for continued examination has been filed with, or prior to, this form.
ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /Jonathan O. Scott/	Date March 27, 2025
Name (Print/Typed) Jonathan O. Scott	Practitioner Registration Number 39,364

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.**

☑ *Total of 1 forms are submitted.

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Form 1449 (Modified) **Information Disclosure Statement By Applicant** (Use Several Sheets if Necessary)	**Atty Docket No.**	RCVRP002C1C5
	Application No.:	Not yet assigned
	Applicant	Unknown
	Filing Date	Herewith
	Group	Unknown
		Page 1 of 2
	Date Submitted	March 27, 2025

U.S. Patent Documents

Examiner Initial	No.	Patent No.	Date	Patentee	Class	Sub-class	Filing Date
	1.	7,379,885	05/27/08	Zakim			03/10/00
	2.	2005/0010444	01/13/05	Iliff			06/04/04
	3.	2019/0198172	06/27/19	Nelson, JR.			02/22/19
	4.	2022/0344020	10/27/22	VanNess et al.			05/13/22
	5.	2002/0002325	01/03/02	Iliff			02/14/01
	6.	2021/0321932	10/21/21	BORSODY			03/01/21
	7.	2023/0410223	12/21/23	Dobson et al.			09/01/23
	8.	2019/0252074	08/15/19	Datla et al.			04/15/19
	9.	2020/0051694	02/13/20	GOLDBERG et al.			08/12/19
	10.	2023/0386681	11/30/23	TULLEY et al.			10/09/23
	11.	11,869,674	01/09/24	Tulley et al.			04/14/23

Foreign Patent or Published Foreign Patent Application

Examiner Initial	No.	Document No.	Publication Date	Country or Patent Office	Class	Sub-Class	Translation Yes	Translation No
	12.	01/069513	09/20/01	WO			Yes	
	13.	2012/122198	09/13/12	WO			Yes	
	14.	2020/006495	01/02/20	WO			Yes	

Other Documents

Examiner Initial	No.	Author, Title, Place (e.g. Journal) of Publication, Date
	15.	Boxwala, A. A., Rocha, B. H., Maviglia, S., Kashyap, V., Meltzer, S., Kim, J., Tsurikova, R., Wright, A., Paterno, M. D., Fairbanks, A., & Middleton, B. (2011). A multi-layered framework for disseminating knowledge for computer-based decision support. Journal of the American Medical Informatics Association : JAMIA, 18 Suppl 1(Suppl 1), i132–i139. https://doi.org/10.1136/amiajnl-2011-000334
	16.	World Health Organization, "Smart Guidelines", https://www.who.int/teams/digital-health-and-innovation/smart-guidelines, Downloaded February 4, 2025.

Examiner	Date Considered

Examiner: Initial citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

Form 1449 (Modified) **Information Disclosure Statement By Applicant** (Use Several Sheets if Necessary)	**Atty Docket No.**	RCVRP002C1C5
	Application No.:	Not yet assigned
	Applicant	Unknown
	Filing Date	Herewith
	Group	Unknown
		Page 2 of 2
	Date Submitted	March 27, 2025

	17.	Maria Michaels, MBA, "Adapting Clinical Guidelines for the Digital Age: Summary of a Holistic and Multidisciplinary Approach", American College of Medical Quality, https://stacks.cdc.gov/view/cdc/133619/cdc_133619_DS1.pdf, 2023.
	18.	Mobilizing Computable Biomedical Knowledge, Regents of the University of Michigan, https://mobilizecbk.med.umich.edu/, 2021.
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Examiner	**Date Considered**

Examiner: Initial citation considered. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	RCVRP002C1C5
	Application Number	
Title of Invention	TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Carl		BATE	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	San Francisco	State/Province	CA	Country of Residence	US

Mailing Address of Inventor:

Address 1	340 Fremont Street		
Address 2			
City	San Francisco	State/Province	CA
Postal Code	94105	Country	US

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Wian		STIPP	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	San Francisco	State/Province	CA	Country of Residence	US

Mailing Address of Inventor:

Address 1	24 Edith St		
Address 2			
City	San Francisco	State/Province	CA
Postal Code	94133	Country	US

Inventor 3 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Thomas		UNGER	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	RCVRP002C1C5
	Application Number	
Title of Invention	TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF	

City	Tiburon	State/Province	CA	Country of Residence	US

Mailing Address of Inventor:

Address 1	c/o Evidium, Inc.		
Address 2	44 Tehama Street, Suite 412		
City	San Francisco	State/Province	CA
Postal Code	94105	Country	US

Inventor 4 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	David	A.	EPSTEIN	

Residence Information (Select One) (•) US Residency ( ) Non US Residency ( ) Active US Military Service

City	Croton-on-Hudson	State/Province	NY	Country of Residence	US

Mailing Address of Inventor:

Address 1	518 Half Moon Bay Drive		
Address 2			
City	Croton-on-Hudson	State/Province	NY
Postal Code	10520	Country	US

Inventor 5 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Matthew		MCSORLEY	

Residence Information (Select One) (•) US Residency ( ) Non US Residency ( ) Active US Military Service

City	Pittsburgh	State/Province	PA	Country of Residence	US

Mailing Address of Inventor:

Address 1	111 Deimling Road		
Address 2			
City	Pittsburgh	State/Province	PA
Postal Code	15229	Country	US

Inventor 6 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Fady		NAKHLA	

Residence Information (Select One) (•) US Residency ( ) Non US Residency ( ) Active US Military Service

City	San Francisco	State/Province	CA	Country of Residence	US

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	RCVRP002C1C5
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Mailing Address of Inventor:

Address 1	c/o Evidium, Inc.		
Address 2	44 Tehama Street, Suite 412		
City	San Francisco	**State/Province**	CA
Postal Code	94105	**Country**	US

Inventor 7 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	David		ROBINSON	

Residence Information (Select One) (•) US Residency ( ) Non US Residency ( ) Active US Military Service

City	Santa Cruz	**State/Province**	CA	**Country of Residence**	US

Mailing Address of Inventor:

Address 1	3340 Sheila Court		
Address 2			
City	Santa Cruz	**State/Province**	CA
Postal Code	95062	**Country**	US

Inventor 8 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Jennifer	May	LEE	

Residence Information (Select One) ( ) US Residency (•) Non US Residency ( ) Active US Military Service

City	London	Country of Residence	GB

Mailing Address of Inventor:

Address 1	41 Newton Road		
Address 2			
City	London	**State/Province**	GB
Postal Code	W2 5JR	**Country**	GB

Inventor 9 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Arthur		BÖÖK	

Residence Information (Select One) (•) US Residency ( ) Non US Residency ( ) Active US Military Service

City	San Francisco	**State/Province**	CA	**Country of Residence**	US

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Mailing Address of Inventor:

Address 1	c/o Evidium, Inc.		
Address 2	44 Tehama Street, Suite 412		
City	San Francisco	**State/Province**	CA
Postal Code	94105	**Country**	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	58766		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF		
Attorney Docket Number	RCVRP002C1C5	**Small Entity Status Claimed**	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	24	**Suggested Figure for Publication (if any)**	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

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Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	58766		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	18446954	2023-08-09

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
18446954	Continuation of	18135026	2023-04-14	11869674	2024-01-09

Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
18135026	Claims benefit of provisional	63331526	2022-04-15

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	RCVRP002C1C5
	Application Number	
Title of Invention	TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF	

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	RCVRP002C1C5
	Application Number	
Title of Invention	TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	RCVRP002C1C5
	Application Number	
Title of Invention	TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF	

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant 1 Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

○ Assignee	○ Legal Representative under 35 U.S.C. 117	○ Joint Inventor
◉ Person to whom the inventor is obligated to assign.	○ Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Evidium, Inc.		
Mailing Address Information For Applicant:			
Address 1	44 Tehama Street, Suite 412		
Address 2			
City	San Francisco	**State/Province**	CA
Country	US	Postal Code	94105
Phone Number		Fax Number	
Email Address			

Additional Applicant Data may be generated within this form by selecting the Add button. Add

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	RCVRP002C1C5
	Application Number	
Title of Invention	TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Jonathan O. Scott/			Date (YYYY-MM-DD)	2025-03-27
First Name	Jonathan	Last Name	Scott	Registration Number	39,364

Additional Signature may be generated within this form by selecting the Add button. Add

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	RCVRP002C1C5
	Application Number	
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This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1 The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3 A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent CooperationTreaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

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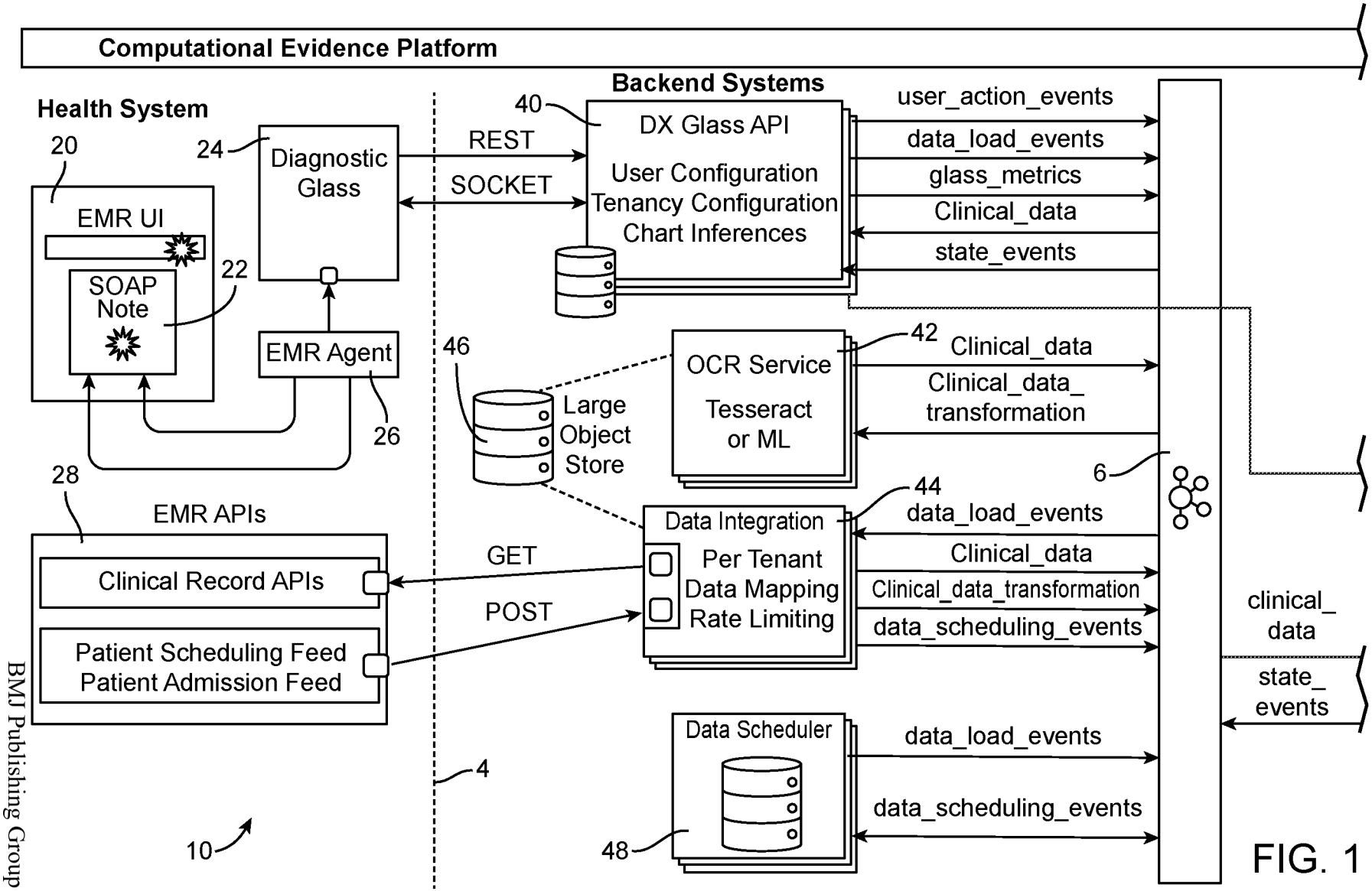

FIG. 1

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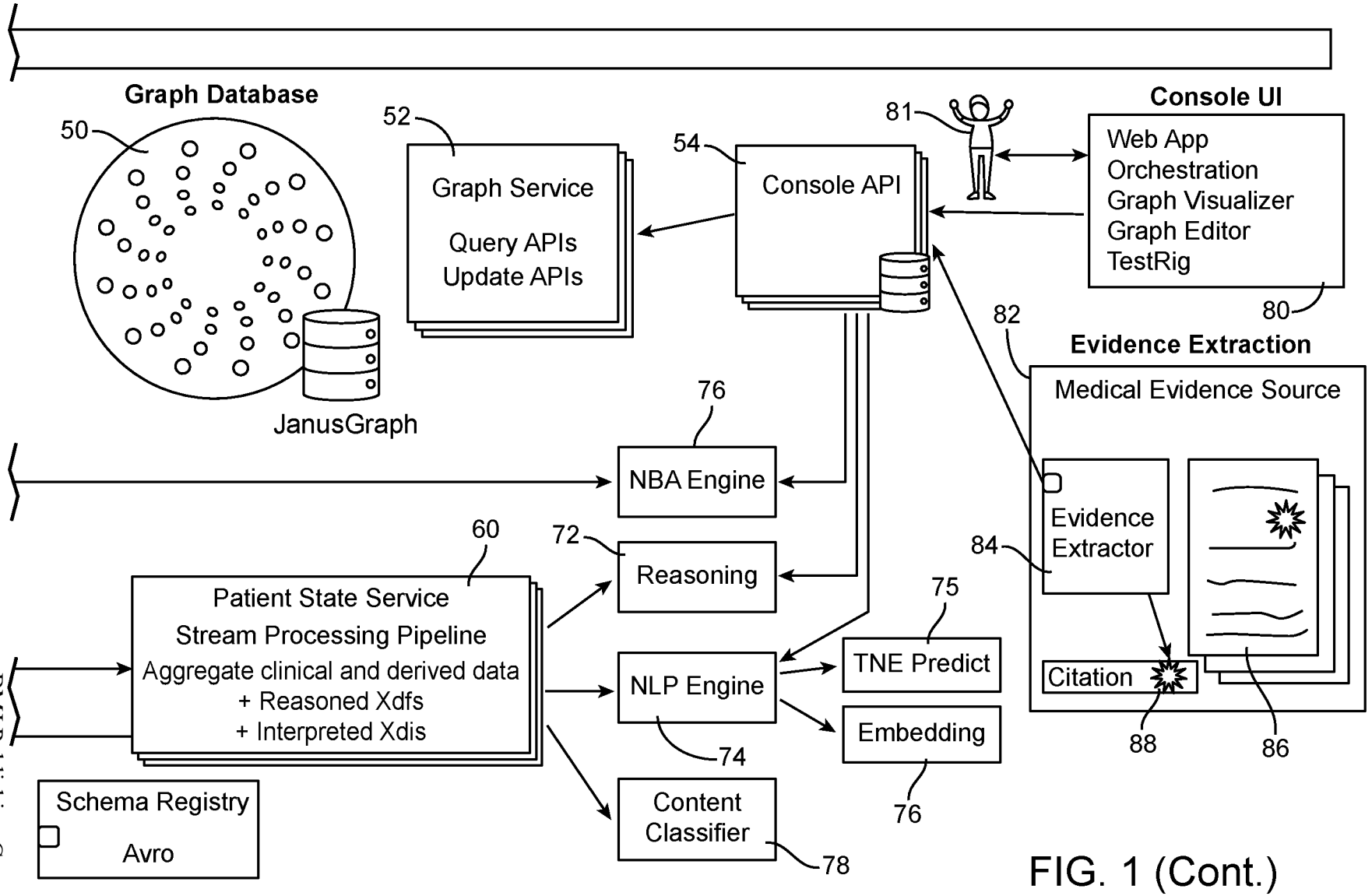

FIG. 1 (Cont.)

BMJ Publishing Group Ex. 1014
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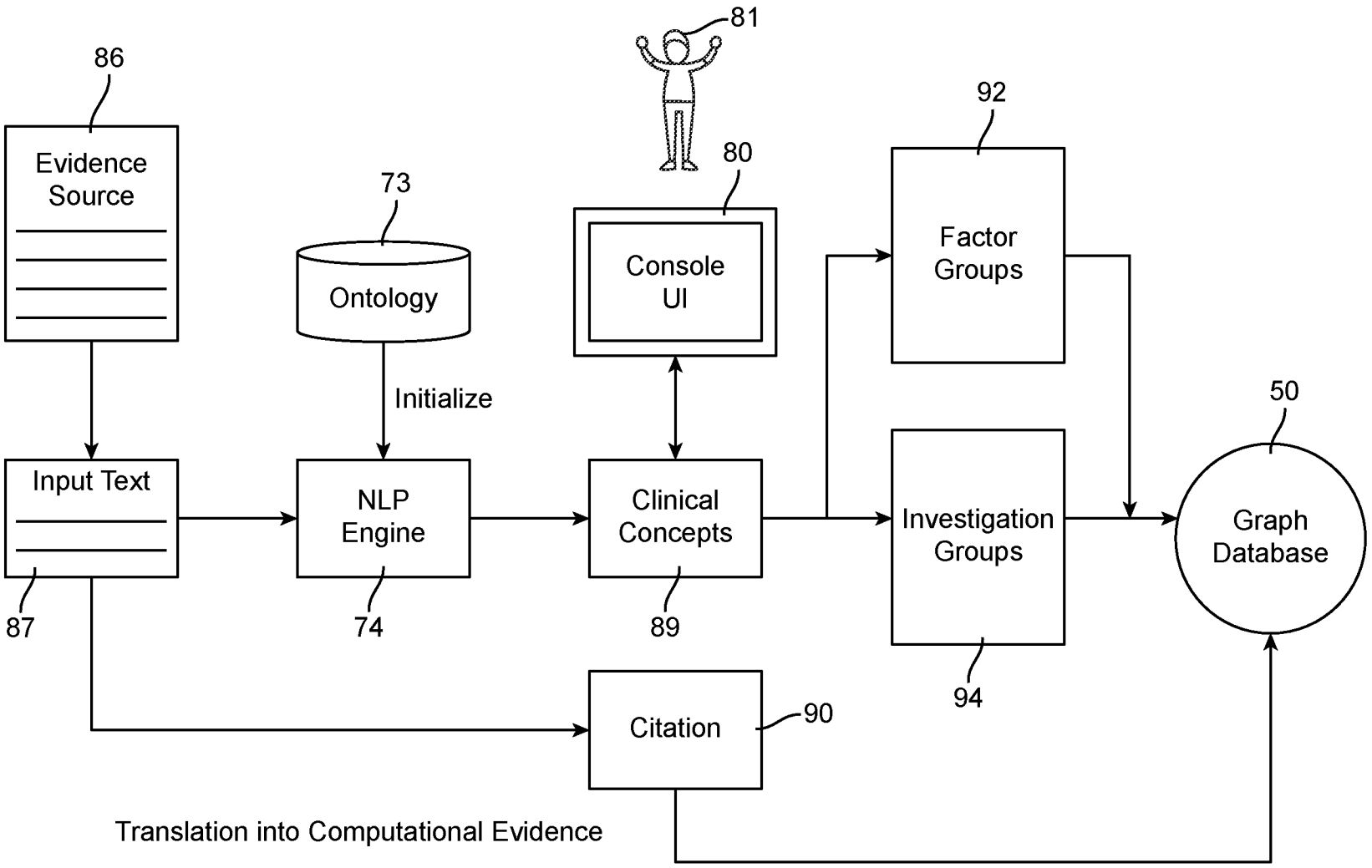

FIG. 2

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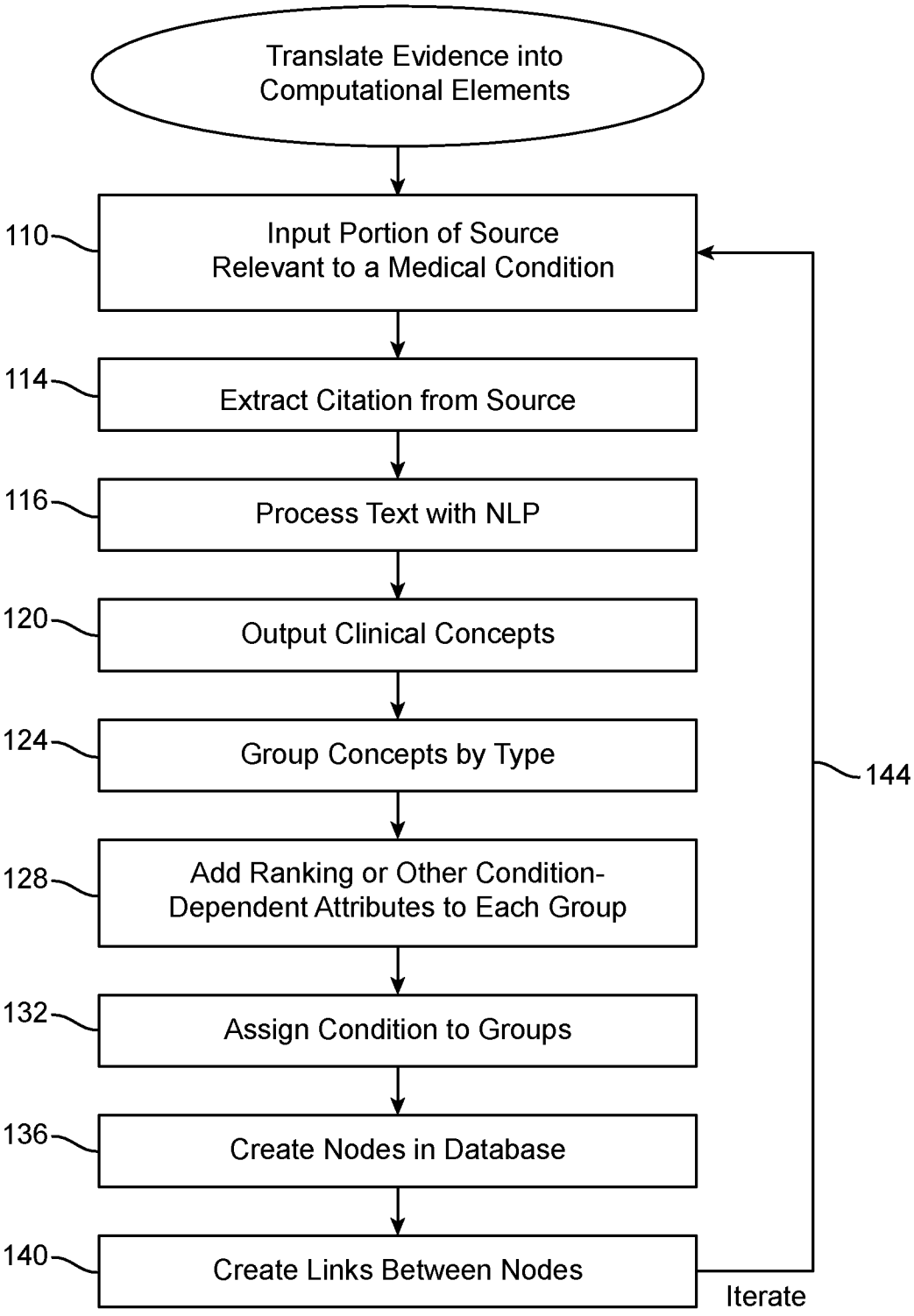

FIG. 3

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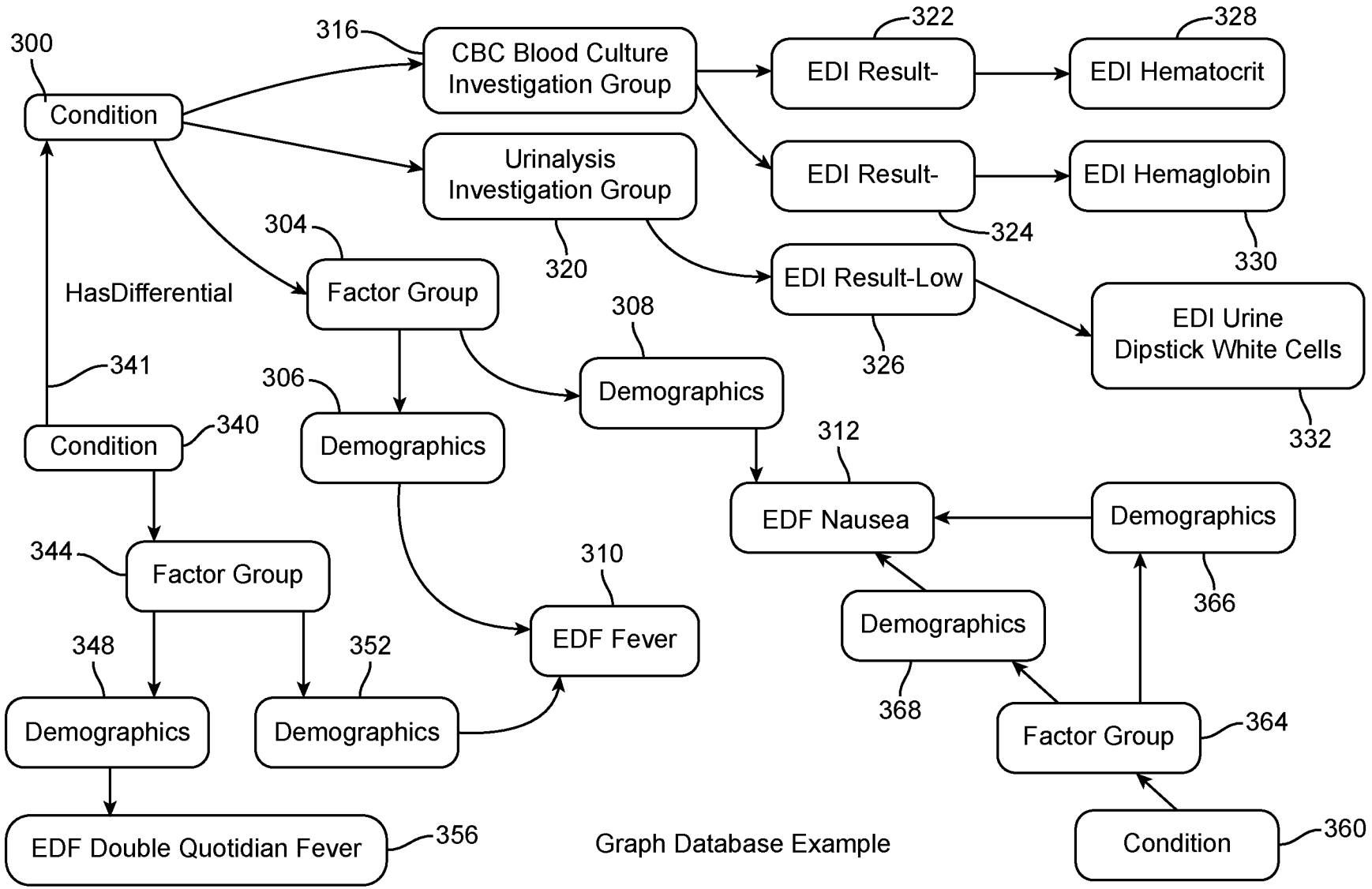

Graph Database Example

FIG. 4A

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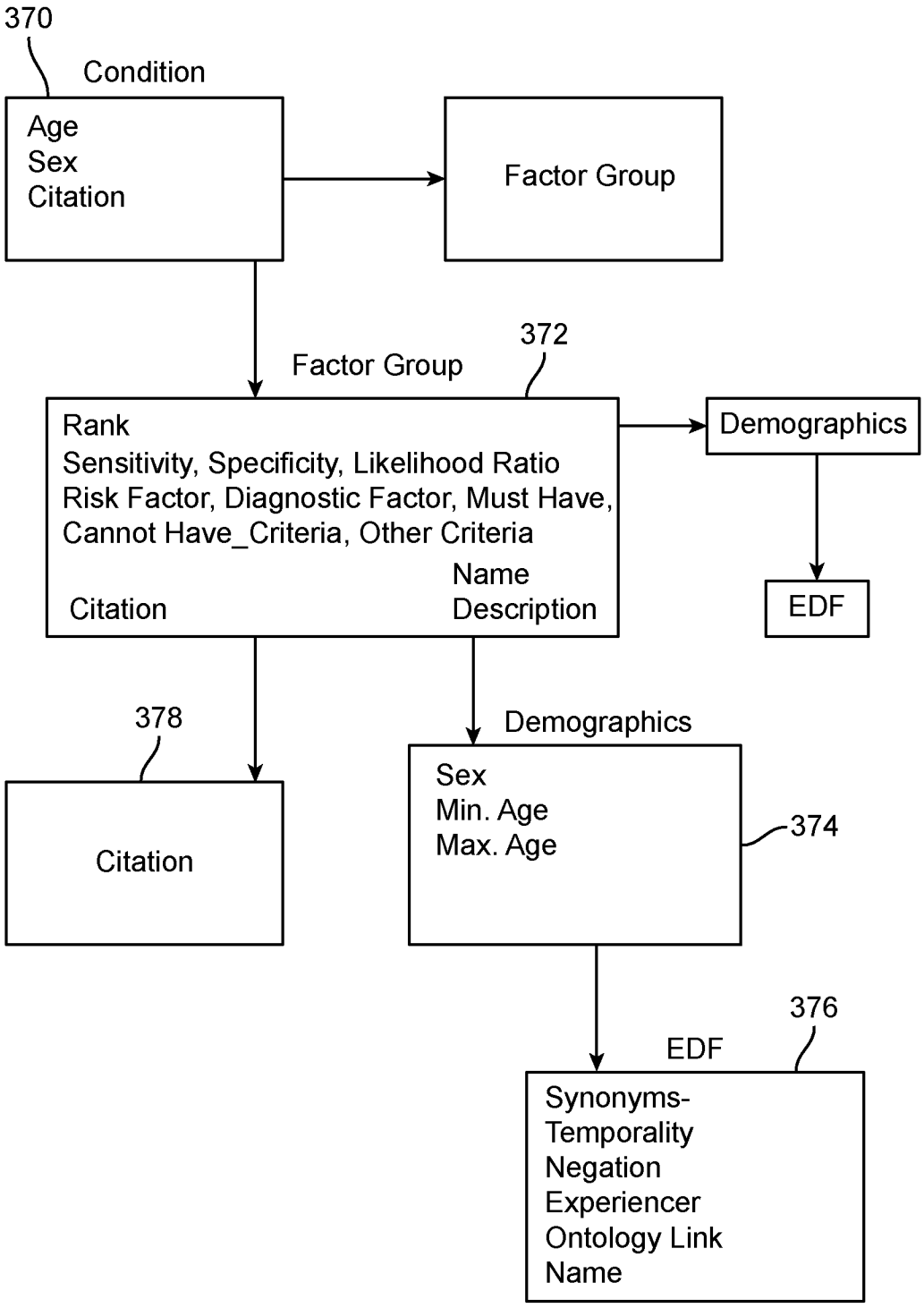

FIG. 4B

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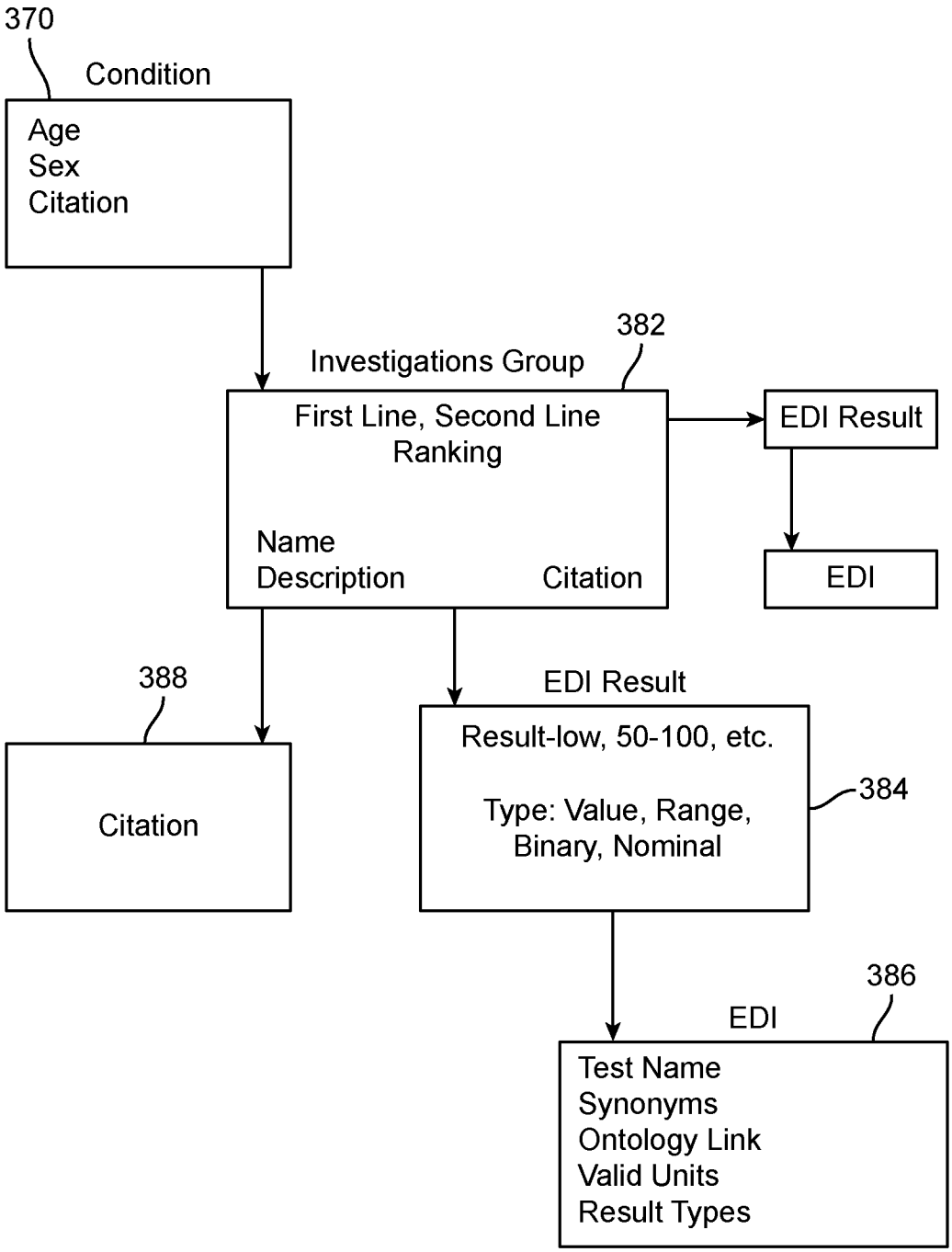

FIG. 4C

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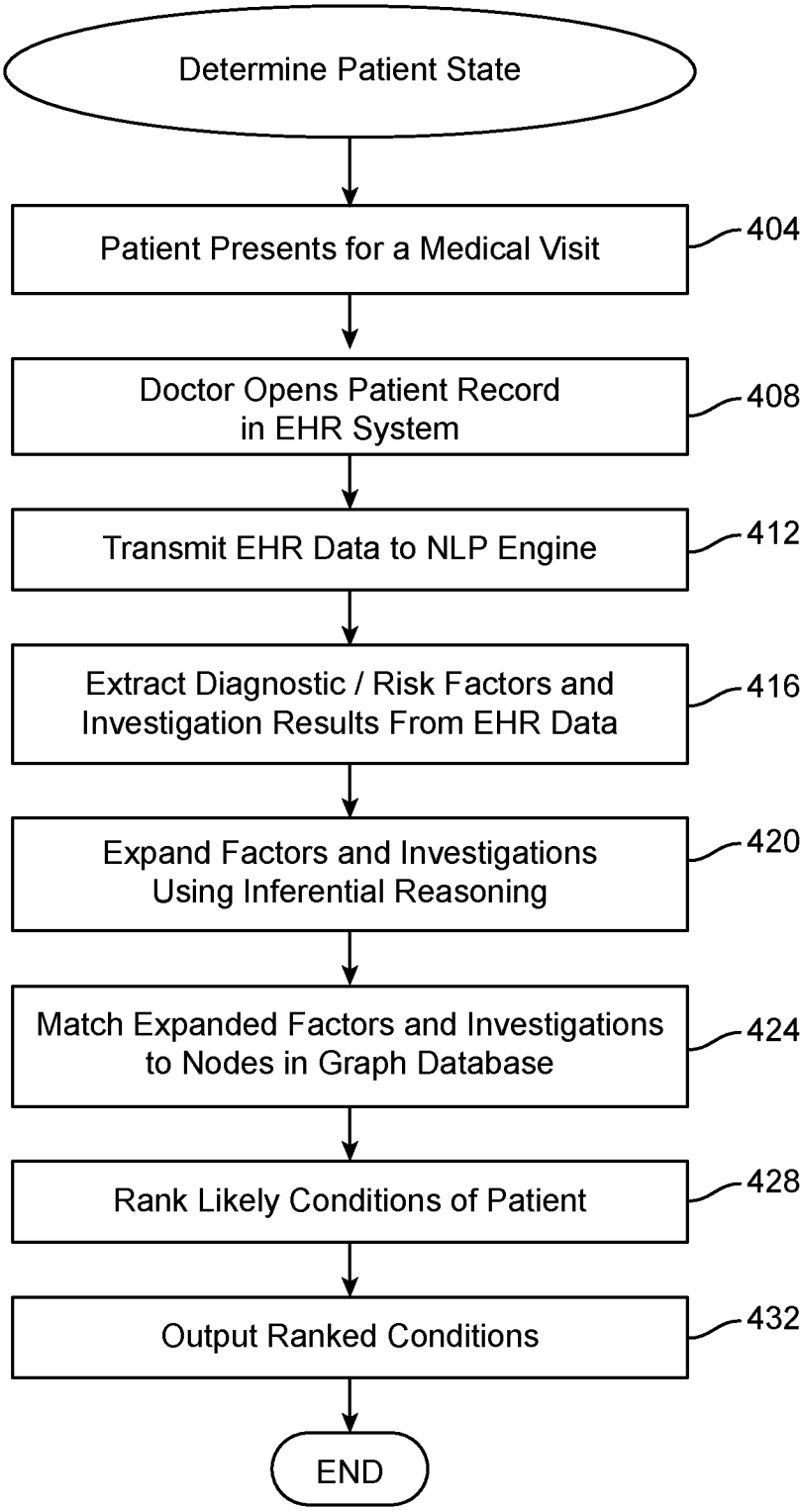

FIG. 5

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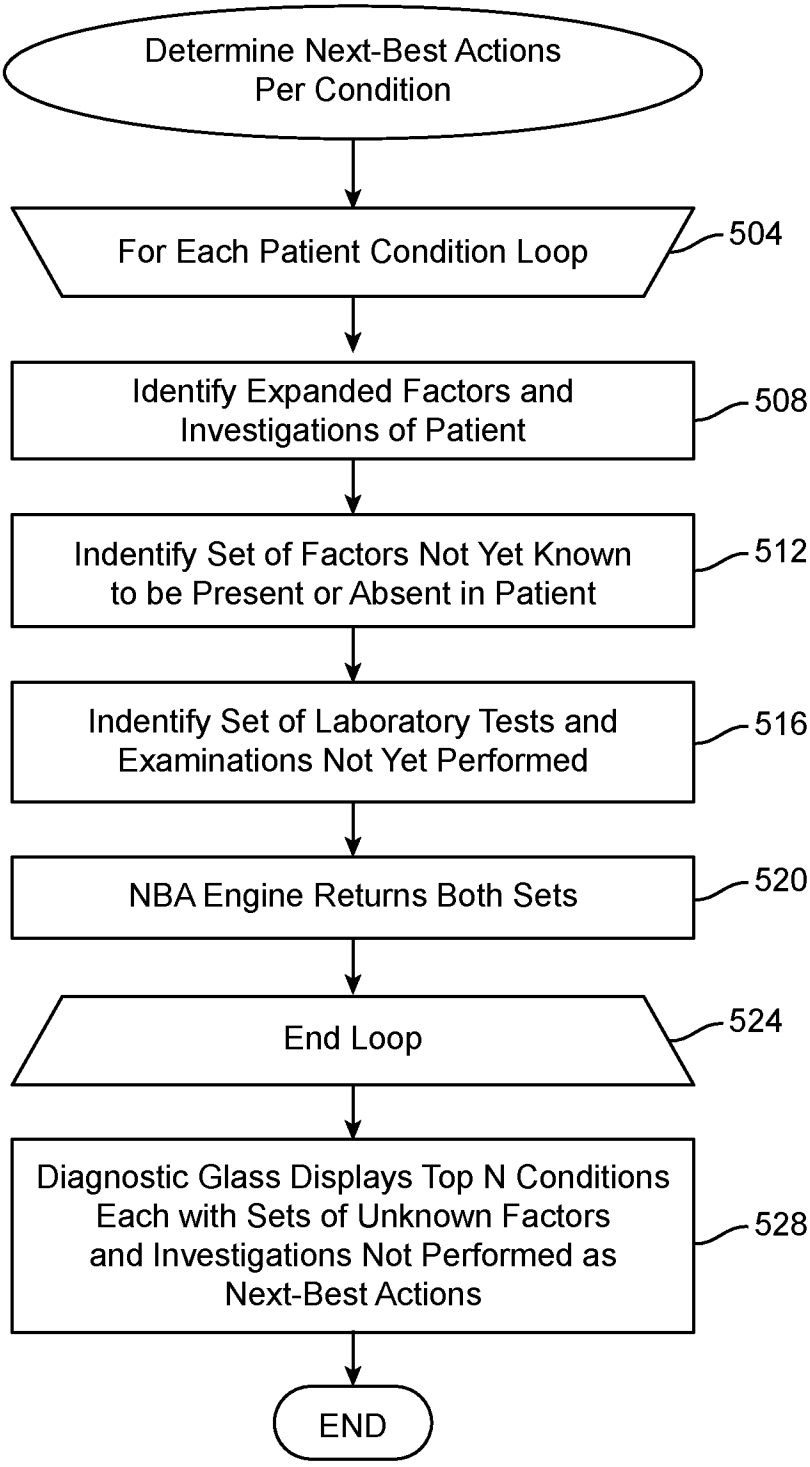

FIG. 6

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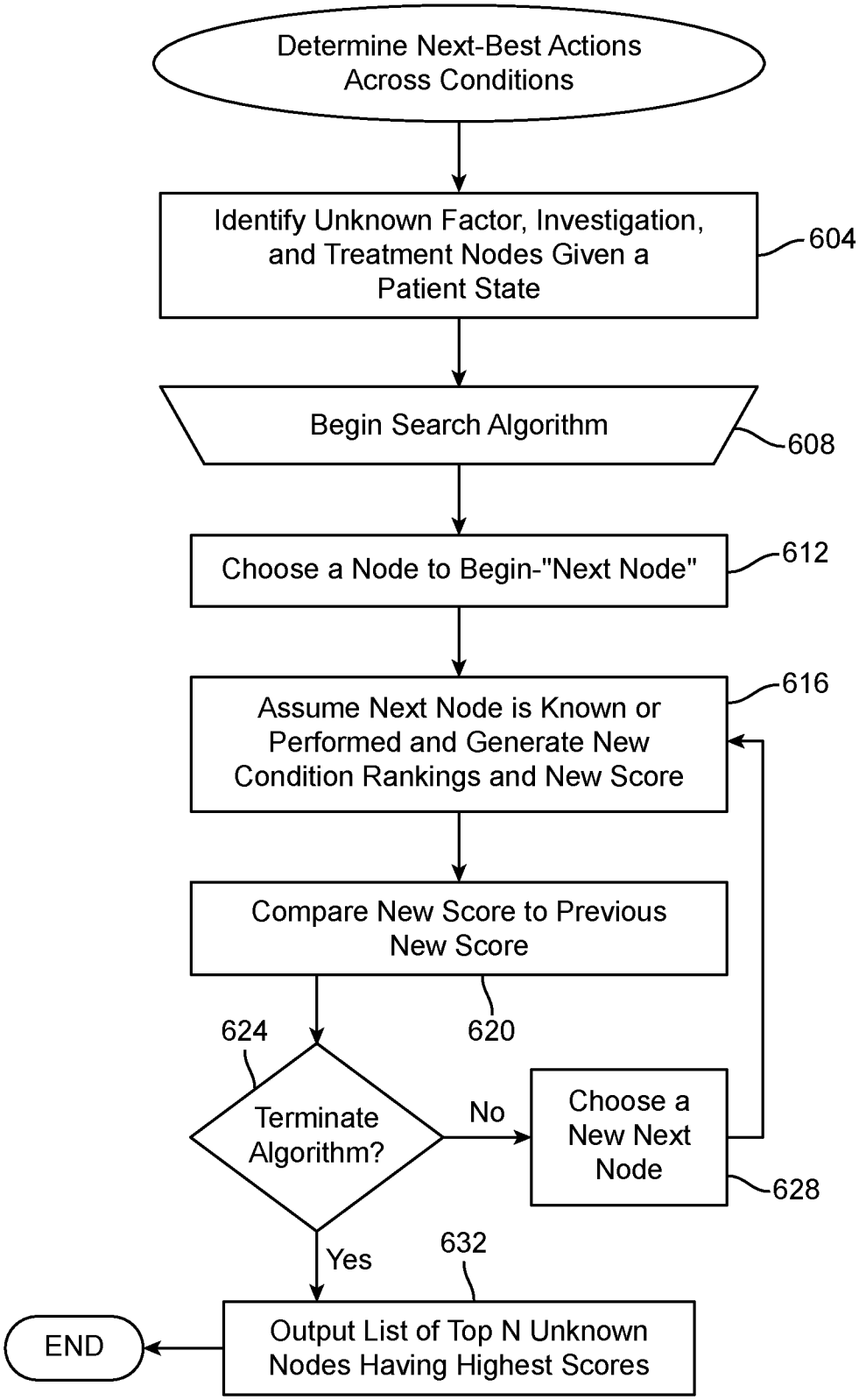

FIG. 7

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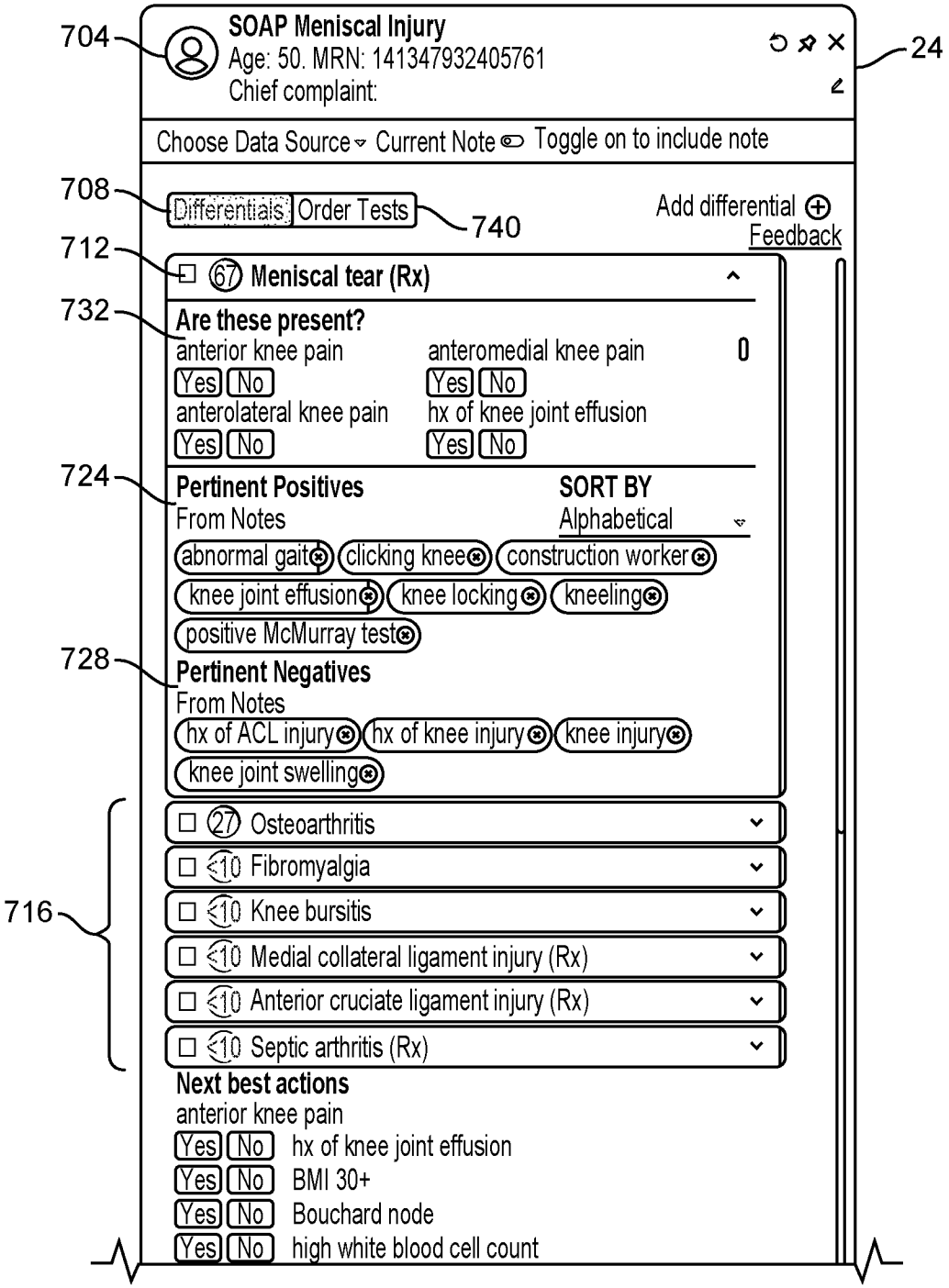

FIG. 8A

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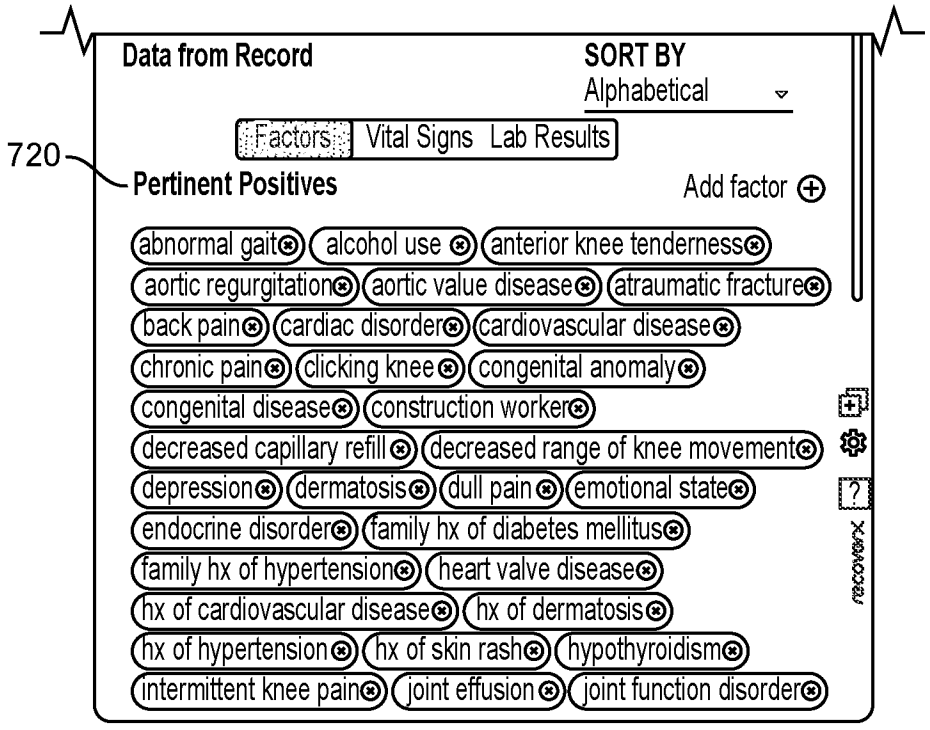

FIG. 8A (Cont.)

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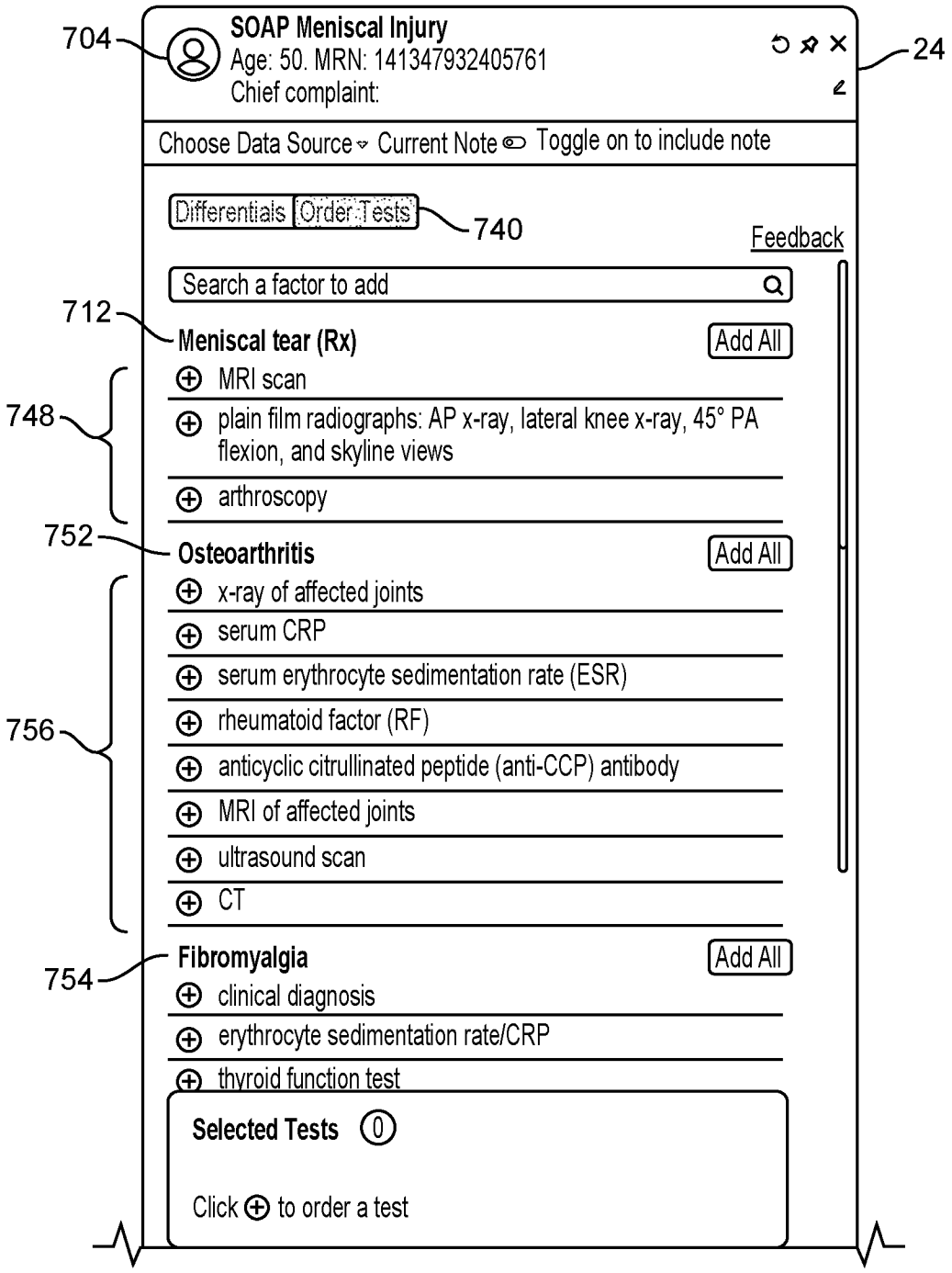

FIG. 8B

BMJ Publishing Group Ex. 1014
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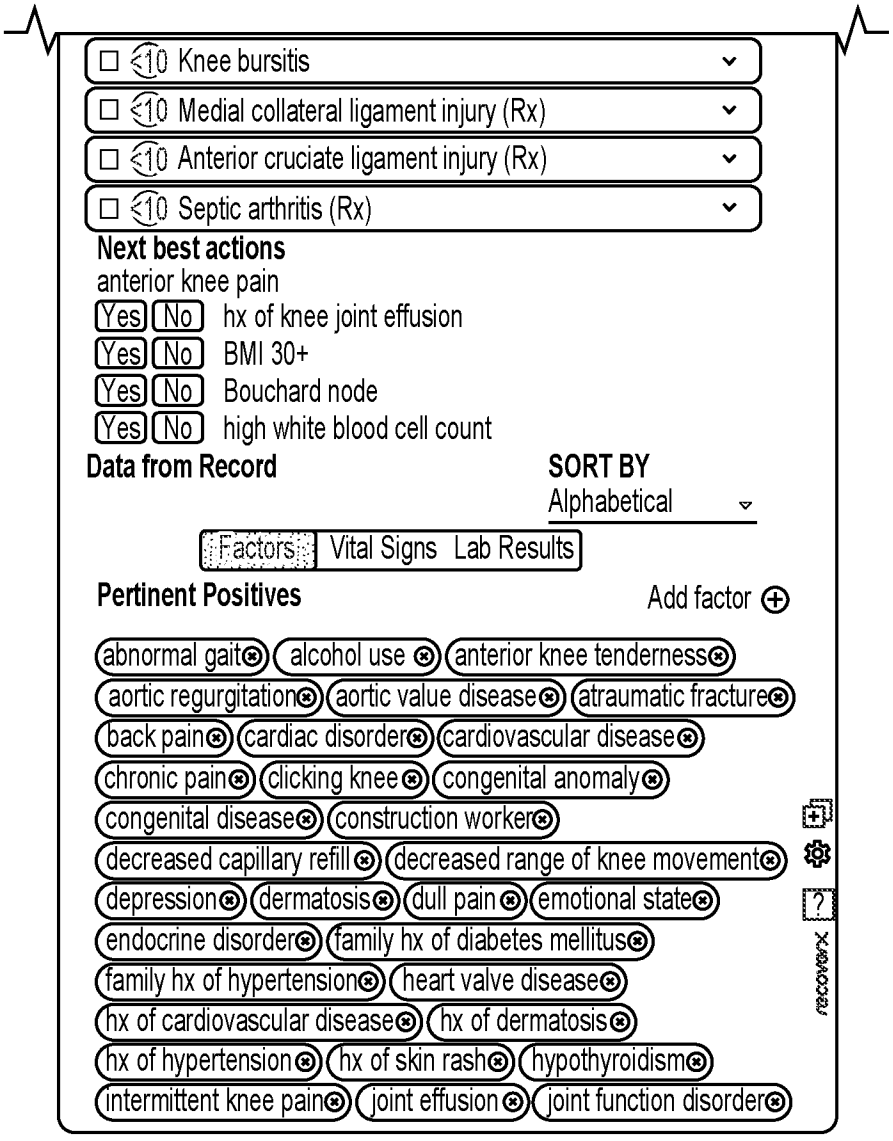

FIG. 8B (Cont.)

BMJ Publishing Group Ex. 1014
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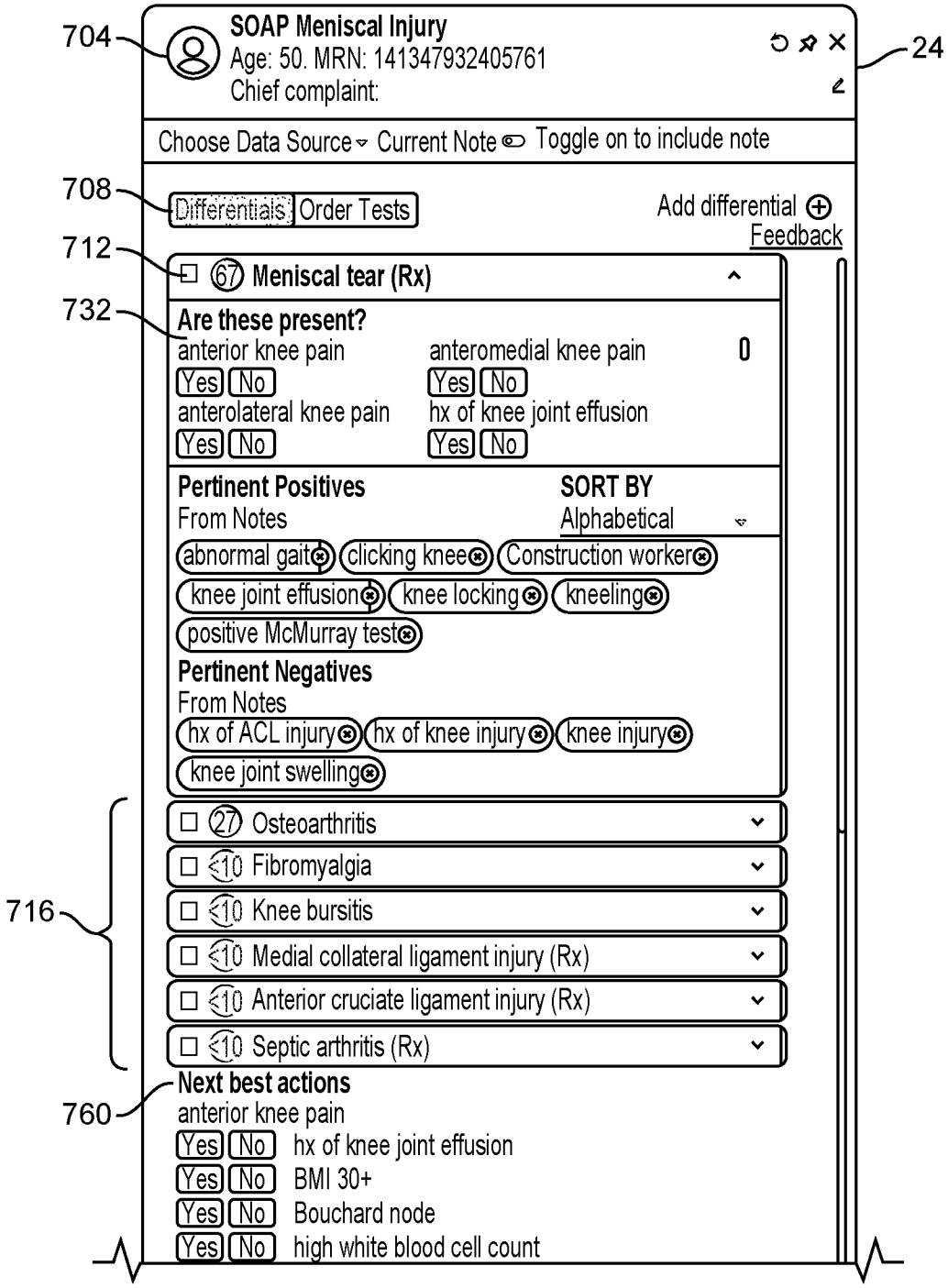

FIG. 8C

BMJ Publishing Group Ex. 1014
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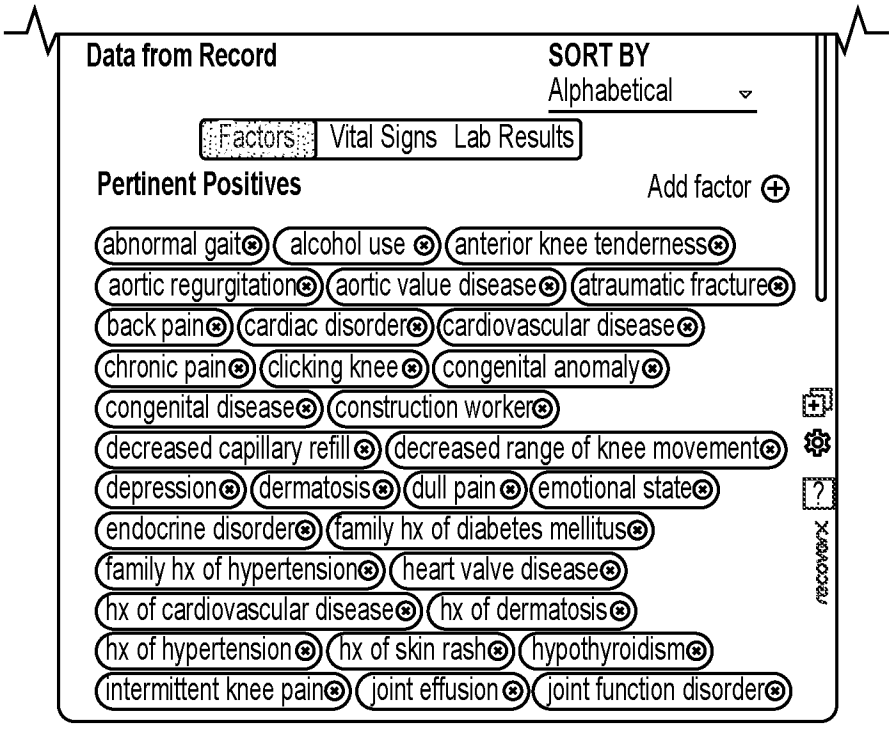

FIG. 8C (Cont.)

BMJ Publishing Group Ex. 1014
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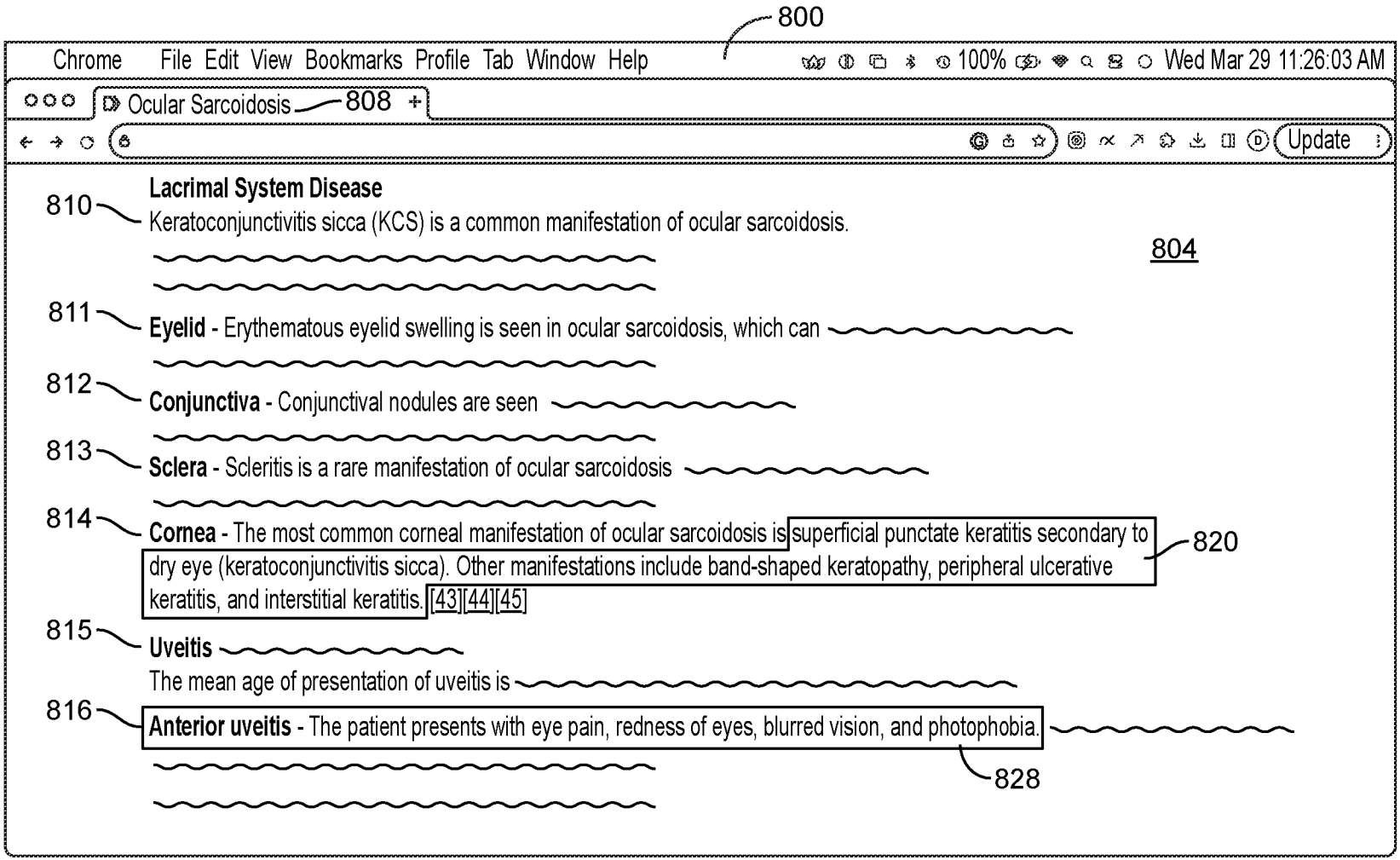

Translation Example

FIG. 9A

BMJ Publishing Group Ex. 1014
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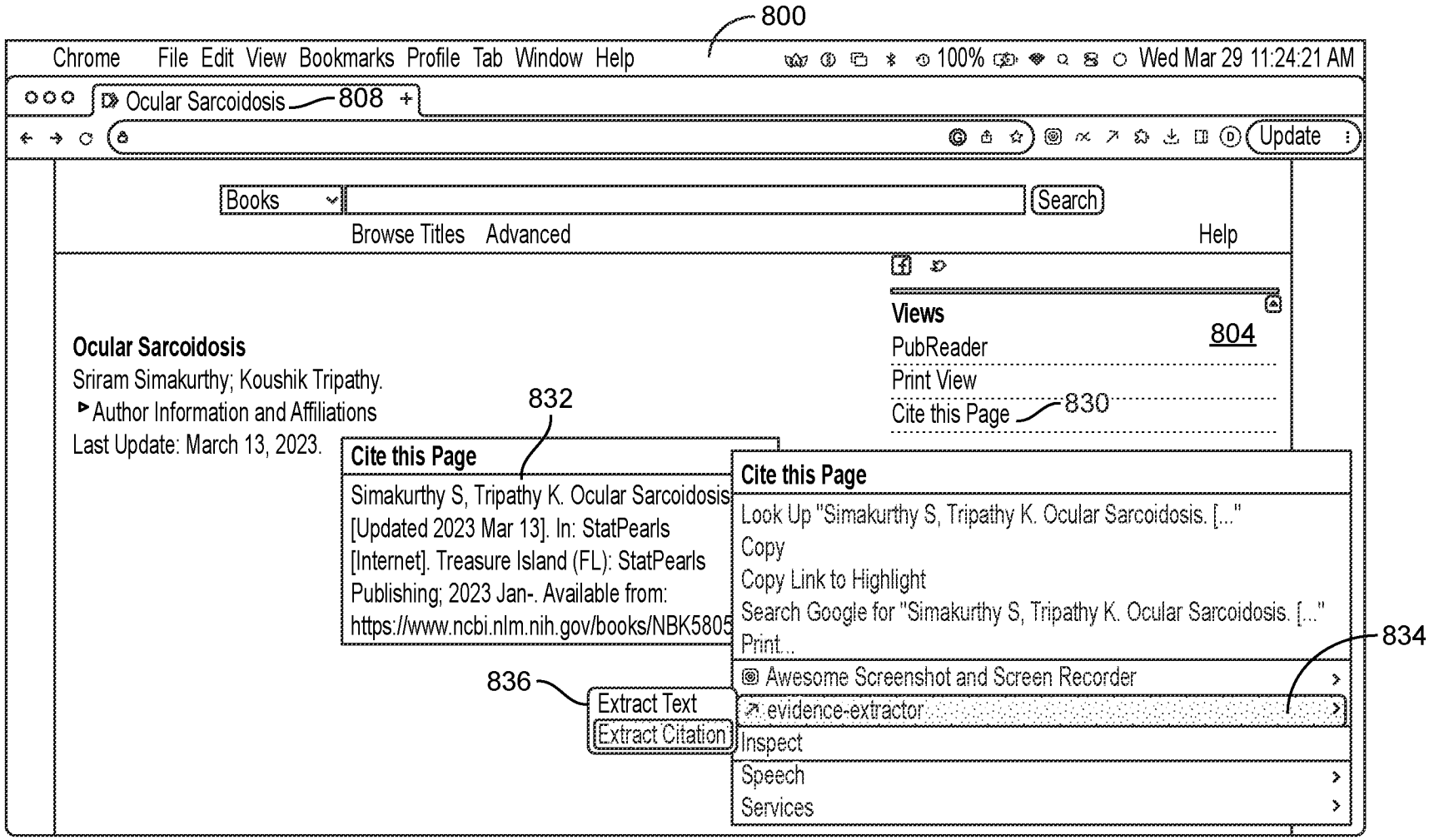

Translation Example

FIG. 9B

BMJ Publishing Group Ex. 1014
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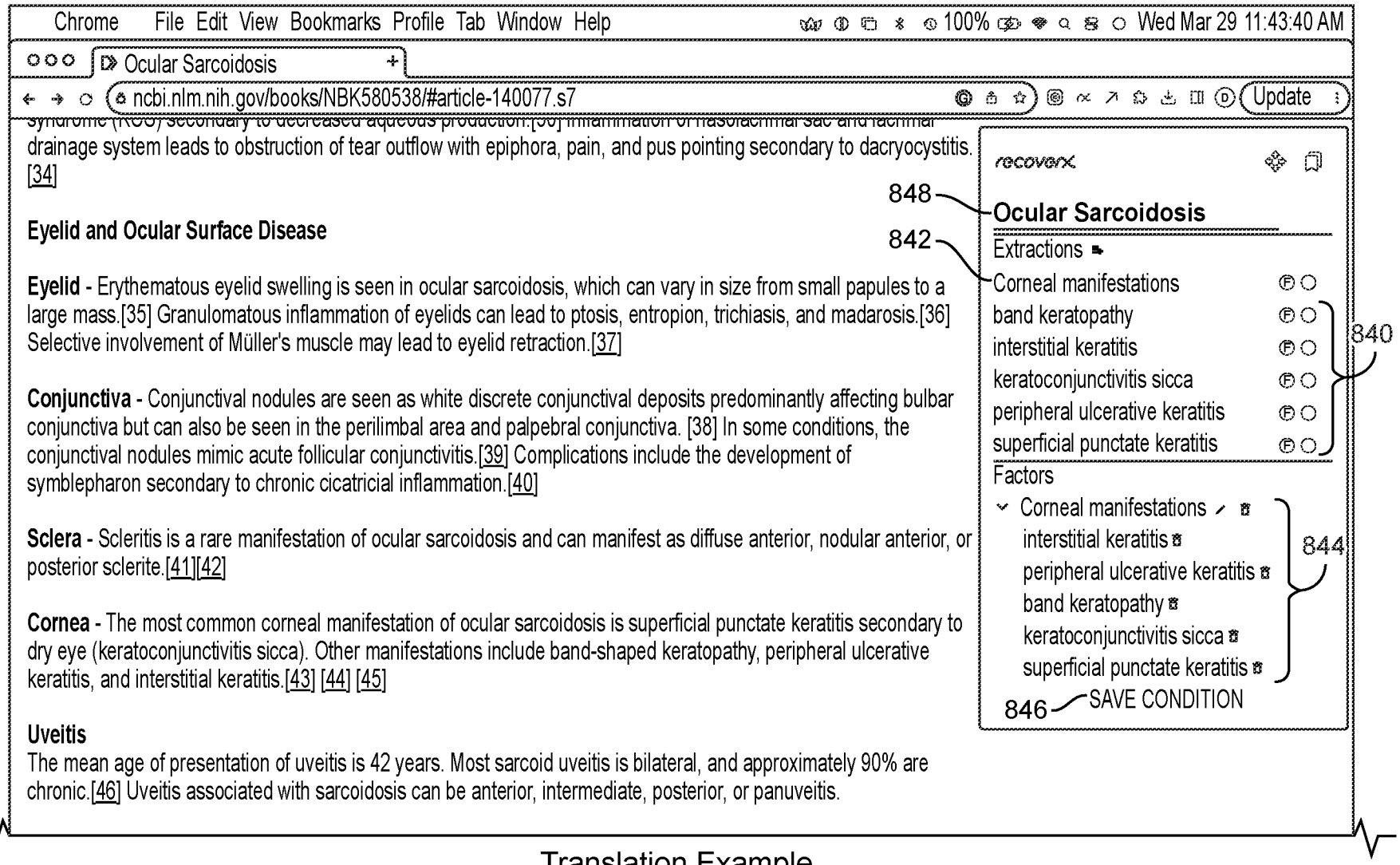

Translation Example

FIG. 9C

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Anterior uveitis - The patient presents with eye pain, redness of eyes, blurred vision, and photophobia. Sarcoidosis is characterized by granulomatous uveitis, with mutton fat keratic precipitates [figure 1], iris, or trabecular meshwork nodules. Busacca nodules are noted in the iris stroma, and the Koeppe nodules involve the pupillary margin. Berlin nodules are present at the angle of the anterior chamber. Hypopyon is usually not seen in sarcoidosis.[47]
Without appropriate treatment, there is a development of peripheral anterior synechiae with raised intraocular pressure or posterior synechiae with complicated cataracts. Patients with ocular sarcoid uveitis tend to develop raised intraocular pressure due to outflow obstruction due to trabecular meshwork block by inflammatory cells, trabecular meshwork nodules, or development of peripheral anterior synechiae.[48]

Intermediate uveitis - Patients complain of either floaters or blurred vision. The most common cause of vision loss is the development of cystoid macular edema or vitreous inflammation. Inflammation of pars plana leads to the development of snowballs in the inferior vitreous and snow banking near ora serrata.[49] Neovascularization may develop in the peripheral retina leading to vitreous hemorrhage in a few patients.[50] The vitreous may show the string of pearls appearance

FIG. 9C (Cont.)
Translation Example

BMJ Publishing Group Ex. 1014
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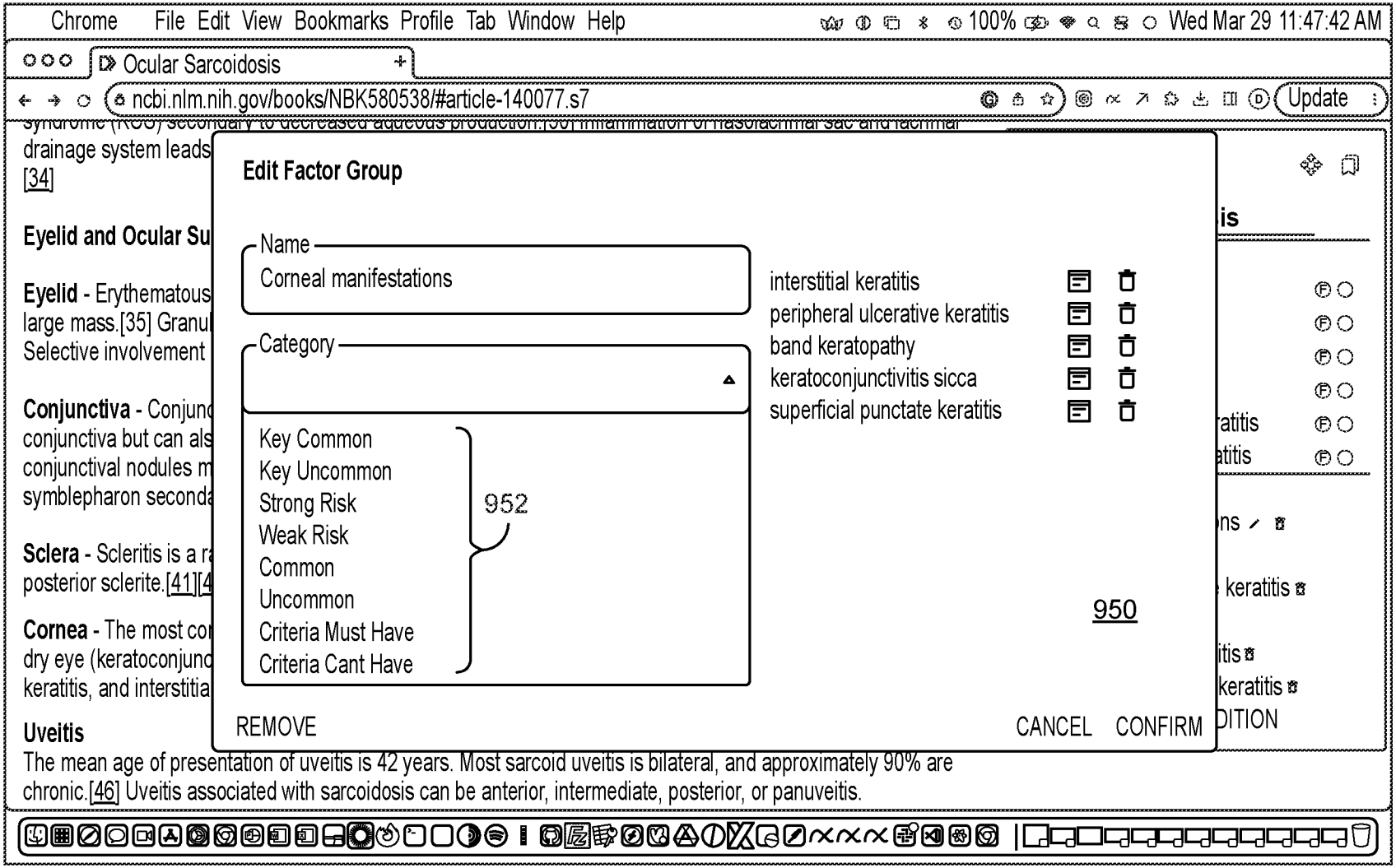

Translation Example

FIG. 9D

BMJ Publishing Group Ex. 1014
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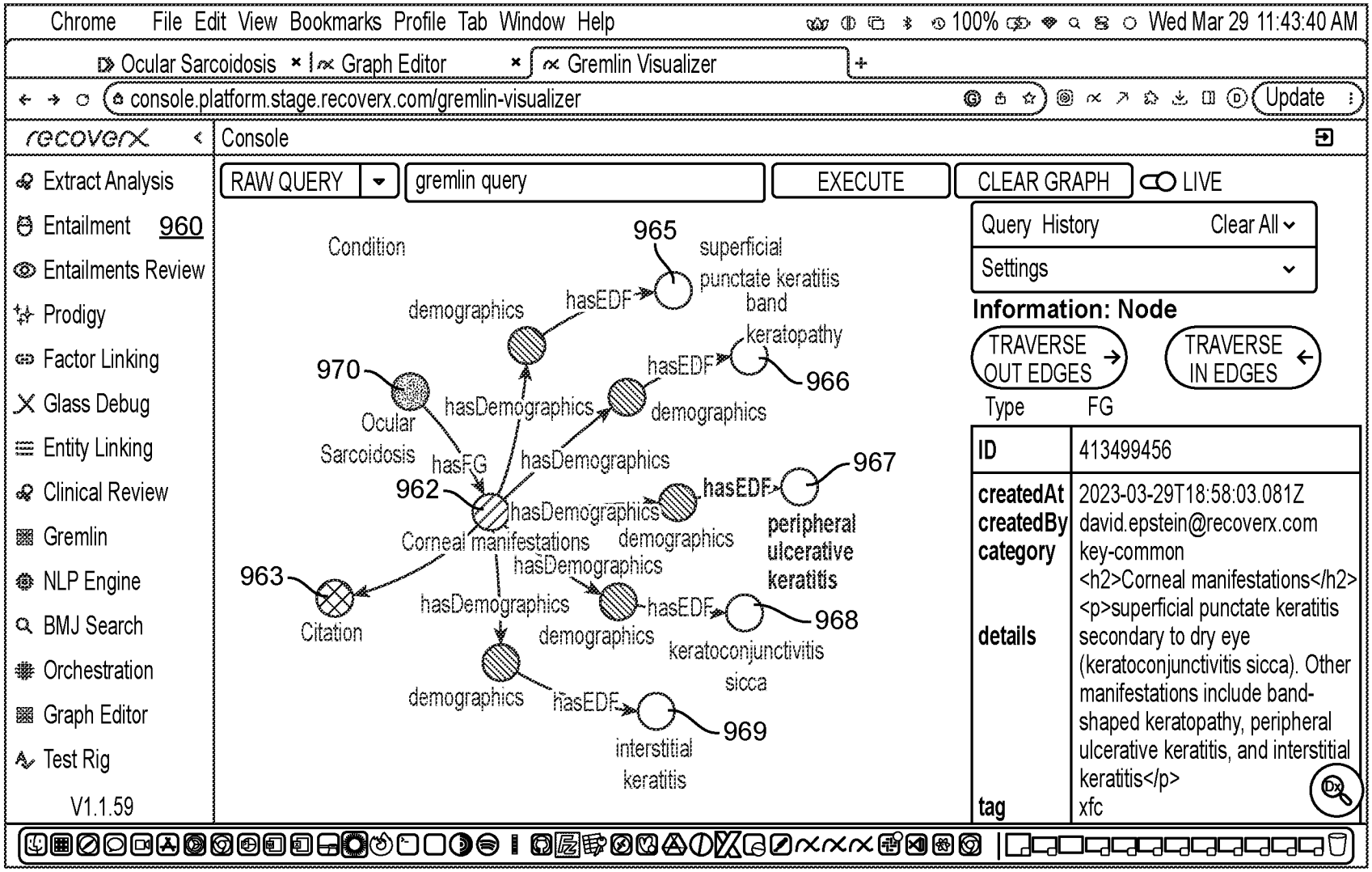

Translation Example

FIG. 9E

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MEDICAL TOPICS & CHAPTER A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z

PROFESSIONAL / CARDIOVASCULAR DISORDERS / HYPERTENSION / HYPERTENSION

→ Hypertension

Diagnosis Of Hypertension

Physical examination and Diagnosis Factors

981

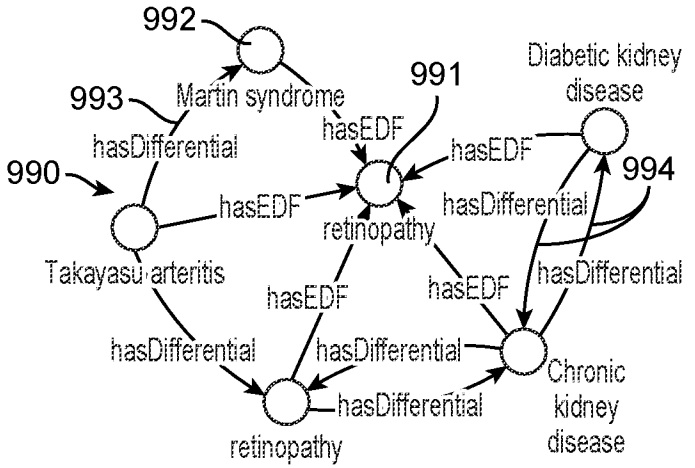
The physical examination includes measurement of height, weight, and waist circumference; funduscopic examination for retinopathy; auscultation for bruits in the neck and abdomen; and a full cardiac, respiratory, and neurologic examination. The abdomen is palpated for kidney enlargement and abdominal masses. Peripheral arterial pulses are evaluated; diminished or delayed femoral pulses suggest aortic coarctation, particularly in patients < 30. A unilateral renal artery bruit may be heard in slim patients with renovascular hypertension. Retinal vascular changes are seen commonly in....

980

982

983

type	xdf	
name	retinopathy	984
snomedCTID	29555009	985
snomedCTExpression	29555009|Retinal disorder (disorder)|	986
synonyms	retinopathy	987
temporality	0	988
negation	0	
experiencer	0	



Example Tranformation of Evidence-Based Text to Computational Data

FIG. 10

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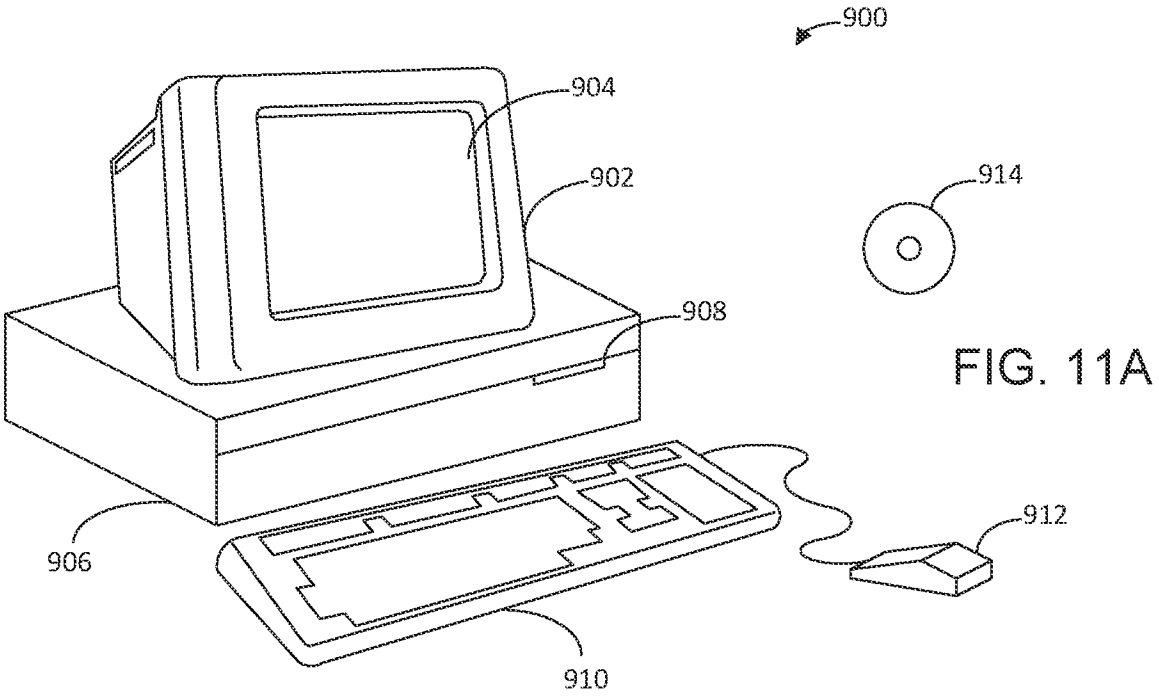

FIG. 11A

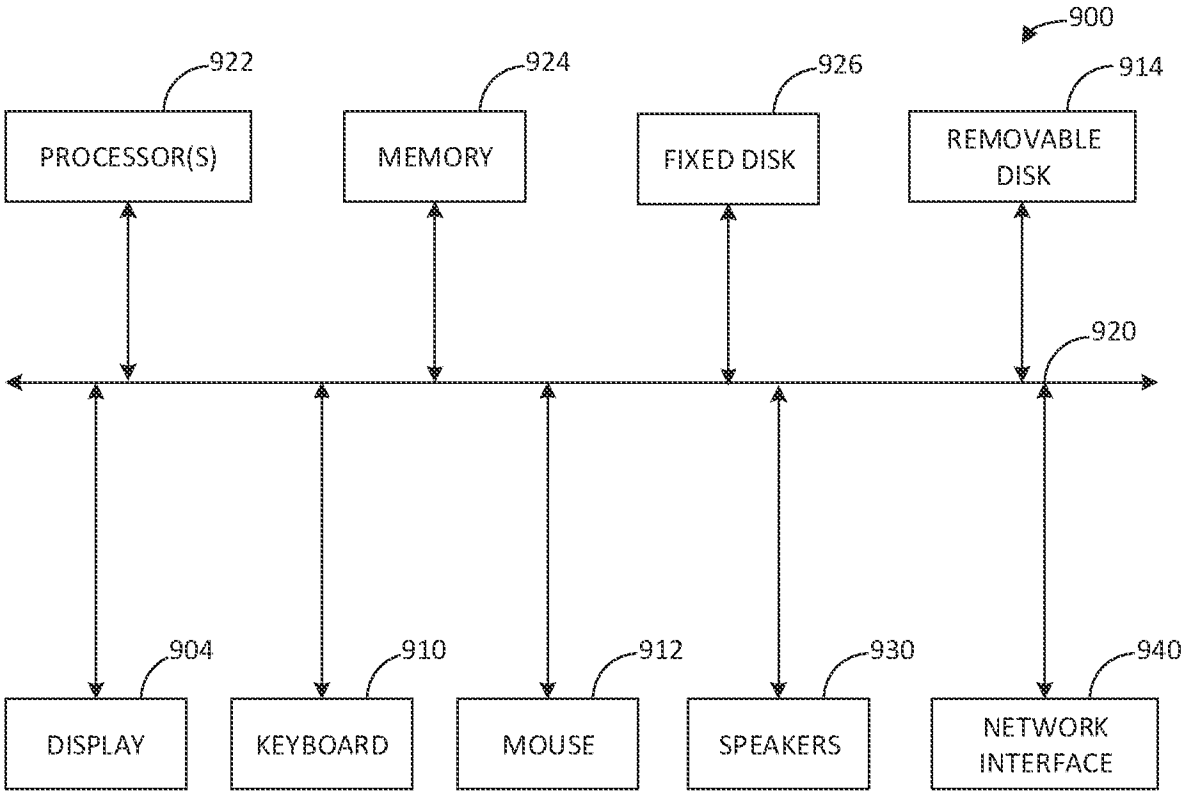

FIG. 11B

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UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
19/092,400	**03/27/2025 02:48:32 PM Z ET**	**RCVRP002C1C5**

Title of Invention

TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	6474	FILED BY	ANDREASARAH DACANAY
PATENT CENTER #	69760428	AUTHORIZED BY	Jonathan Scott
CUSTOMER #	58766	FILING DATE	-
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Carl BATE

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
DA / 504481	**E20253QE48567551**	**ANDREASARAH DACANAY**

PRE-AUTHORIZED ACCOUNT	PRE-AUTHORIZED CATEGORY
504481	**37 CFR 1.16 (National application filing, search, and examination fees); 37 CFR 1.17 (Patent application and reexamination processing fees); 37 CFR 1.19 (Document supply fees); 37 CFR 1.20 (Post Issuance fees); 37 CFR 1.21 (Miscellaneous fees and charges)**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
4011	BASIC FILING FEE- UTILITY	70.00	1	70.00
2111	UTILITY PATENT APPL. SEARCH FEE	308.00	1	308.00
2311	EXAMINATION OF ORIGINAL PATENT APPLICATION	352.00	1	352.00
2817	REQUEST FOR PRIORITIZED EXAMINATION	1806.00	1	1806.00
2830	PROCESSING FEE, EXCEPT IN	60.00	1	60.00

	PROVISIONAL APPLICATIONS			
2202	EACH CLAIM IN EXCESS OF 20	80.00	10	800.00
2201	EACH INDEPENDENT CLAIM IN EXCESS OF THREE	240.00	1	240.00
			TOTAL AMOUNT:	**$3,636.00**

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: BATE et al.	Attorney Docket No.: RCVRP002C1C5
Application No.: Not yet assigned	Examiner: Unknown
Filed: Herewith	Group: Unknown
Title: TRANSLATION OF MEDICAL EVIDENCE INTO COMPUTATIONAL EVIDENCE AND APPLICATIONS THEREOF	Confirmation No.: Unknown

Certificate of Transmission via USPTO Patent Electronic Filing System
I hereby certify that this correspondence is being transmitted via the U.S. Patent and Trademark Office (USPTO) patent electronic filing system to the USPTO on March 27, 2025.

Signed: _____/Andrea Dacanay/_____
Andrea Dacanay

INFORMATION DISCLOSURE STATEMENT
37 CFR §§1.56 AND 1.97(b)

Mail Stop Amendment
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Commissioner:

The reference(s) identified in the attached PTO Form 1449 (copies of non-U.S. references are attached) may be material to examination of the above-identified patent application. Applicants identify the reference(s) in compliance with their duty of disclosure pursuant to 37 CFR §§1.56 and 1.97. The Examiner is requested to make the identified reference(s) of official record in this application.

This Information Disclosure Statement is not to be construed as a representation that a search has been made, that additional information material to the examination of this application does not exist, or that the identified reference(s) indeed constitute prior art.

This Information Disclosure Statement is: (i) filed within three (3) months of the filing date of the above-referenced application, (ii) believed to be filed before the mailing date of a first Office Action on the merits, or (iii) believed to be filed before the mailing of a first Office Action after the filing of a Request for Continued Examination under §1.114. Accordingly, it is believed that no fees are due in connection with the filing of this Information Disclosure Statement.

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However, if it is determined that any fees are due, the Commissioner is hereby authorized to charge such fees to Deposit Account 50-4481 (Order No. RCVRP002C1C5).

Respectfully submitted,
BEYER LAW GROUP LLP

/Jonathan O. Scott/

Jonathan O. Scott
Registration No. 39,364

P. O. Box 51887
Palo Alto, CA 94303-1887
650-842-1300

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7 March 2012 (07.03.2012)

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13/077,464	31 March 201 1 (31.03.201 1)	US

(71) Applicant *(for all designated States except US):* **INTERNATIONAL BUSINESS MACHINES CORPORATION** [US/US]; New Orchard Road, Armonk, NY 10504 (US).

(72) Inventors *(for all designated States except US):* **BAGCHI, Sugato;** T.J. Watson Research Center-IBM, 19 Skyline Drive, Hawthorne, NY 10532 (US). **FERRUCCI, David, A.;** T.J. Watson Research Center-IBM, 19 Skyline Drive, Hawthorne, NY 10532 (US). **LEVAS, Anthony, T.;** T.J. Watson Research Center-IBM, 19 Skyline Drive, Hawthorne, NY 10532 (US). **MUELLER, Erik,** T.; T.J. Watson Research Center-IBM, 19 Skyline Drive, Hawthorne, NY 10532 (US).

(74) Agent: **GIBB, III, Frederick W.;** Gibb I.P. Law Firm, LLC, 844 West Street, Suite 100, Annapolis, Maryland 21401 (US).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available):* AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available):* ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE,

[Continued on nextpage]

(54) Title: A DECISION-SUPPORT APPLICATION AND SYSTEM FOR PROBLEM SOLVING USING A QUESTION-ANSWERING SYSTEM

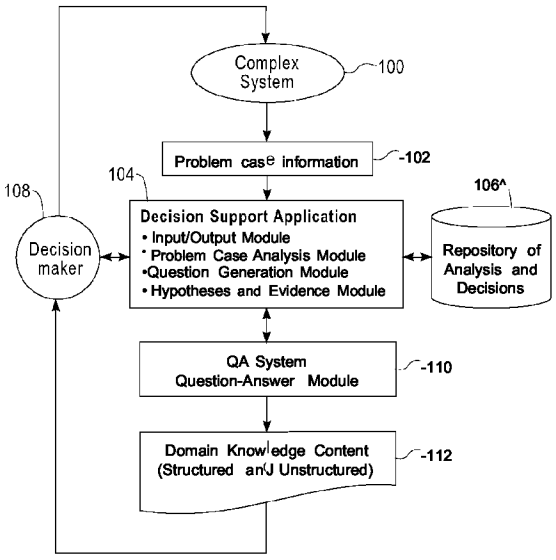

FIG. 1

(57) Abstract: A decision- support system for problem solving comprises software modules embodied on a computer readable medium, and the software modules comprise an input/output module and a question-answering module. The method receives problem case information using the input/output module, generates a query based on the problem case information, and generates a plurality of answers for the query using the question-answering module. The method also calculates numerical values for multiple evidence dimensions from evidence sources for each of the answers using the question-answering module and calculates a corresponding confidence value for each of the answers based on the numerical value of each evidence dimension using the question-answering module. Further, the method outputs the answers, the corresponding confidence values, and the numerical values of each evidence dimension for one or more selected answers using the input/output module.

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DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report (Art. 21(3))*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

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A DECISION-SUPPORT APPLICATION AND SYSTEM FOR PROBLEM SOLVING USING A QUESTION-ANSWERING SYSTEM

BACKGROUND

[01] The embodiments herein relate to using a question-answering system to support a human expert in problem solving in a particular domain, and more specifically to a decision-support application and system for problem solving using a question-answering system.

[02] Decision-support systems exist in many different industries where human experts require assistance in retrieving and analyzing information. An example that will be used throughout this application is a diagnosis system employed in the health care industry.

[03] Diagnosis systems can be classified into systems that use structured knowledge, systems that use unstructured knowledge, and systems that use clinical decision formulas, rules, trees, or algorithms. The earliest diagnosis systems used structured knowledge or classical, manually constructed knowledge bases. The Internist-I system developed in the 1970s uses disease-finding relations and disease-disease relations, with associated numbers such as sensitivity, the fraction of patients with a disease who have finding (Myers, J.D. The background of INTERNIST-I and QMR. *In Proceedings of ACM Conference on History of Medical Informatics* (1987), 195-197).

[04] The MYCIN system for diagnosing infectious diseases, also developed in the 1970s, uses structured knowledge in the form of production rules, stating that if certain facts are true, then one can conclude certain other facts with a given certainty factor (Buchanan, B.G. and Shortliffe, E. H. (Eds.) *Rule-Based Expert Systems: The MYCIN Experiments of the Stanford Heuristic Programming Project.* Addison-Wesley, Reading, MA, 1984). DXplain, developed starting in the 1980s, uses structured knowledge similar to that of Internist-I, but adds a hierarchical lexicon of findings (Barnett, G.O., Cimino, J.J., Hupp, J.A., Hoffer, E.P. DXplain: An evolving diagnostic decision-support system. *JAMA 258,* 1 (1987), 67-74).

[05] Iliad, developed starting in the 1990s, adds more sophisticated probabilistic reasoning. Each disease has an associated a priori probability of the disease (in the population for which Iliad was designed), and a list of findings, along with the fraction of patients with the disease who have the finding (sensitivity), and the fraction of patients without the disease who have the finding (1 - specificity) (Warner, H.R., Haug, P., Bouhaddou, O., Lincoln, M.,

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Warner, H., Sorenson, D., Williamson, J.W. and Fan, C. ILIAD as an expert consultant to teach differential diagnosis. In *Proc. Annu. Symp. Comput. Appl. Med. Care.* (1988), 371-376). DiagnosisPro (http://en.diagnosispro.com) is a structured knowledge base that can be queried and browsed online.

[06] In 2000, diagnosis systems using unstructured knowledge started to appear. These systems use some structuring of knowledge. For example, entities such as findings and disorders may be tagged in documents to facilitate retrieval. ISABEL uses Autonomy information retrieval software and a database of medical textbooks to retrieve appropriate diagnoses given input findings (Ramnarayan, P., Tomlinson, A., Rao, A., Coren, M., Winrow, A. and Britto, J. ISABEL: A web-based differential diagnostic aid for paediatrics: Results from an initial performance evaluation. *Archives of Disease in Childhood 88,* 5 (2003), 408-413).

[07] Autonomy Auminence uses the Autonomy technology to retrieve diagnoses given findings and organizes the diagnoses by body system (http://www.autonomyhealth.com). First CONSULT allows one to search a large collection of medical books, journals, and guidelines by chief complaints and age group to arrive at possible diagnoses (http://www.firstconsult.com). PEPID DDX is a diagnosis generator based on PEPID's independent clinical content (http://www.pepid.com/products/ddx/).

[08] Clinical decision rules have been developed for a number of disorders, and computer systems have been developed to help practitioners and patients apply these rules. The Acute Cardiac Ischemia Time-Insensitive Predictive Instrument (ACI-TIPI) takes clinical and ECG features as input and produces probability of acute cardiac ischemia as output (Selker, H.P., Beshansky, J.R., Griffith, J.L., Aufderheide, T.P., Ballin, D.S., Bernard, S.A., Crespo, S.G., Feldman, J.A., Fish, S.S., Gibler, W.B., Kiez, D.A., McNutt, R.A., Moulton, A.W., Ornato, J.P., Podrid, P.J., Pope, J.H., Salem, D.N., Sayre, M.R. and Woolard, R.H. Use of the acute cardiac ischemia time-insensitive predictive instrument (ACI-TIPI) to assist with triage of patients with chest pain or other symptoms suggestive of acute cardiac ischemia: A multicenter, controlled clinical trial. *Annals of Internal Medicine 129,* 11 (1998), 845-855). For example, ACI-TIPI is incorporated into commercial heart monitors/defibrillators.

[09] The CaseWalker system uses a four-item questionnaire to diagnose major depressive disorder (Cannon, D.S. and Allen, S.N. A comparison of the effects of computer and manual reminders on compliance with a mental health clinical practice guideline. *Journal of the American Medical Informatics Association* 7, 2 (2000), 196-203). The PKC Advisor

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provides guidance on 98 patient problems such as abdominal pain and vomiting (http://www.pkc.com/software/advisor/).

[010] The strengths of current diagnosis systems are that they can improve clinicians' diagnostic hypotheses (Friedman, CP., Elstein, A.S., Wolf, F.M., Murphy, G.C., Franz, T.M., Heckerling, P.S., Fine, P.L., Miller, T.M. and Abraham, V. Enhancement of clinicians' diagnostic reasoning by computer-based consultation: A multisite study of 2 systems. *JAMA 282,* 19 (1999), 1851-1856), and can help clinicians avoid missing important diagnoses (Ramnarayan, P., Roberts, G.C., Coren, M., Nanduri, V., Tomlinson, A., Taylor, P.M., Wyatt, J.C. and Britto, J.F. Assessment of the potential impact of a reminder system on the reduction of diagnostic errors: A quasi-experimental study. *BMC Med. Inform. Decis. Mak. 6,* 22 (2006)).

[01 1] Current diagnosis systems are not widely used (Berner, E.S. Diagnostic Decision Support Systems: Why aren't they used more and what can we do about it? *AMIA Annu. Symp. Proc. 2006* (2006), 1167-1168, hereinafter referred to as Berner, 2006) because the systems suffer from limitations that prevent them from being integrated into the day-to-day operations of health organizations (Coiera, E. *Guide to Health Informatics* (Second Edition). Hodder Arnold, 2003; and Shortliffe, T. Medical thinking: What should we *do? In Proceedings of Medical Thinking: What Do We Know? A Review Meeting* (2006), http://www.openclinical.org/ medicalThinking2006Summary2.html, hereinafter referred to as Shortliffe, 2006).

[012] Many different healthcare workers may see a patient, and patient data may be scattered across many different computer systems in both structured and unstructured form. Also, the systems are difficult to interact with (Berner, 2006; Shortliffe, 2006). The entry of patient data is difficult, the list of diagnostic suggestions may be too long, and the reasoning behind diagnostic suggestions is not always transparent. Further, the systems are not focused enough on next actions, and do not help the clinician figure out what to do to help the patient (Shortliffe, 2006). The systems are also unable to ask the practitioner for missing information that would increase confidence in a diagnosis, and they are not always based on the latest, high-quality medical evidence and have difficulty staying up-to-date (Sim, I., Gorman, P., Greenes, R.A., Haynes, R.B., Kaplan, B., Lehmann, H. and Tang, P.C. Clinical decision support systems for the practice of evidence-based medicine. *J. Am. Med. Inform. Assoc. 8,* 6 (2001), 527-534).

[013] In view of these issues, the disclosed embodiments herein provide an improved medical diagnosis system.

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SUMMARY

[014] One exemplary method embodiment herein provides a decision-support system for problem solving. The system comprises software modules embodied on a computer readable medium, and the software modules comprise an input/output module and a question-answering module. The method receives problem case information using the input/output module, generates a query based on the problem case information, and generates a plurality of answers for the query using the question-answering module. The method also calculates numerical values for multiple evidence dimensions from evidence sources for each of the answers using the question-answering module and calculates a corresponding confidence value for each of the answers based on the numerical value of each evidence dimension using the question-answering module. Further, the method outputs the answers, the corresponding confidence values, and the numerical values of each evidence dimension for one or more selected answers using the input/output module.

[015] An exemplary system embodiment herein comprises a first repository maintaining problem case information, a computer processor operatively connected to the first repository, and a second repository operatively connected to the computer processor. The computer processor is configured to receive the problem case information from the first repository. The computer processor is also configured to generate a query based on the problem case information, and to generate a plurality of answers for the query. The computer processor is further configured to calculate numerical values for multiple evidence dimensions from evidence sources for each of the answers, and to calculate corresponding confidence values for each of the answers based on the numerical values of each evidence dimension. Additionally, the computer processor is configured to output the queries, the answers, the corresponding confidence values, and the numerical values of each evidence dimension to the second repository.

[016] An additional embodiment herein comprises a computer program product comprising a computer readable storage medium storing computer readable program code comprising instructions executable by a computerized device. The computer program code comprises an input/output module receiving problem case information, a problem case analysis module analyzing the problem case information in order to identify semantic concepts, a question generation module generating a query from the semantic concepts, a question-answering module generating a plurality of answers for the query. The question-

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answering module calculates numerical values for multiple evidence dimensions from evidence sources for each of the answers. The question-answering module calculates corresponding confidence values for each of the answers based on the numerical value of each evidence dimension using the question-answering module. The input/output module outputs the queries, the answers, the corresponding confidence values, and the numerical values for multiple evidence dimensions.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[017] Figure 1 is a schematic diagram illustrating a system architecture chart for an embodiment herein;

[018] Figure 2 is a schematic diagram illustrating of the decision support process flow;

[019] Figure 3 is a schematic diagram illustrating a semantic model for the medical domain;

[020] Figure 4 is a schematic diagram illustrating the marginal contribution of evidence along the dimensions of present illness, family history, findings, and demographics for four disease answers;

[021] Figure 5 is a schematic diagram illustrating an embodiment herein applied to the medical domain;

[022] Figure 6 is a schematic diagram illustrating an embodiment herein applied to the medical domain;

[023] Figure 7 is a schematic diagram illustrating an embodiment herein applied to the medical domain;

[024] Figure 8 is a schematic diagram illustrating an embodiment herein applied to the medical domain;

[025] Figure 9 is a schematic diagram illustrating an embodiment herein applied to the medical domain;

[026] Figure 10 is a schematic diagram illustrating an embodiment herein applied to the medical domain;

[027] Figure 11 is a schematic diagram illustrating an embodiment herein applied to the medical domain;

[028] Figure 12 is a schematic diagram illustrating an embodiment herein applied to the medical domain;

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[029] Figure 13 is a schematic diagram illustrating an embodiment herein applied to the medical domain;

[030] Figure 14 is a schematic diagram illustrating an embodiment herein applied to the medical domain;

[031] Figure 15 is a schematic diagram illustrating a computing node according to an embodiment herein;

[032] Figure 16 is a schematic diagram illustrating a cloud computing environment according to an embodiment herein; and

[033] Figure 17 is a schematic diagram illustrating an abstraction model layers according to an embodiment herein.

DETAILED DESCRIPTION

[034] The following disclosure explains a decision-support application for problem solving in a particular domain. The domain can be specific, for example differential diagnosis in the medical domain, as will be discussed below, or broader ranging. The objective of the decision-support application is to inform a problem solving process based on relevant contextual information for the problem, as described in a target case. This case input information can be structured, unstructured or in other forms. Decision support is provided using a question-answering system that takes in questions or queries and returns a list of answers and associated confidences.

[035] When the method refers to a question-answering system, it means a system that can take an input query expressed in many possible forms, including natural language, structured language or many other means. Note, that an answer need not be limited to be a single "atomic" concept (such as person, place or thing), but may be a complex entity. Some examples of complex entities are elaborate explanations reached through complex reasoning or a sequence of process steps required to achieve the intended goal of the user. Embodiments herein can be applied to a variety of domains involving complex systems that require human experts to solve problems. For example, a detailed explanation is provided for a decision support application targeting differential diagnosis and treatment in the medical domain (as an example of one of many domains). As would be understood by those ordinarily skilled in the art, this system can be used for other complex systems as well.

[036] One embodiment herein allows "mixed-initiative" dialog. For example, the user may ask queries and get answers from the application. Additionally, the application can

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automatically provide "push" notifications (e.g., alerting of some significant change) to the user or ask queries of the user that would help change the systems confidence in answers that it provides. In effect, the system can continuously monitor relevant case input as well as take directed queries regarding a specific case.

[037] Figure 1 is a schematic diagram illustrating a broader decision-making context in a system architecture chart of an embodiment herein. The decision-maker 108 may enter information through a range of devices including mobile phones, tablets, computers, appliances, etc. This information can be input through a variety of modalities including spoken, typed, constructed through a series of GUI interactions, etc. The information can be either problem case information or a query. The query can be in the form of natural language, structured language, or any other query format. The problem case information that the system uses can be multimodal and can take the form of text, images, audio, or any other media form.

[038] In general, the embodiments herein are intended to allow interaction to occur over a period of time and to support an iterative refinement approach. Therefore, one aspect of embodiments herein is a repository of all relevant analysis and decisions made to date. This repository 106 contains a representation of the reasoning and decision process not only as an efficiency mechanism, but allows the system to re-evaluate assumptions and decisions in light of new evidence relevant to the case. This allows users to interact with this representation, accepting, rejecting, or modifying it to as they think necessary to explore alternative solutions based on the users' insights into the validity or importance of the evidence or reasoning chain. This repository 106 is not only useful in the current evolving decision making interaction, but can be used to track the provenance of decisions that were made in the past and allow notification of actions to take based on newly arriving information that comes possibly years after decisions were made. For example, if a new study reports a contraindication for a drug in a given situation, the system could use this repository 106 of prior analysis to reevaluate its conclusions and provide relevant notification of alternative therapies to a patient that has been on this drug for years.

[039] Lastly, in general, all embodiments herein are meant to inform the decision making process and allow the decision-maker 108 to view alternatives and associated confidences in proposed answers, explore the evidence and reasoning process the system used to come to its conclusions, and to get feedback on what additional information, if provided, would result in changing the answers.

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[040] The term diagnosis used in the medical domain can be generalized to mean "inform" in other domains. The medical examples found herein illustrates this through answers, confidences, dimensions of evidence, associated evidence passages, and documents where this evidence is found, as well as, reliability of the evidence source. In the medical domain, the embodiments herein can be used as a clinical decision support tool by physicians who are providing care to a patient. Examples of queries include (but are not limited to): what clinical conditions are characterized by a set of symptoms?; what is the "differential diagnosis" (a ranked list of diseases) that could potentially cause a set of symptoms, conditions, findings? (this can be conditioned by providing other pertinent patient information such as active diseases, current medications, allergies, past disease history, family disease history and patient demographics); what tests would increase or decrease confidence in a given disease hypothesis present in the differential diagnosis?; and/or what treatments are recommended for a specified disease, given information about the patient?; etc. In the medical domain, the problem case information can be electronic medical records.

[041] The question-answering system derives answers from a repository of 'domain knowledge'. The embodiments herein leave delineation of the domain knowledge up to the question-answering system. The question-answering system in the exemplary medical implementation actually uses the natural language of medical text books, clinical guidelines, and other documents as the domain knowledge as well as structured sources of information provided in databases or ontologies or any other potential structured form.

[042] In general, the embodiments herein describe a decision-support application 104 that is positioned in-between a source of problem case information 102 and a question-answering system 110 using the example of a medical diagnosis system. However, as would be understood by those ordinarily skilled in the art, the embodiments herein are not limited to medical diagnosis systems. To the contrary, the embodiments herein apply to diagnostic problem solving in any other complex-system domains that require question answering over unstructured material. Examples of such domains include aircraft maintenance (and other vehicles of similar complexity) and information technology support (call centers). This system could be used for automobiles, submarines, or even less complex but likely more universally accessible applications, for example, finding answers to "how to" queries in information technology or suitable meal recipes given input specifications such as ingredients, cost requirements, time, complexity, elegance, etc. These are all characterized by large amounts of structured and unstructured "problem case information" and domain knowledge, and requiring a deep question-answer type technology. Therefore, while the

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examples herein utilize a medical diagnosis system, those ordinarily skilled in the art would understand that the embodiments herein are applicable to all question-answer systems and the embodiments herein are not limited to just the exemplary medical diagnosis system that is used as a platform to illustrate the embodiments herein.

[043] The system 104 comprises software modules (embodied on a computer readable medium) including an input/output module, a problem case analysis module, a question generation module, a hypotheses and evidence module, etc. The QA system 110 includes a question-answering module, etc. The objective of decision-making is to diagnose and solve problems that arise in a complex system 100 specified in the domain. A human expert (user) 108 who interacts with the decision-support application 104 (through items 100 and 102) makes decisions. A record of past decisions and the associated information used to arrive at the decision is maintained in the repository 106. In some embodiments, the question-answering module can match the query to at least one of the previously generated medical diagnosis queries that were generated by the question generation module and stored in the repository 106.

[044] The decision-support application 104 may be triggered in several ways. In one mode, the decision-maker 108 asks a query about a particular case. The application 104 may expand the query with relevant problem case information and submit it to the question-answering (QA) system 110. The resulting answers or hypotheses are then presented to the decision-maker 108 who may iterate further, honing in to an acceptable resolution of the problem.

[045] Another mode of operation assumes the existence of standing queries defined by the question generation module and/or the decision-maker 108. As new case information comes in, these queries are automatically run by the decision-support application 104 without the active involvement of the decision-maker 108. The results may be proactively sent to the decision-maker 108 or stored in the repository 106 for a subsequent scheduled interaction.

[046] The above modes of operation assume the presence of active problem cases that are yet to be satisfactorily resolved. Another mode of operation can be triggered by changes in the content of domain knowledge used by the question-answering system in item 112. In the medical domain, new clinical literature and guidelines are continuously being published, describing new screening procedures, therapies, and treatment complications. The decision-support application 104 can use its repository 106 of past analyses and decisions to determine if any of its previous cases would be sufficiently affected by this new knowledge, and if so, send alerts to the responsible decision-makers 108.

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[047] Thus, Figure 1 can also be considered to illustrate an exemplary system embodiment herein that comprises a first repository 102 maintaining problem case information, a computer processor 104/1 10 (running the modules) operatively connected to the first repository 102, and a second repository 106 operatively connected to the computer processor 104/110. Items are considered operatively connected to each other when the items are directly or indirectly connected to one another (e.g., physically, functionally, wired, wirelessly, etc.).

[048] This "computer processor" 104/1 10 automatically analyzes the problem case information in order to identify semantic concepts, relations, and data and automatically generates at least one diagnosis query from the semantic concepts, relations and data. The computer processor 104/110 also automatically generates a plurality of diagnosis answers for each diagnosis query, and calculates confidence values for each of the answers based on numerical values for several dimensions of evidence that are relevant to the problem-solving domain. The computer processor 104/1 10 can then automatically calculate corresponding confidence values for each of the diagnosis answers based on the numerical value of each evidence dimension of evidence sources of the confidence values. Further, the computer processor 104/1 10 can then automatically generate links to each item of evidence to allow the user to examine the passages that justify the answer in a given. For example, links can be generated to the source of a passage, its type (text book, guideline, journal article, web content, database or structured source). The computer processor 104/1 10 also outputs the queries, the answers, the corresponding confidence values, the links to the evidence sources, and the numerical value of each evidence dimension to the decision-maker 108 and/or the second repository 106.

[049] Figure 2 is a schematic diagram illustrating the decision support process flow performed by the decision support application 104. More specifically, Figure 2 illustrates the flow of information from the problem case information 102 to the question-answering system 110 and the flow of information returned from the question-answering system 110 back to the decision-maker 108. Thus, the method receives problem case information using the input/output module. Further, in the medical domain, the problem case information can comprise illness symptoms of a patient, family history of the patient, demographics of the patient, etc. The output from the question-answering system 110 is used by the decision-maker 108 to either make a decision or seek additional information about the problem.

[050] In item 202, the method receives input about the current problem. The method can receive a user inquiry through the input/output module in the form of a free-form query, a

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free-form statement, and/or keyword search, etc. The input from the problem can be multi-modal, such as text, audio, images, and video. The text can be unstructured, such as paragraphs of problem description in natural language, or structured, such as the content derived from a database. For example, in the medical domain, the input can be clinical information pertinent to a patient's "History of Present Illness" (HPI). This can be in the form of paragraphs of unstructured text describing any aspect of the patient's HPI as written or dictated by a nurse or physician, or semi-structured, with shorter sentences or snippets assigned to specific HPI categories.

[05 1] The input information can come in over time. The input may be triggered by a change in the problem condition, the result of additional tests or procedures performed, or a response to a query for more information generated by the decision-maker 108. In addition, the information within the domain knowledge content 102 can change according to evolving demographic changes, evolving medical discoveries, evolving medication conflicts, evolving side effect information, etc. This time-stamped information is recorded in the repository 106 in the system.

[052] In item 204, the method automatically analyzes the problem case information 102, using the problem case analysis module, in order to identify semantic concepts, relations and other relevant knowledge (e.g., medical patient data). Thus, the method identifies semantic concepts, relations and other relevant knowledge when the incoming information is unstructured, such as natural language text, audio or images, the concepts, relations and other kinds of information relevant to the domain has to be identified. This is done by software components called "annotators". They can be procedural code, rule based, using programmed logic or in many other forms for determining concepts, relations and other relevant information. They could, for example, be based on machine learning, using a set of training data containing known concepts and relations.

[053] For the medical domain, annotators can recognize the phrases relating to clinical concepts such as patient symptoms, current medical conditions, clinical findings, medications, family history, demographics, etc. Annotators may also identify relations between entities such as location of symptom, the severity of a condition, or the numerical value of a finding. The concepts and relations are represented by domain-specific semantic model or type system. An example of such a semantic model for the medical domain is shown in Figure 3. More specifically, in the example shown in Figure 3, various elements have different logical/causal relationships. For example, substance 302 has an "is a" relationship to agent 304 indicating that substance 302 "is an" agent 304. Similarly, a

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disease/syndrome 306 can be caused by the agent 304, and the disease/syndrome can be a complication of another disease/syndrome in item 306.

[054] With respect to the disease/syndrome 306, it can be confirmed by test 308, may be located at anatomy location 310, can be presented by a finding 318, and can be a complication of a certain treatment 312 (or may be treated by the treatment 312). The treatments 312 may be a procedure 314, a drug 316, etc. Similarly, with respect to the finding 318, it may be measured by the test 308, located at the anatomy location 310, treated by the treatment 312, be a side effect of the treatment 312, or may specify a clinical attribute 320. Additionally, the clinical attribute 320 may be influenced by the treatment 312. Therefore, the semantic model illustrated in Figure 3 (which may be referred to as a factoid physiology definition guideline) illustrates various concepts and relations of a domain-specific semantic model.

[055] In item 206, the method can receive queries or automatically generate queries from the semantic concepts, relations and data using the question generation module. Thus, using the semantic concepts and relations found in the previous step, queries for the question-answering system can be automatically formulated. Alternatively, it is also possible for the decision-maker 108 to enter queries in natural language or other ways, as described above.

[056] In case of automatic formulation, a set of "standing" queries can be designed as a template. For example, a standing query in the medical domain is the "differential diagnosis." This is a list of potential hypotheses of the diseases or other medical conditions that explain a patient's symptoms and abnormal findings. The diagnosis query templates herein have blank slots for concepts such as symptoms, findings, past diseases, current medications, allergies, etc. Once the semantic concepts and relations are identified, these fill in the blanks in the template, resulting in a synthesized query. The concept of a template is a general computational element for automatically constructing a set of relevant queries (queries) to the underlying question-answering system that is used to synthesize and return information relevant to the specific information need at hand.

[057] There are many ways to implement templates. For example, queries may be automatically generated in item 206 based on what is known and unknown about the problem case. For example, in the medical domain, if symptom and finding concepts have been identified in the patient case information, but no diseases are found, a diagnosis query may be generated. The physician is also able to type in a query such as "What is the diagnosis?" and rely on the rest of the context to come from the semantic concepts. The physician is also able

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to fine-tune the querying by specifying more constraints such as "Is there an infectious cause of these symptoms?"

[058] In item 208, the method sends queries to the QA system 110. Thus, the method can automatically generate a plurality of answers for each query using the question-answering module. Once a query is formulated, the question-answering system 110 is invoked. For aiding the subsequent interpretation of the answers, a query may be converted into multiple queries. Each query in this set may contain a subset of the concepts found about the problem. For example, a clinical diagnosis query containing symptoms, findings, family history and demographic information, could generate a series of queries as follows, where the text in the < > characters is replaced by the corresponding concepts found in the case text: "What disease of condition could cause <symptom>?"; "What disease of condition could cause <symptom> and <findings>?; "What disease of condition could cause <symptom>, <findings> and <family history>?; "What disease of condition could cause <symptom>, <findings>, <family history> and <demographics>?; etc. This build-up of information in the query makes it possible to calculate the marginal contribution of findings, family history and demographic information to the confidence of a diagnosis. Other strategies for breaking down a query into a set of queries could also be used.

[059] The method receives answers from the question-answering system in item 210. For each query submitted, the question-answering system 110 returns a list of answers, their confidences, evidence dimensions, and evidence sources. The confidence of each answer can, for example, be a number between 0 and 1. This confidence is constructed from various answer scorers in the question-answering system, which evaluates the correctness of the answer according to various dimensions of evidence sources. For example, a candidate answer to a medical diagnosis query can be evaluated in terms of the semantic type of the answer. The score along this dimension will be high if the answer is a type of disease or medical condition that can be considered as a diagnosis. For every answer to a query, the passages of domain knowledge from which the answer was extracted are also available from the question-answering system. This can be snippets of text that match the structure of the query or entire documents that were returned from search components during the question-answering process. For each passage, a citation to the original source of information is also recorded.

[060] In item 212, the method further automatically calculates confidence values for each of the answers based on numerical values for several dimensions of evidence that are relevant to the problem-solving domain.. The numerical value of each evidence dimension

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can be based upon the various semantic concepts and relations found in the problem case information 102, as described by the method in item 204. For example, in the medical domain, these could be the patient's symptoms, findings, family history, demographics, etc.

[061] The above processes described methods of formulating multiple queries containing a subset of the concepts found in the problem text. By analyzing answers and their confidences for these queries, an estimate of the marginal contribution of these concepts can be generated. For the example for the queries generated, the marginal impact of symptoms, findings, family history and demographics are calculated. Other techniques for achieving this are possible as well.

[062] In item 214, the method displays information to support decision-making. The list of answers is displayed along with answer confidences for the decision-maker 108 to evaluate (see Figure 4 for an example). Thus, the method outputs the queries, the answers, the corresponding confidence values, the links to the evidence sources, and the numerical value of each evidence dimension using the input/output module upon user inquiry. Additionally, the decision maker can explore each evidence dimension further by viewing each piece of evidence and explore its associated provenance. For example, a piece of evidence may be a supporting passage, reasoning chain, or database fact. Similarly, examples of associated provenances include journal articles, textbooks, and databases. Further, when outputting the numerical value of each evidence dimension , this embodiment can illustrate the amount each evidence dimension contributes to a corresponding confidence value (on a scale or percentage basis, for example) and illustrate how changes in each of the numerical value of each evidence dimension produce changes in the corresponding confidence value.

[063] Further, the embodiments herein automatically and continuously update the diagnosis answers, the corresponding confidence values, and the numerical value of each evidence dimension based on revisions to the problem case information to produce revised queries, answers, corresponding confidence values, etc. (using the question-answering module). This method can also automatically output the revised queries, answers, and/or corresponding confidence values when a difference threshold is exceeded. This "difference threshold" can comprise a time period (e.g., hours, weeks, months, etc.), the amount one or more answers change (e.g., percentage change, polarity (yes/no) change, number of answers changing, etc.) and/or an amount of confidence value changes (percent confidence change, confidence polarity change, etc.).

[064] Therefore, the decision support application 104 continuously and dynamically

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automatically provides queries and answers based upon the evolving semantic concepts, relations and other relevant data (e.g., medical patient data) in order to provide the highest confidence answers and the most information on such answers to the decision-maker 108. Rather than providing static applications that always provide the same answers when given the same input (as is done conventionally), the embodiments herein continually update the values and relationships of the numerical values of each evidence dimension to change the confidence values of potential answers. When the confidence values of the potential answers change, the answers that are most highly recommended can also change, thereby dynamically allowing the decision-maker to be provided with different best answers as the problem case information evolves over time.

[065] Thus, the embodiments herein provide substantial advantages over systems that generate answers and confidence values based on preset, fixed criteria that is rarely revised (or only revised at periodic updates (e.g., software updates)). For example, in the medical domain, by acting dynamically, previous answers and recommendations can change based on evolving demographic changes, evolving medical discoveries, evolving medication conflicts, evolving side effect information, etc., within the domain knowledge content 112. Therefore, the embodiments herein can change a course of medical treatment advice for a patient, even if that patient does not experience a personal change, merely because other data within the domain knowledge content 112 evolves over time. This allows medical providers a fully automated system for constantly prescribing the best medical treatment for their patients as medical advances and demographics change over time.

[066] In many domains, the answer with the highest confidence need not be the appropriate answer because there can be several possible explanations for a problem. For example, in the medical domain, several diseases may cause a patient to present a set of symptoms. In addition to displaying a list of answers and their confidences, one or more of the answers may be selected to drill down into the dimensions of evidence. Figure 4 is a schematic diagram illustrating the contribution of each dimension value of evidence from evidence sources to the overall confidence of an answer. The output shown in Figure 4 compares each dimension across multiple answers. Figure 4 illustrates the marginal contribution of evidence 400 along the dimensions of present illness 402, family history 404, findings 406, and demographics 408 for four disease answers. In this example, the "dimensions" are 'present illness', 'findings', 'family history', and 'demographics' and each has its own value. This comparative analysis of multiple answers along the evidence dimensions

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allows the decision-maker 108 to consider and visualize the trade-offs in evidence in order to arrive at a decision.

[067] The decision-maker 108 can also drill down deeper into each answer and dimension of evidence and examine the supporting pieces of evidence that justify the answer along that dimension. For example, the source of the passage, its type (text book, guideline, journal article, web content) and a link to the source is provided for the decision maker to delve deeper and confirm its validity.

[068] The method can also identify missing information in item 216. More specifically, this embodiment automatically identifies information relevant to the answers that is not contained within the problem case information as missing information, and further automatically identifies the amount the missing information affects the corresponding confidence values (both using the using the question-answering module) and outputs this information to the user.

[069] If the answers and their evidence returned by the question- answering system are not adequate for arriving at a decision, the application 104 may be used to identify missing information that has potential for affecting the confidence in answers. For a given answer, the decision-maker 108 may want to know what hypothetical information, if provided, can produce the greatest change in the confidence. For example, in the medical domain, if the answer is a disease, the missing information may be a lab test that confirms or rules out the disease. It may also be other signs or symptoms not specified for the patient. In reality, there may be a large amount of missing information associated with an answer and the embodiments herein can rank the missing information. Characteristics that can be used to rank the potential value of the missing information are factors such as the cost of obtaining this information, the time taken, and the amount by which the missing information affects the confidence of the answer.

[070] When two answers have similar confidences, making it difficult to choose between them, it is helpful to identify the missing information that will cause the biggest difference between these confidences. For example, in the medical domain, the answers may be two related diseases and the missing information may be a lab test designed to differentiate between them. This evidence could increase as well as decrease the confidence of one answer thus helping to ascertain the correct diagnosis in the case of a medical diagnostic system.

[071] The identification of missing information need not only be done at the initiative of the decision-maker 108. When certain criteria are met, for example, confidence

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of two top answers are very close, the application 104 itself may take the initiative and may automatically request the missing information.

[072] Once the missing information is identified, the decision-maker 108 has to seek this missing information using procedures specific to the domain. In the medical domain, this may require ordering lab tests or asking the patient for more information. When this missing information becomes available, it is sent back to the decision-support as described above and a new iteration of question-answering and decision support process illustrated in Figure 2 is begun.

[073] Figures 5-14 are schematic diagrams of screenshots that can be presented to the users. In Figure 5, profiles 502, 504 for two patients are shown on a screenshot 500. Additional profiles for further patients can be created. In Figure 6, the first patient 502 has been selected and has described symptoms that are listed in the History of Present Illness section 506. This information can be input by a health care professional into an Electronic Health Record (EHR) or merely made available for the system to consider by typing into the box 506. The proposed system can pull the relevant information automatically from the health record or text field above, use analytics to find relevant concepts, classify them as belonging to the symptoms dimension and automatically generate the query listed in the queries field 508. Alternatively, the user (physician/patient) could enter a query directly into the query field. The user can then click on the "Ask Watson" button 510 to proceed. Figure 6 also lists an "Evidence" button 512, which is discussed below.

[074] In Figure 7, the decision-support application 104 has generated a set of possible answers to the query with associated confidence scores associated with each answer and the same is displayed in area 514. In Figure 8, having confirmed the condition, the user can enter the condition into the History of Present Illness section, or the condition can be extracted automatically from the EHR. Subsequently, the physician can ask another query or have the decision-support application 104 automatically generate another query.

[075] In Figure 9, the process continues with new information having been added in item 506 that is analyzed and grouped in relevant dimensions such as present illness, family history, etc. In Figure 10, the same process continues as more information continues to be added in item 506, thereby refining the potential diagnosis. In Figure 11, the process has reached a point where the decision-support application 104 indicates in item 514 with high confidence over other potential answers that the proper diagnosis for the particular patient is Lyme disease. From the example of Figure 11, the information contained in these dimensions come from the case information (respectively, 'uveitis', 'circular rash...', 'arthritis', and

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'Connecticut'). The numerical value of each evidence dimension comes from the presence of the information contained in these dimensions in the medical content in the context of the hypothesized answer (e.g., Lyme disease).

[076] In Figure 12, the decision-support application 104 allows the user to select the answer Lyme disease in order to view the evidence profile 516 for the answer. The application 104 reveals the dimensions of evidence and their associated contribution to the Lyme disease diagnosis. The user can then further select a particular dimension to explore snippets of evidence that contribute to this dimension. Finally, the application 104 allows for the physician to view the whole documents from which the snippets were derived by clicking on one of the links labeled 518 in Figure 12, such as a textbook, journal, or website. In Figure 13, the decision-support application 104 is again shown, except in this case the application 104 is directed towards exploring possible treatments for treating the identified condition. In Figure 14, new information has been added or automatically extracted from the patient's medical record relevant to the appropriate treatment to the identified condition. In this case, the application 104 has identified that the patient is allergic to penicillin and that the patient is pregnant. The application 104 uses this information to find the appropriate treatment, in this case indicating a confidence score for a particular treatment option.

[077] As will be appreciated by one skilled in the art, aspects of the embodiments herein may be embodied as a system, method or computer program product. Accordingly, aspects of the embodiments herein may take the form of an entirely hardware embodiment, an entirely software embodiment (including firmware, resident software, micro-code, etc.) or an embodiment combining software and hardware aspects that may all generally be referred to herein as a "circuit," "module" or "system." Furthermore, aspects of the embodiments herein may take the form of a computer program product embodied in one or more computer readable medium(s) having computer readable program code embodied thereon.

[078] Any combination of one or more computer readable medium(s) may be utilized. The computer readable medium may be a computer readable signal medium or a computer readable storage medium. A computer readable storage medium may be, for example, but not limited to, an electronic, magnetic, optical, electromagnetic, infrared, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing. More specific examples (a non-exhaustive list) of the computer readable storage medium would include the following: an electrical connection having one or more wires, a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM),an erasable programmable read-only memory (EPROM or Flash memory), an optical

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fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing. In the context of this document, a computer readable storage medium may be any tangible medium that can contain, or store a program for use by or in connection with an instruction execution system, apparatus, or device.

[079] A computer readable signal medium may include a propagated data signal with computer readable program code embodied therein, for example, in baseband or as part of a carrier wave. Such a propagated signal may take any of a variety of forms, including, but not limited to, electro-magnetic, optical, or any suitable combination thereof. A computer readable signal medium may be any computer readable medium that is not a computer readable storage medium and that can communicate, propagate, or transport a program for use by or in connection with an instruction execution system, apparatus, or device.

[080] Program code embodied on a computer readable medium may be transmitted using any appropriate medium, including but not limited to wireless, wireline, optical fiber cable, RF, etc., or any suitable combination of the foregoing.

[081] Computer program code for carrying out operations for aspects of the embodiments herein may be written in any combination of one or more programming languages, including an object oriented programming language such as Java, Smalltalk, C++ or the like and conventional procedural programming languages, such as the "C" programming language or similar programming languages. The program code may execute entirely on the user's computer, partly on the user's computer, as a stand-alone software package, partly on the user's computer and partly on a remote computer or entirely on the remote computer or server. In the latter scenario, the remote computer may be connected to the user's computer through any type of network, including a local area network (LAN) or a wide area network (WAN), or the connection may be made to an external computer (for example, through the Internet using an Internet Service Provider).

[082] Aspects of the embodiments herein are described below with reference to flowchart illustrations and/or block diagrams of methods, apparatus (systems) and computer program products according to embodiments of the invention. It will be understood that each block of the flowchart illustrations and/or block diagrams, and combinations of blocks in the flowchart illustrations and/or block diagrams, can be implemented by computer program instructions. These computer program instructions may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of

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the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks.

[083] These computer program instructions may also be stored in a computer readable medium that can direct a computer, other programmable data processing apparatus, or other devices to function in a particular manner, such that the instructions stored in the computer readable medium produce an article of manufacture including instructions which implement the function/act specified in the flowchart and/or block diagram block or blocks. The computer program instructions may also be loaded onto a computer, other programmable data processing apparatus, or other devices to cause a series of operational steps to be performed on the computer, other programmable apparatus or other devices to produce a computer implemented process such that the instructions which execute on the computer or other programmable apparatus provide processes for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks.

[084] The flowchart and block diagrams in the Figures illustrate the architecture, functionality, and operation of possible implementations of systems, methods and computer program products according to various embodiments herein. In this regard, each block in the flowchart or block diagrams may represent a module, segment, or portion of code, which comprises one or more executable instructions for implementing the specified logical function(s). It should also be noted that, in some alternative implementations, the functions noted in the block may occur out of the order noted in the figures. For example, two blocks shown in succession may, in fact, be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved. It will also be noted that each block of the block diagrams and/or flowchart illustration, and combinations of blocks in the block diagrams and/or flowchart illustration, can be implemented by special purpose hardware-based systems that perform the specified functions or acts, or combinations of special purpose hardware and computer instructions.

[085] It is understood in advance that although this disclosure includes a detailed description on cloud computing, implementation of the teachings recited herein are not limited to a cloud computing environment. Rather, embodiments herein are capable of being implemented in conjunction with any other type of computing environment now known or later developed. Cloud computing is a model of service delivery for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, network bandwidth, servers, processing, memory, storage, applications, virtual machines, and

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services)that can be rapidly provisioned and released with minimal management effort or interaction with a provider of the service. This cloud model may include at least five characteristics, at least three service models, and at least four deployment models. Characteristics are as follows:

[086] On-demand self-service: a cloud consumer can unilaterally provision computing capabilities, such as server time and network storage, as needed automatically without requiring human interaction with the service's provider.

[087] Broad network access: capabilities are available over a network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client platforms (e.g., mobile phones, laptops, and PDAs).

[088] Resource pooling: the provider's computing resources are pooled to serve multiple consumers using a multi-tenant model, with different physical and virtual resources dynamically assigned and reassigned according to demand. There is a sense of location independence in that the consumer generally has no control or knowledge over the exact location of the provided resources but may be able to specify location at a higher level of abstraction (e.g., country, state, or datacenter).

[089] Rapid elasticity: capabilities can be rapidly and elastically provisioned, in some cases automatically, to quickly scale out and rapidly released to quickly scale in. To the consumer, the capabilities available for provisioning often appear to be unlimited and can be purchased in any quantity at any time.

[090] Measured service: cloud systems automatically control and optimize resource use by leveraging a metering capability at some level of abstraction appropriate to the type of service (e.g., storage, processing, bandwidth, and active user accounts). Resource usage can be monitored, controlled, and reported providing transparency for both the provider and consumer of the utilized service. Service Models are as follows: Software as a Service (SaaS): the capability provided to the consumer is to use the provider's applications running on a cloud infrastructure. The applications are accessible from various client devices through a thin client interface such as a web browser (e.g., web-based e-mail). The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user-specific application configuration settings.

[091] Platform as a Service (PaaS): the capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider. The consumer does not manage

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or control the underlying cloud infrastructure including networks, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations.

[092] Infrastructure as a Service (IaaS): the capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems, storage, deployed applications, and possibly limited control of select networking components (e.g., host firewalls).

[093] Deployment Models are as follows:

[094] Private cloud: the cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on-premises or off-premises. Community cloud: the cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on-premises or off-premises.

[095] Public cloud: the cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.

[096] Hybrid cloud: the cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds).

[097] A cloud computing environment is service oriented with a focus on statelessness, low coupling, modularity, and semantic interoperability. At the heart of cloud computing is an infrastructure comprising a network of interconnected nodes.

[098] Referring now to Fig. 15, a schematic of an example of a cloud computing node is shown. Cloud computing node 10 is only one example of a suitable cloud computing node and is not intended to suggest any limitation as to the scope of use or functionality of embodiments of the invention described herein.

[099] Regardless, cloud computing node 10 is capable of being implemented and/or performing any of the functionality set forth hereinabove. In cloud computing node 10 there is a computer system/server 12, which is operational with numerous other general purpose or special purpose computing system environments or configurations. Examples of well-known computing systems, environments, and/or configurations that may be suitable for use with

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computer system/server 12 include, but are not limited to, personal computer systems, server computer systems, thin clients, thick clients, hand-held or laptop devices, multiprocessor systems, microprocessor-based systems, set top boxes, programmable consumer electronics, network PCs, minicomputer systems, mainframe computer systems, and distributed cloud computing environments that include any of the above systems or devices, and the like.

[0100] Computer system/server 12 may be described in the general context of computer system executable instructions, such as program modules, being executed by a computer system. Generally, program modules may include routines, programs, objects, components, logic, data structures, and so on that perform particular tasks or implement particular abstract data types. Computer system/server 12 may be practiced in distributed cloud computing environments where tasks are performed by remote processing devices that are linked through a communications network. In a distributed cloud computing environment, program modules may be located in both local and remote computer system storage media including memory storage devices.

[0101] As shown in Fig. 15, computer system/server 12 in cloud computing node 10 is shown in the form of a general-purpose computing device. The components of computer system/server 12 may include, but are not limited to, one or more processors or processing units 16, a system memory 28, and a bus 18 that couples various system components including system memory 28 to processor 16. Bus 18 represents one or more of any of several types of bus structures, including a memory bus or memory controller, a peripheral bus, an accelerated graphics port, and a processor or local bus using any of a variety of bus architectures. By way of example, and not limitation, such architectures include Industry Standard Architecture (ISA) bus, Micro Channel Architecture (MCA) bus, Enhanced ISA (EISA) bus, Video Electronics Standards Association (VESA) local bus, and Peripheral Component Interconnects (PCI) bus. Computer system/server 12 typically includes a variety of computer system readable media. Such media may be any available media that is accessible by computer system/server 12, and it includes both volatile and non-volatile media, removable and non-removable media.

[0102] System memory 28 can include computer system readable media in the form of volatile memory, such as random access memory (RAM) 30 and/or cache memory 32. Computer system/server 12 may further include other removable/non-removable, volatile/non-volatile computer system storage media. By way of example only, storage system 34 can be provided for reading from and writing to a non-removable, non-volatile magnetic media (not shown and typically called a "hard drive"). Although not shown, a

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magnetic disk drive for reading from and writing to a removable, non-volatile magnetic disk (e.g., a "floppy disk"), and an optical disk drive for reading from or writing to a removable, non-volatile optical disk such as a CD-ROM, DVD-ROM or other optical media can be provided. In such instances, each can be connected to bus 18 by one or more data media interfaces. As will be further depicted and described below, memory 28 may include at least one program product having a set (e.g., at least one) of program modules that are configured to carry out the functions of embodiments of the invention. Program/utility 40, having a set (at least one) of program modules 42, may be stored in memory 28 by way of example, and not limitation, as well as an operating system, one or more application programs, other program modules, and program data. Each of the operating system, one or more application programs, other program modules, and program data or some combination thereof, may include an implementation of a networking environment. Program modules 42 generally carry out the functions and/or methodologies of embodiments of the invention as described herein. Computer system/server 12 may also communicate with one or more external devices 14 such as a keyboard, a pointing device, a display 24, etc.; one or more devices that enable a user to interact with computer system/server 12; and/or any devices (e.g., network card, modem, etc.) that enable computer system/server 12 to communicate with one or more other computing devices. Such communication can occur via Input/Output (I/O) interfaces 22. Still yet, computer system/server 12 can communicate with one or more networks such as a local area network (LAN), a general wide area network (WAN), and/or a public network (e.g., the Internet) via network adapter 20. As depicted, network adapter 20 communicates with the other components of computer system/server 12 via bus 18. It should be understood that although not shown, other hardware and/or software components can be used in conjunction with computer system/server 12. Examples, include, but are not limited to: microcode, device drivers, redundant processing units, external disk drive arrays, RAID systems, tape drives, and data archival storage systems, etc.

[0103] Referring now to Fig. 16, illustrative cloud computing environment 50 is depicted. As shown, cloud computing environment 50 comprises one or more cloud computing nodes 10 with which local computing devices used by cloud consumers, such as, for example, personal digital assistant (PDA) or cellular telephone 54A, desktop computer 54B, laptop computer 54C, and/or automobile computer system 54N may communicate. Nodes 10 may communicate with one another. They may be grouped (not shown) physically or virtually, in one or more networks, such as Private, Community, Public, or Hybrid clouds as described hereinabove, or a combination thereof. This allows cloud computing

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environment 50 to offer infrastructure, platforms and/or software as services for which a cloud consumer does not need to maintain resources on a local computing device. It is understood that the types of computing devices 54A-N shown in Fig. 2 are intended to be illustrative only and that computing nodes 10 and cloud computing environment 50 can communicate with any type of computerized device over any type of network and/or network addressable connection (e.g., using a web browser).

[0104] Referring now to Fig. 17, a set of functional abstraction layers provided by cloud computing environment 50 (Fig. 2) is shown. It should be understood in advance that the components, layers, and functions shown in Fig. 3 are intended to be illustrative only and embodiments of the invention are not limited thereto. As depicted, the following layers and corresponding functions are provided: Hardware and software layer 60 includes hardware and software components. Examples of hardware components include mainframes, in one example IBM® zSeries® systems; RISC (Reduced Instruction Set Computer) architecture based servers, in one example IBM pSeries® systems; IBM xSeries® systems; IBM BladeCenter® systems; storage devices; networks and networking components. Examples of software components include network application server software, in one example IBM WebSphere® application server software; and database software, in one example IBM DB2® database software. (IBM, zSeries, pSeries, xSeries, BladeCenter, WebSphere, and DB2 are trademarks of International Business Machines Corporation registered in many jurisdictions worldwide). Virtualization layer 62 provides an abstraction layer from which the following examples of virtual entities may be provided: virtual servers; virtual storage; virtual networks, including virtual private networks; virtual applications and operating systems; and virtual clients. In one example, management layer 64 may provide the functions described below. Resource provisioning provides dynamic procurement of computing resources and other resources that are utilized to perform tasks within the cloud computing environment. Metering and Pricing provide cost tracking as resources are utilized within the cloud computing environment, and billing or invoicing for consumption of these resources. In one example, these resources may comprise application software licenses. Security provides identity verification for cloud consumers and tasks, as well as protection for data and other resources. User portal provides access to the cloud computing environment for consumers and system administrators. Service level management provides cloud computing resource allocation and management such that required service levels are met. Service Level Agreement (SLA) planning and fulfillment provide pre-arrangement for, and procurement of,

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cloud computing resources for which a future requirement is anticipated in accordance with an SLA.

[0105] Workloads layer 66 provides examples of functionality for which the cloud computing environment may be utilized. Examples of workloads and functions which may be provided from this layer include: mapping and navigation; software development and lifecycle management; virtual classroom education delivery; data analytics processing; transaction processing; and decision-support for problem solving using a question-answering system.

[0106] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.

[0107] The corresponding structures, materials, acts, and equivalents of all means or step plus function elements in the claims below are intended to include any structure, material, or act for performing the function in combination with other claimed elements as specifically claimed. The description of the embodiments herein has been presented for purposes of illustration and description, but is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the invention. The embodiment was chosen and described in order to best explain the principles of the invention and the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated.

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CLAIMS

What is claimed is:

1. A method comprising:

providing a decision-support system for problem solving, said system comprising software modules embodied on a computer readable medium, and said software modules comprising an input/output module and a question-answering module;

receiving problem case information using said input/output module;

generating a query based on said problem case information;

generating a plurality of answers for said query using said question-answering module;

calculating numerical values for multiple evidence dimensions from evidence sources for each of said answers using said question-answering module;

calculating a corresponding confidence value for each of said answers based on said numerical value of each evidence dimension using said question-answering module;

outputting said answers, said corresponding confidence values, and said numerical values of each evidence dimension for one or more selected answers using said input/output module.

2. The method according to claim 1, wherein said decision-support system further comprises a problem case analysis module and question generation module, and wherein said step of generating said query is carried out by steps comprising:

automatically analyzing said problem case information, using said problem case analysis module, in order to identify semantic concepts; and

automatically generating said query from said semantic concepts using said question generation module.

3. The method according to claim 2, wherein said steps of generating said query, generating said plurality of answers, calculating said numerical values for multiple evidence dimensions from evidence sources for each of said answers, and calculating said confidence value for each of said answers based on said numerical value of each evidence dimension are carried out automatically if new problem case information is received.

4. The method according to claim 3, further comprising:

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storing, in a repository, said plurality of answers, numerical values and confidence values generated automatically if new problem case information is received.

5. The method according to claim 1, wherein the step of generating said plurality of answers is carried out by analyzing domain knowledge content.

6. The method according to claim 5, further comprising:

storing, in a repository, said plurality of answers, numerical values and confidence values;

determining whether a plurality of previously generated answers and corresponding confidence values stored in said repository would change if new domain knowledge is added to said domain knowledge content; and

sending an alert using said input/output model if a change is determined.

7. The method according to claim 1, wherein said step of generating said query is carried out by steps comprising:

receiving said query through said input/output module in a form of at least one of a free-form query, a free-form statement, and keyword search.

8. The method according to claim 7, wherein said decision-support system further comprises a problem case analysis module and question generation module, the method further comprising:

automatically analyzing said problem case information, using said problem case analysis module, in order to identify semantic concepts; and

expanding said query using said semantic concepts using said question generation module.

9. The method according to claim 1, further comprising:

outputting, for a selected evidence dimension, each piece of evidence supporting said selected evidence dimension and an associated provenance for said piece of evidence.

10. The method according to claim 9, further comprising:

removing a selected piece of evidence from said evidence sources contributing to a numerical value of an evidence dimension;

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recalculating, using said question-answering module, said numerical value of said evidence dimension having said selected piece of evidence removed; and

recalculating a new confidence value of an answer based on said recalculated numerical value using said question-answering module.

11. The method according to claim 1, further comprising:

identifying, using said question-answering module, information relevant to said answers that is not contained within said problem case information as missing information; and

outputting a request to add said missing information to said problem case information.

12. The method according to claim 11, further comprising:

identifying, using said question-answering module, an amount said missing information affects corresponding confidence values of answers.

13. A system comprising:

a first repository maintaining problem case information;

a computer processor operatively connected to said first repository; and

a second repository operatively connected to said computer processor,

said computer processor configured to receive said problem case information from said first repository;

said computer processor configured to generate a query based on said problem case information;

said computer processor configured to generate a plurality of answers for said query;

said computer processor configured to calculate numerical values for multiple evidence dimensions from evidence sources for each of said answers;

said computer processor configured to calculate corresponding confidence values for each of said answers based on said numerical values of each evidence dimension; and

said computer processor configured to output said queries, said answers, said corresponding confidence values, and said numerical values of each evidence dimension to said second repository.

14. The system according to claim 13, wherein said configuration of said computer processer to generate a query based on said problem case information is carried out by

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configuring said computer processor to analyze said problem case information in order to identify semantic concepts and generate said query from said semantic concepts.

15. The system according to claim 14, wherein said computer processor is further configured to automatically generate said query, automatically generate said plurality of answers, automatically calculate said numerical values for multiple evidence dimensions from evidence sources for each of said answers, and automatically calculate said confidence value for each of said answers based on said numerical value for each evidence dimension if new problem case information is received.

16. The system according to claim 13, further comprising a third repository for maintaining domain knowledge content, wherein said configuration of said computer processor to generate said plurality of answers is carried out by configuring said computer processor to analyze said domain knowledge content.

17. The system according to claim 16, wherein said computer processor is further configured to determine whether a plurality of previously generated answers and corresponding confidence values stored in said second repository would change if new domain knowledge is added to said domain knowledge content stored in said third repository and wherein said computer processor is further configured to send an alert if a change is determined.

18. The system according to claim 13, wherein said configuration of said computer processor to generate said query is carried out by configuring said computer processor to receive said query as an input in a form of at least one of a free-form query, a free-form statement, and keyword search.

19. The system according to claim 13, wherein said computer processor is further configured to output a piece of evidence supporting a selected evidence dimension and an associated provenance for said piece of evidence.

20. The system according to claim 19, wherein said computer processor is further configured to remove a selected piece of evidence from said evidence sources contributing to a numerical value of an evidence dimension, recalculating said numerical value of said

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evidence dimension having said selected piece of evidence removed, and recalculating a new confidence value of an answer based on said recalculated numerical value.

21. The system according to claim 13, wherein said computer processor is further configured to identify information relevant to said answers that is not contained within said problem case information as missing information and output a request to add said missing information to said problem case information.

22. The system according to claim 21, wherein said computer processor is further configured to identify an amount said missing information affects corresponding confidence values of answers.

23. A computer program product comprising a computer readable storage medium storing computer readable program code comprising instructions executable by a computerized device, said computer program code comprising:

an input/output module receiving problem case information;

a problem case analysis module analyzing said problem case information in order to identify semantic concepts;

a question generation module generating a query from said semantic concepts; and

a question-answering module generating a plurality of answers for said query,

said question-answering module calculating numerical values for multiple evidence dimensions from evidence sources for each of said answers,

said question-answering module calculating corresponding confidence values for each of said answers based on said numerical value of each evidence dimension using said question-answering module, and

said input/output module outputting said queries, said answers, said corresponding confidence values, and said numerical values for multiple evidence dimensions.

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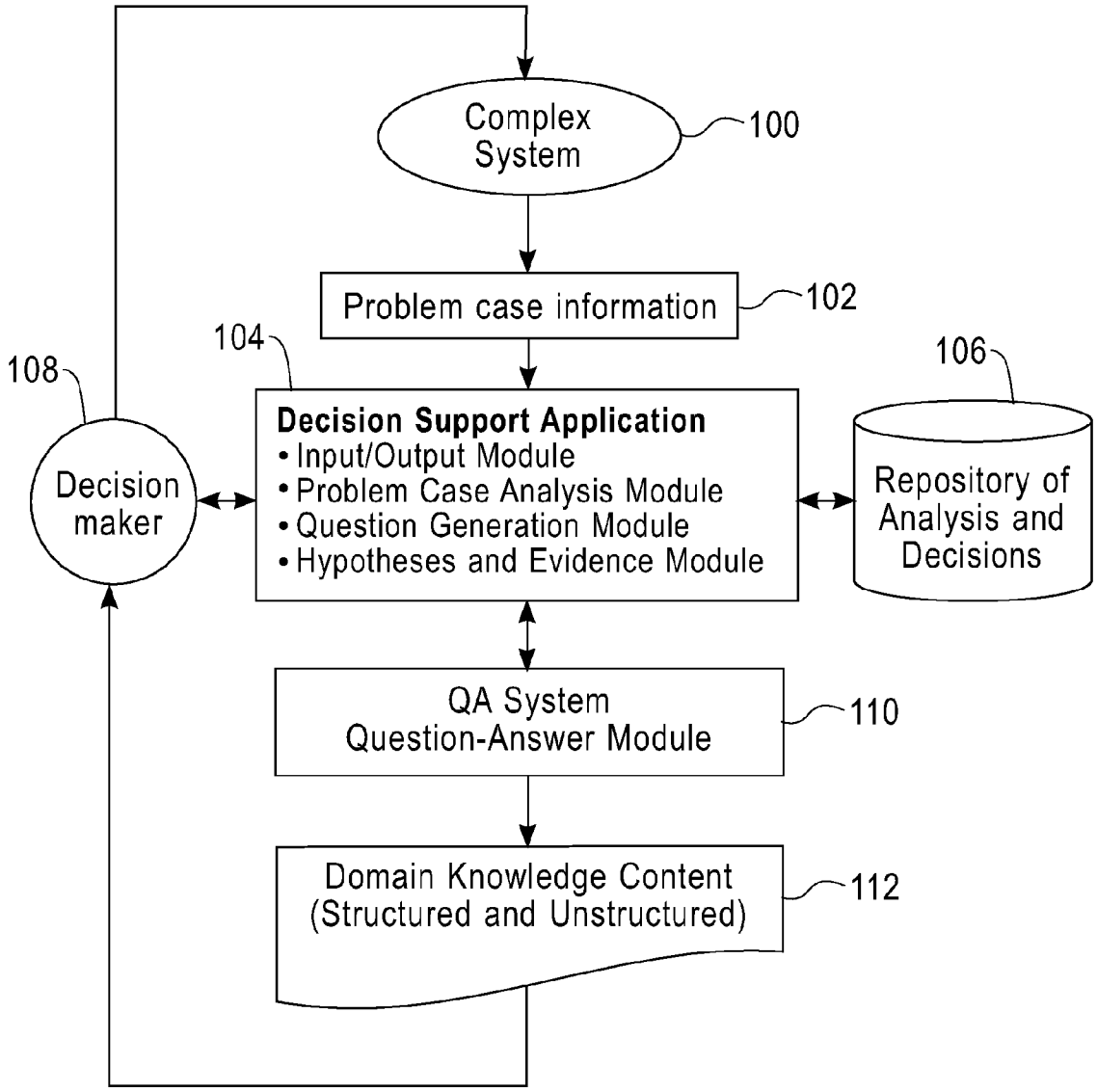

FIG. 1

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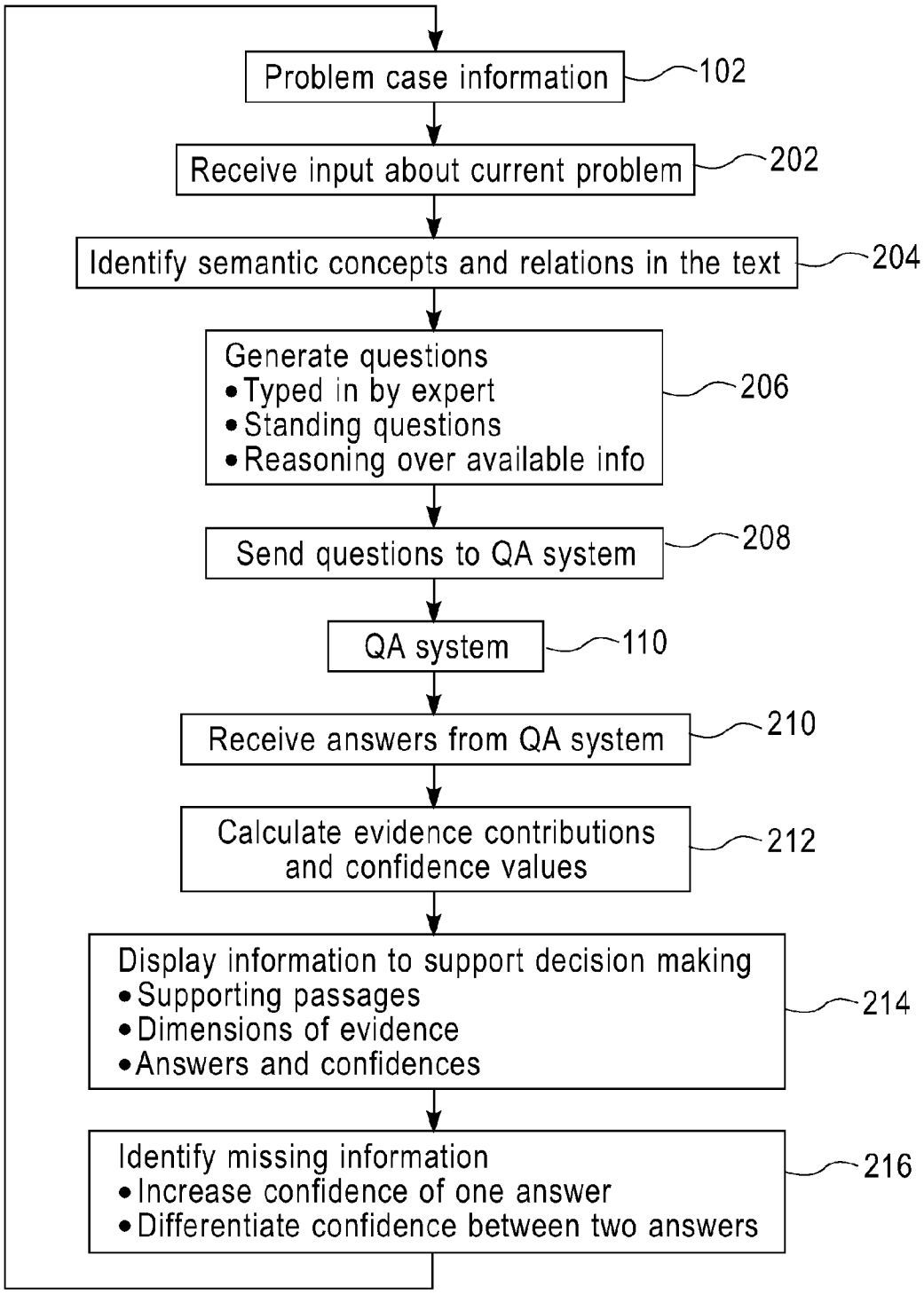

FIG. 2

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

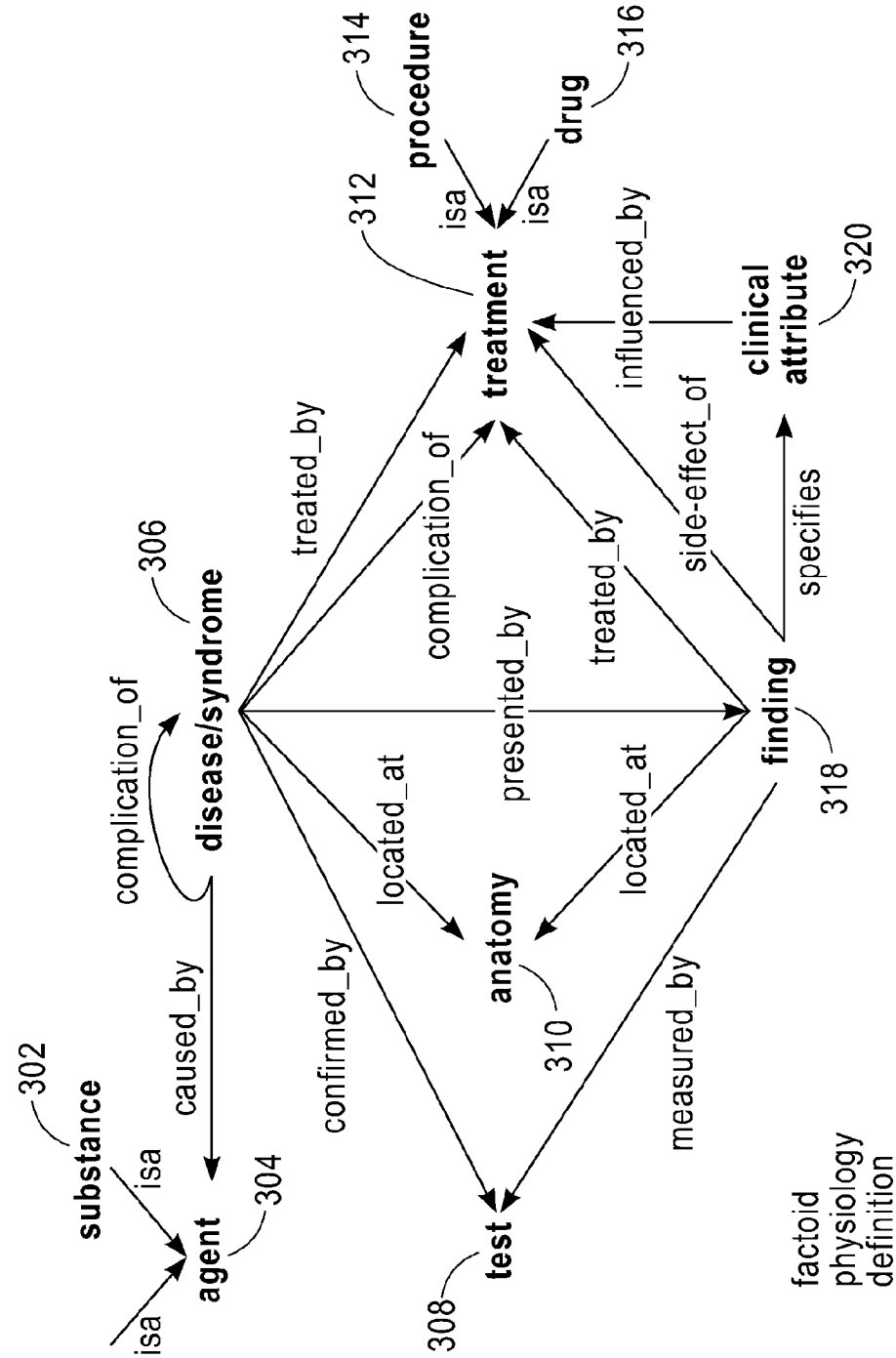
substance
302
isa
agent
304
caused_by
complication_of
disease/syndrome
306
confirmed_by
test
308
located_at
anatomy
310
presented_by
treated_by
treatment
312
procedure
314
isa
drug
316
isa
complication_of
influenced_by
side-effect_of
clinical attribute
320
specifies
finding
318
located_at
measured_by
factoid
physiology
definition
guideline

FIG. 3

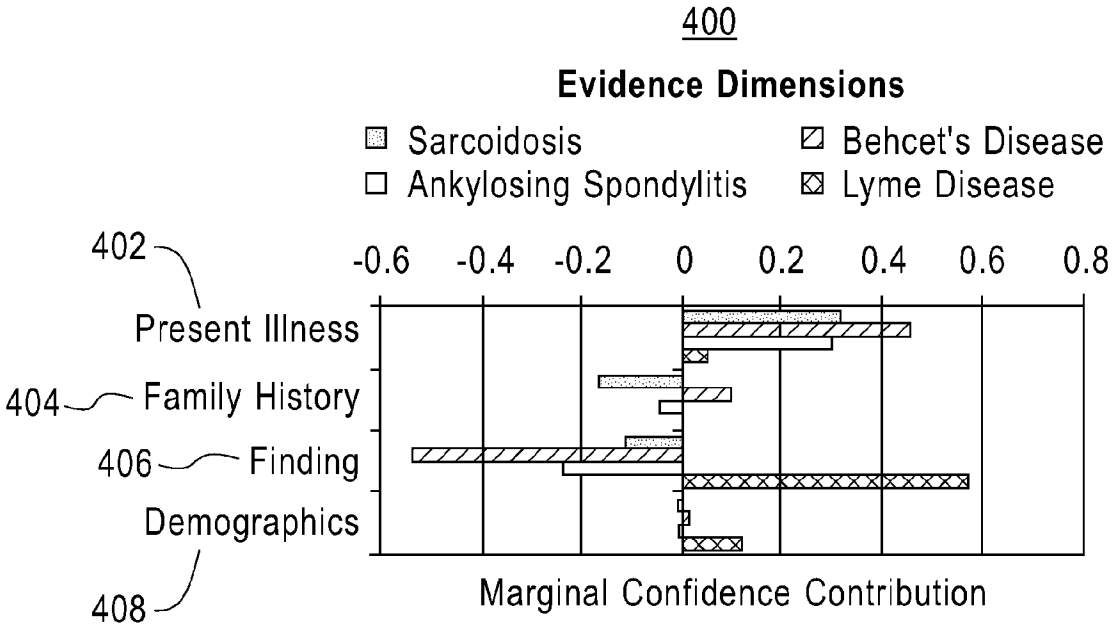

FIG. 4

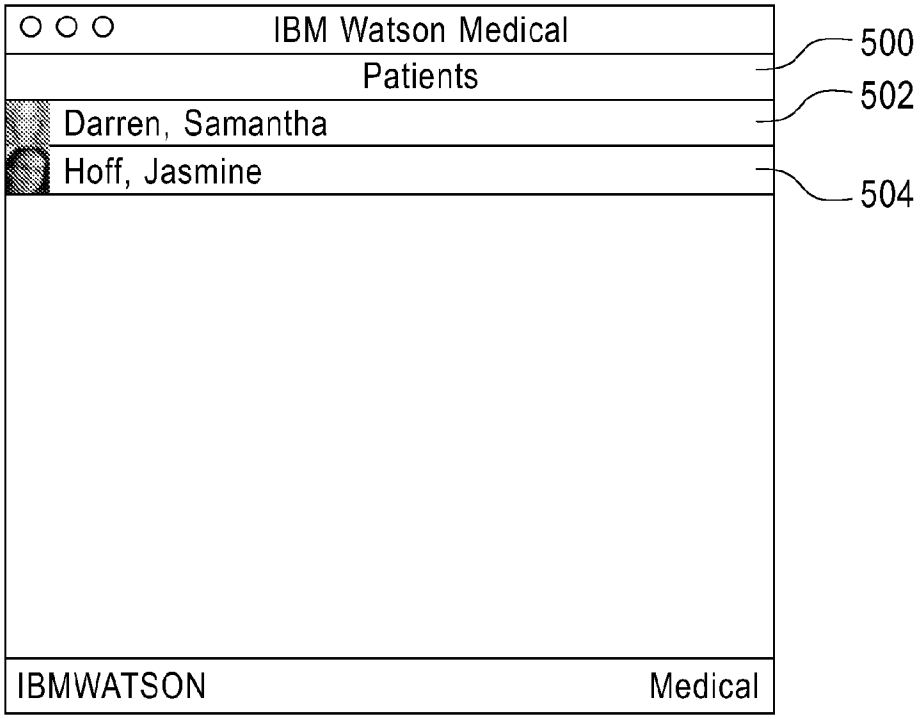

FIG. 5

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BMJ Publishing Group v. Evidium

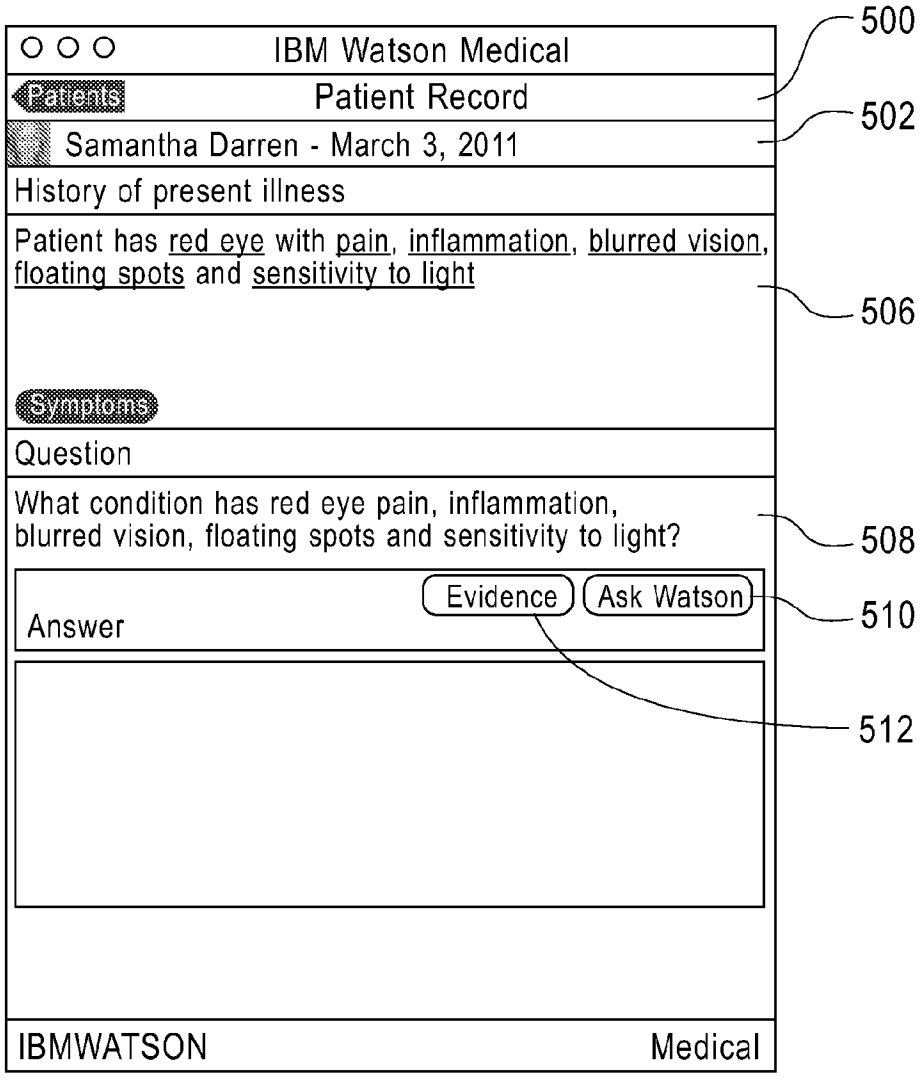
IBM Watson Medical
Patients
Patient Record
Samantha Darren - March 3, 2011
History of present illness
Patient has red eye with pain, inflammation, blurred vision, floating spots and sensitivity to light
Symptoms
Question
What condition has red eye pain, inflammation, blurred vision, floating spots and sensitivity to light?
Evidence
Ask Watson
Answer
IBMWATSON
Medical
500
502
506
508
510
512

FIG. 6

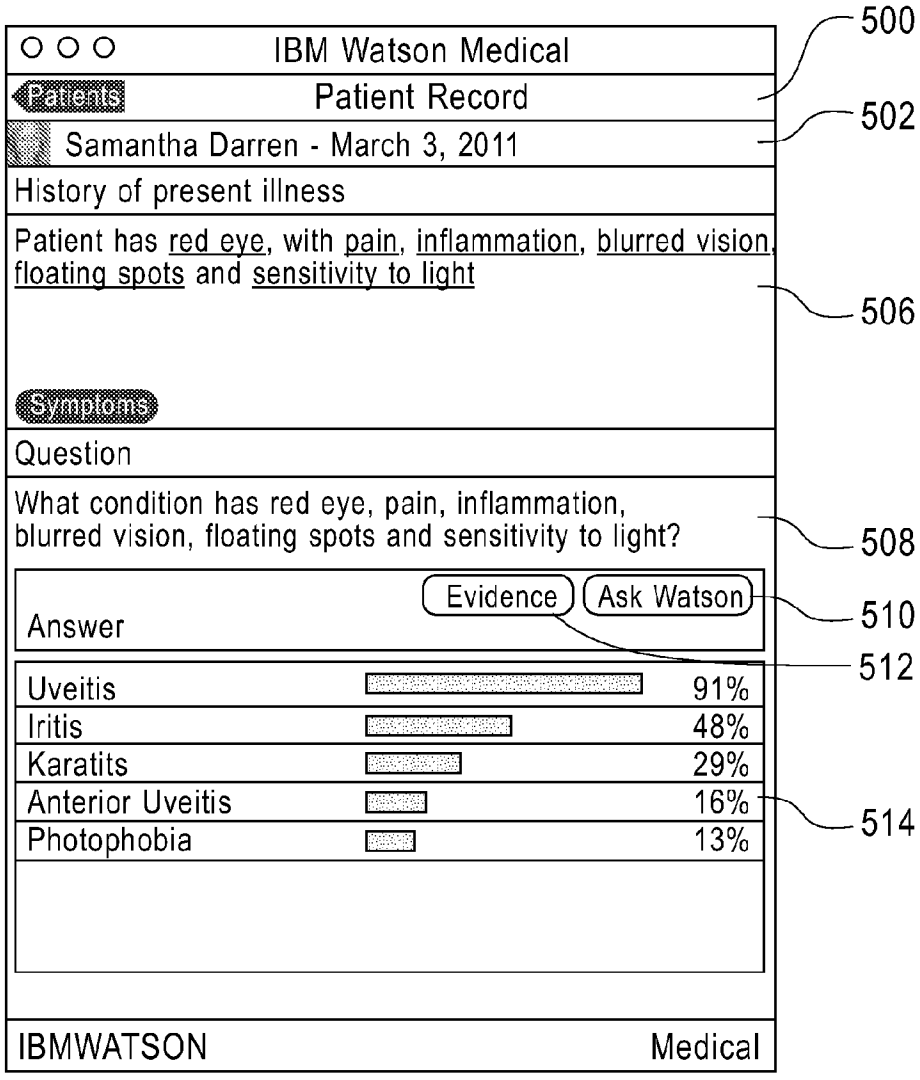
IBM Watson Medical
Patients
Patient Record
Samantha Darren - March 3, 2011
History of present illness
Patient has red eye, with pain, inflammation, blurred vision, floating spots and sensitivity to light
Symptoms
Question
What condition has red eye, pain, inflammation, blurred vision, floating spots and sensitivity to light?
Evidence
Ask Watson
Answer
Uveitis 91%
Iritis 48%
Karatits 29%
Anterior Uveitis 16%
Photophobia 13%
IBMWATSON Medical
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FIG. 7

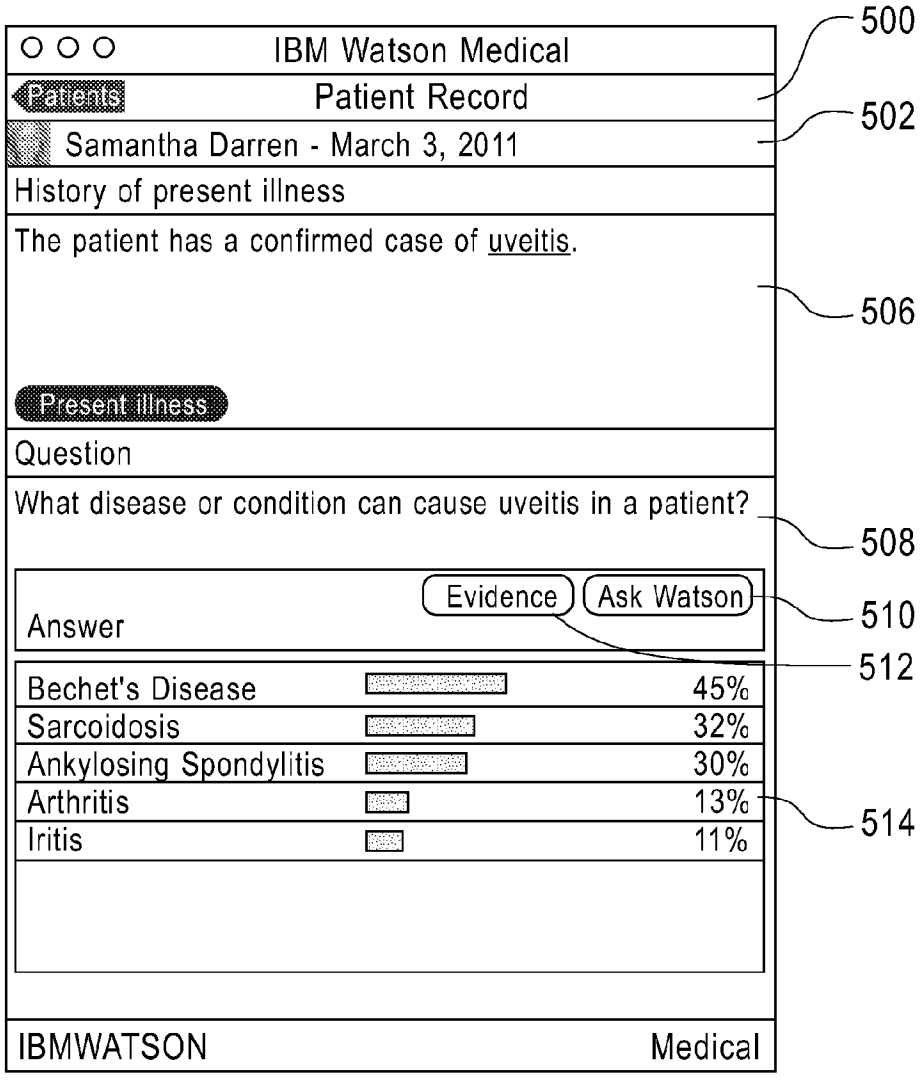
IBM Watson Medical
Patients
Patient Record
Samantha Darren - March 3, 2011
History of present illness
The patient has a confirmed case of uveitis.
Present illness
Question
What disease or condition can cause uveitis in a patient?
Evidence
Ask Watson
Answer
Bechet's Disease 45%
Sarcoidosis 32%
Ankylosing Spondylitis 30%
Arthritis 13%
Iritis 11%
IBMWATSON Medical
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FIG. 8

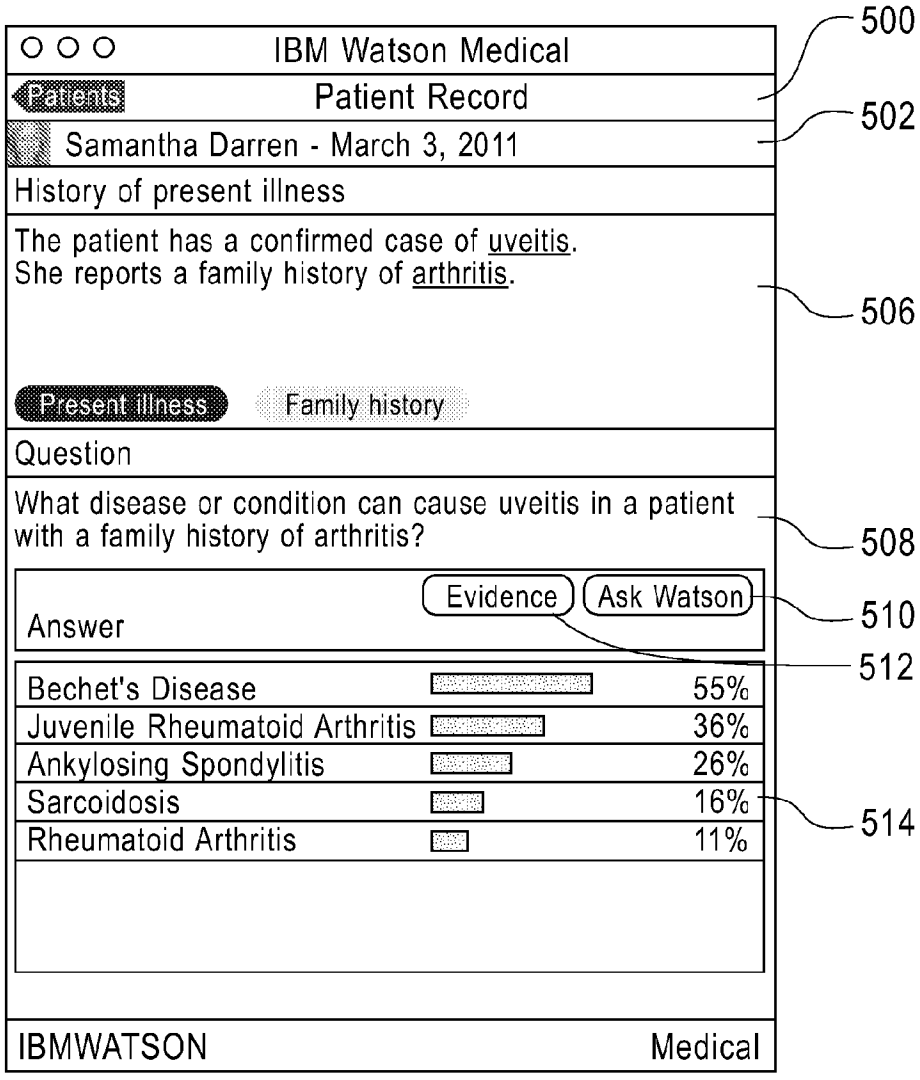
IBM Watson Medical
Patients
Patient Record
Samantha Darren - March 3, 2011
History of present illness
The patient has a confirmed case of uveitis.
She reports a family history of arthritis.
Present illness
Family history
Question
What disease or condition can cause uveitis in a patient with a family history of arthritis?
Evidence
Ask Watson
Answer
Bechet's Disease 55%
Juvenile Rheumatoid Arthritis 36%
Ankylosing Spondylitis 26%
Sarcoidosis 16%
Rheumatoid Arthritis 11%
IBMWATSON Medical
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FIG. 9

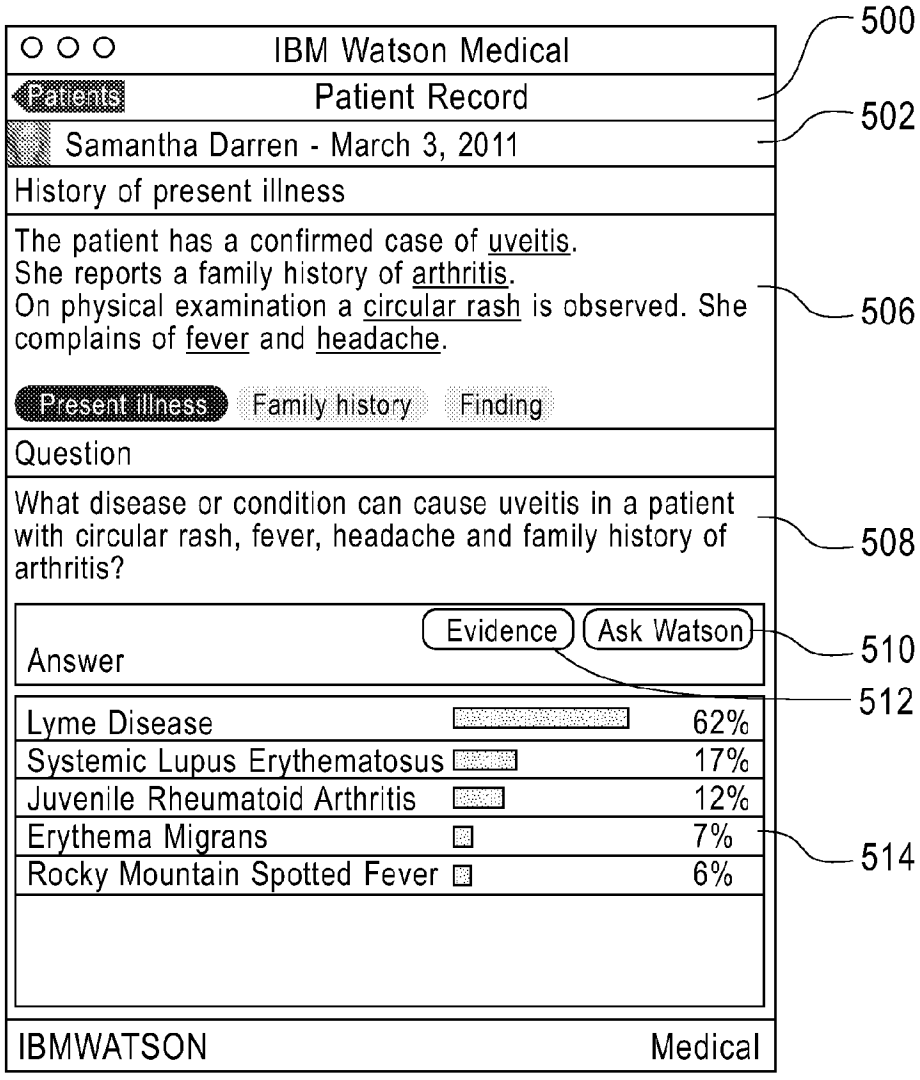
IBM Watson Medical
Patients
Patient Record
Samantha Darren - March 3, 2011
History of present illness
The patient has a confirmed case of uveitis.
She reports a family history of arthritis.
On physical examination a circular rash is observed. She complains of fever and headache.
Present illness
Family history
Finding
Question
What disease or condition can cause uveitis in a patient with circular rash, fever, headache and family history of arthritis?
Evidence
Ask Watson
Answer
Lyme Disease 62%
Systemic Lupus Erythematosus 17%
Juvenile Rheumatoid Arthritis 12%
Erythema Migrans 7%
Rocky Mountain Spotted Fever 6%
IBMWATSON Medical
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FIG. 10

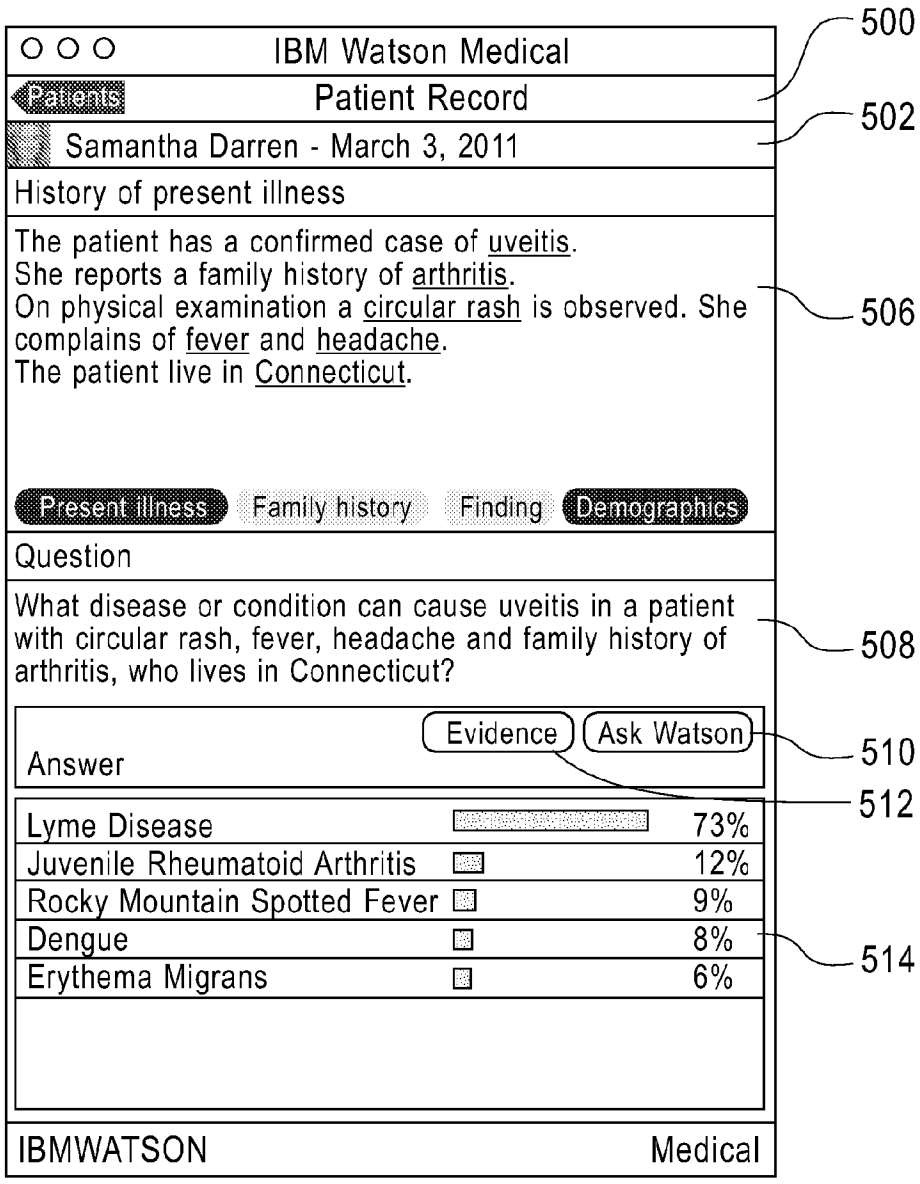

FIG. 11

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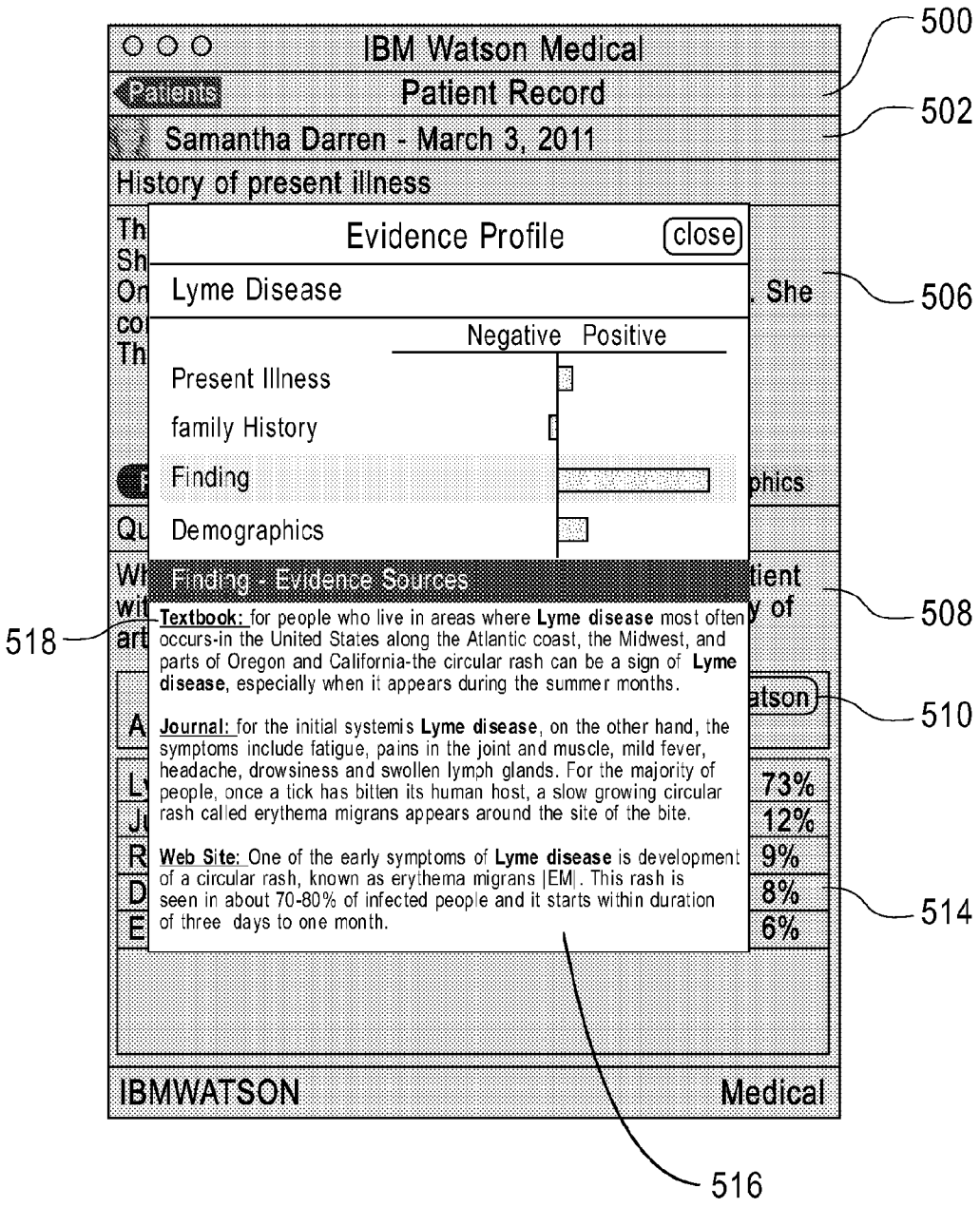

FIG. 12

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

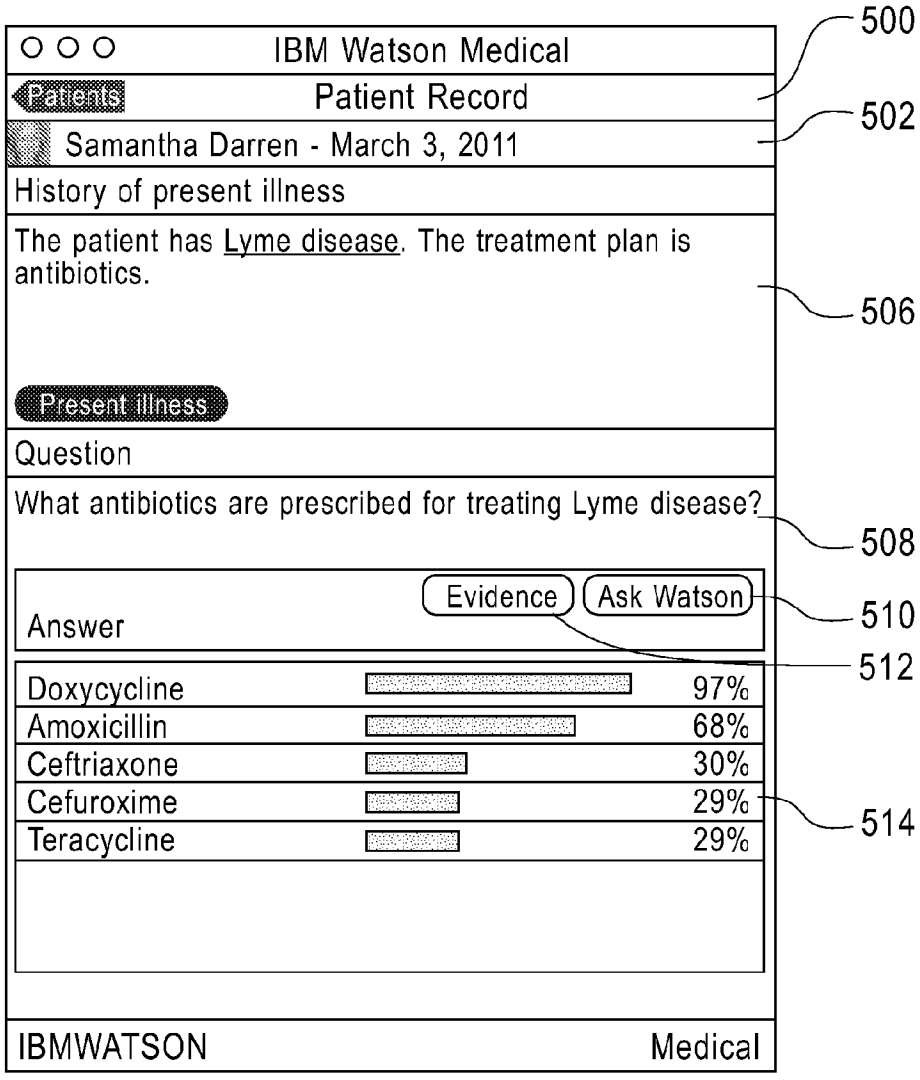
IBM Watson Medical
Patients
Patient Record
Samantha Darren - March 3, 2011
History of present illness
The patient has Lyme disease. The treatment plan is antibiotics.
Present illness
Question
What antibiotics are prescribed for treating Lyme disease?
Evidence
Ask Watson
Answer
Doxycycline 97%
Amoxicillin 68%
Ceftriaxone 30%
Cefuroxime 29%
Teracycline 29%
IBMWATSON Medical
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FIG. 13

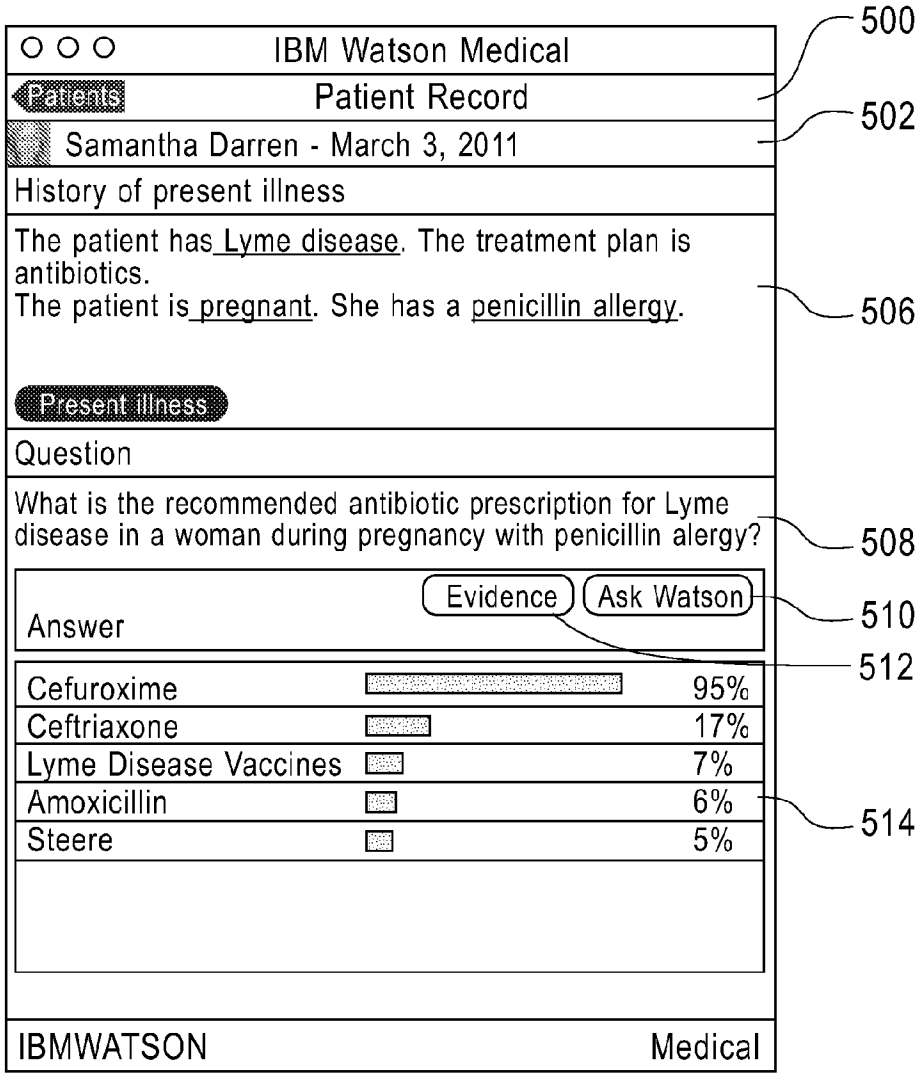
IBM Watson Medical
Patients
Patient Record
Samantha Darren - March 3, 2011
History of present illness
The patient has Lyme disease. The treatment plan is antibiotics.
The patient is pregnant. She has a penicillin allergy.
Present illness
Question
What is the recommended antibiotic prescription for Lyme disease in a woman during pregnancy with penicillin alergy?
Evidence
Ask Watson
Answer
Cefuroxime 95%
Ceftriaxone 17%
Lyme Disease Vaccines 7%
Amoxicillin 6%
Steere 5%
IBMWATSON Medical
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FIG. 14

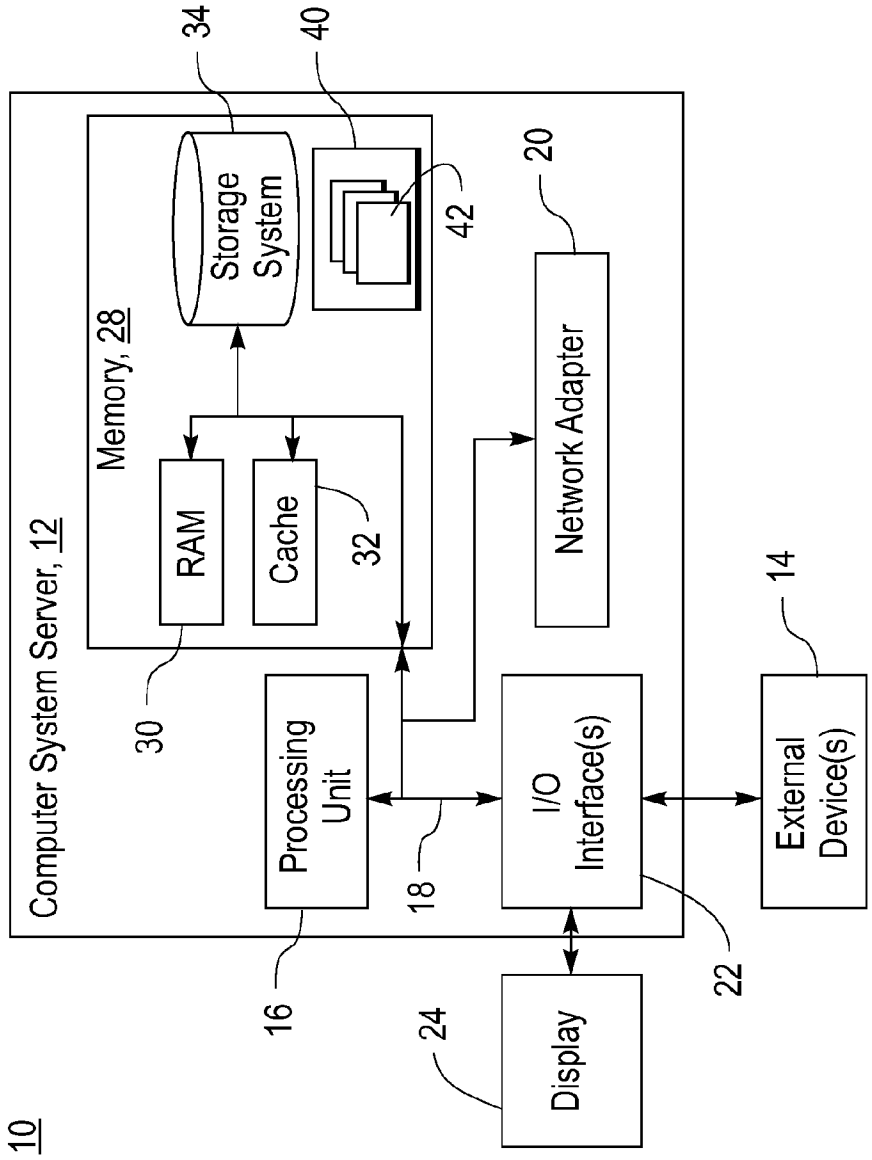

FIG. 15

BMJ Publishing Group Ex. 1014
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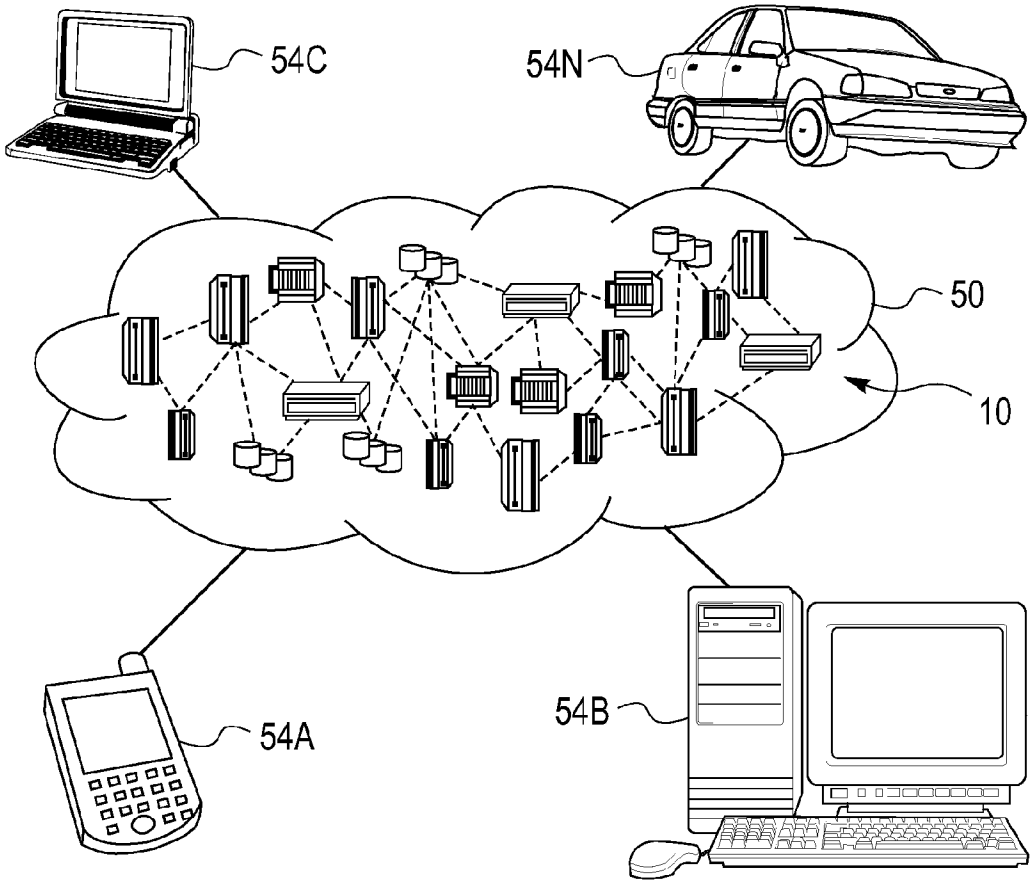

FIG. 16

BMJ Publishing Group Ex. 1014
BMJ Publishing Group v. Evidium

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2012/027942

A. CLASSIFICATION OF SUBJECT MATTER
INV. G06F19/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011/004588 A1 (LEITERSDORF AMIR [IL] ET AL) 6 January 2011 (2011-01-06) paragraph [0018] - paragraph [0072] figures 1,2	1-23
A	US 2011/055240 A1 (LI HAN YU [CN] ET AL) 3 March 2011 (2011-03-03) paragraph [0025] - paragraph [0095]	1-23
A	US 2008/201280 A1 (MARTIN HUBER [DE] ET AL) 21 August 2008 (2008-08-21) figure 3	1,13,23

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

"L" documentwhioh may throw doubts on priority olaimfs) orwhioh is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 August 2012	21/08/2012

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Rinelli, Pietro

1

Form PCT/ISA/210 (second sheet) (April 2005)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2012/027942

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2011004588 A1	06-01-2011	NONE	
US 2011055240 A1	03-03-2011	CN 101996208 A	30-03-2011
		US 2011055240 A1	03-03-2011
US 2008201280 A1	21-08-2008	NONE	

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DocCode - SCORE

Placeholder Sheet for Supplemental Content

Application Number: 19092400 Document Date: 03/27/2025

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