

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

MICROSOFT CORPORATION,
Petitioner,

v.

REALD SPARK, LLC,
Patent Owner.

Case No. IPR2023-01046

Patent No. 10,740,985

Before JEAN R. HOMERE, CHARLES J. BOUDREAU, and
CHRISTOPHER L. OGDEN, *Administrative Patent Judges*.

PETITIONER'S REPLY TO

PATENT OWNER'S RESPONSE TO PETITION

U.S. PATENT NO. 10,740,985 (CLAIMS 1-14 AND 16-19)

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EXHIBIT LIST (NEW EXHIBITS IN ITALICS)

EXHIBITS FILED BY PETITIONER	
EX-1001	U.S. Patent No. 10,740,985 to Eric Sommerlade and Alexandros Neophytou (“’985 Patent”)
EX-1002	Patent Prosecution History of U.S. Patent No. 10,740,985
EX-1003	Declaration of L. Karam Regarding Invalidity of U.S. Patent No. 10,740,985
EX-1004	Curriculum Vitae of Lina Karam
EX-1005	U.S. Patent No. 10,664,949 to Edmond Chalom and Or Shimshi (“Chalom”)
EX-1006 (corrected 3/4/24)	Ganin <i>et al.</i> “Deepwarp: Photorealistic image resynthesis for gaze manipulation.” In <i>ECCV 2016: 14th European Conference on Computer Vision, Amsterdam, The Netherlands, October 11-14, 2016</i> . Archived at https://web.archive.org/web/20170329084730/http://sites.skoltech.ru/compvision/projects/deepwarp/files/deepwarp_eccv2016.pdf (“Ganin”)
EX-1007	U.S. Patent Application Publication No. 2017/0132528 A1 to Aslan <i>et al.</i> (“Aslan”)
EX-1008	Webpage printout at https://link.springer.com/chapter/10.1007/978-3-319-46475-6_20 (DeepWarp: Photorealistic Image Resynthesis for Gaze Manipulation)

EX-1009	U.S. Patent Application Publication No. 2018/0158246 A1 to Oliver Grau and Daniel Pohl (“Grau”)
EX-1010	U.S. Patent No. 8,942,283 to Charles P. Pace (“Pace”)
EX-1011	U.S. Provisional Application No. 62/542,661 filed August 8, 2017 (“661 Prov. Appl.”)
EX-1012	U.S. Provisional Application No. 62/543,587 filed August 10, 2017 (“587 Prov. Appl.”)
EX-1013	Prosecution of European Patent Application No. 18844651
EX-1014	[Reserved]
EX-1015	[Reserved]
EX-1016	Liu <i>et al.</i> “Optical flow and principal component analysis-based motion detection in outdoor videos.” <i>Eurasip Journal on Advances in Signal Processing</i> , volume 2010, article id 680623, 6 pages, 2010. Hindawi Publishing Corporation. (“Liu”)
EX-1017	Webpage printout at https://www.reald.com/privacypolicy (RealD Privacy Policy)
EX-1018	Webpage printout at https://web.archive.org/web/20161231162955/https://www.skoltech.ru/en/2016/11/ckolteh-litsenziroval-tehnologiyu-obespecheniya-zritel'nogo-kontakta-v-videokonferentsiyah-v-

	kompaniyu-reald/ (Skoltech Licenses Eye Contact Videoconferencing Technology to RealD)
EX-1019	Kononenko, Daniil. “Learnable Warping-Based Approach To Image Re-Synthesis With Application to Gaze Redirection.” (2017): 1-131. (Kononenko Doctoral Thesis)
EX-1020	Sotera Stipulation
EX-1021	Yang <i>et al.</i> “Eye gaze correction with stereovision for video-teleconferencing.” <i>ECCV 2002: 7th European Conference on Computer Vision, Copenhagen, Denmark, May 28–31, 2002, Proceedings, Part II</i> (pp. 479-494). Springer Berlin Heidelberg, 2002. (“Yang”)
EX-1022	Cham <i>et al.</i> “Analogous view transfer for gaze correction in video sequences.” <i>7th International Conference on Control, Automation, Robotics and Vision, Singapore, December 2-5, 2002, Proceedings</i> (pp. 1415-1420). IEEE Xplore. (“Cham”)
EX-1023	Webpage printout at: https://ieeexplore.ieee.org/abstract/document/1234980 (Analogous view transfer for gaze correction in video sequences)
EX-1024	Wood <i>et al.</i> “Gazedirector: Fully articulated eye gaze redirection in video.” <i>arXiv: 1704.08763v1 [cs.CV]</i> , 27 April 2017.
EX-1025	Zitnick <i>et al.</i> “Manipulation of video eye gaze and head orientation for video teleconferencing.” <i>Technical Report MSR-TR-99-46, Microsoft Research, 16 June 1999.</i>

EX-1026	Webpage printout at: https://www.microsoft.com/en-us/research/publication/manipulation-of-video-eye-gaze-and-head-orientation-for-video-teleconferencing/ (Manipulation of Video Eye Gaze and Head Orientation for Video Teleconferencing – Microsoft Research)
EX-1027	Gemmell <i>et al.</i> “Gaze awareness for video-conferencing: A software approach.” <i>IEEE Multimedia</i> , volume 7, issue 4, October-December 2000 (pp. 26-35). (“Gemmell”)
EX-1028	Kononenko <i>et al.</i> “Learning to look up: Realtime monocular gaze correction using machine learning.” <i>CVPR 2015: IEEE/CVF Conference on Computer Vision and Pattern Recognition</i> , Boston, MA, USA, 7-12 June 2015 (pp. 4667-4675). (“Kononenko”)
EX-1029	Webpage printout at: https://github.com/BlueWinters/DeepWarp (GitHub - BlueWinters_DeepWarp_ Tensorflow implement for DeepWarp)
EX-1030	Aleš Hladnik, “Image Compression and Face Recognition: Two Image Processing Applications of Principal Component Analysis.” <i>International Circular of Graphic Education and Research</i> , No. 6, January 2013 (pp. 56-61).
EX-1031	Complaint: <i>RealD Spark, LLC v. Microsoft Corporation</i> , WDWA-2-22-cv-00942, Dkt. 1.
EX-1032	Hinton <i>et al.</i> Distilling the Knowledge in a Neural Network, arXiv:1503.02531v1 [stat.ML], March 2015. (“Hinton”)
EX-1033	C. Bucilua, R. Caruana, and A. Niculescu-Mizil. “Model Compression.” <i>KDD 2006: In Proceedings of the 12th ACM SIGKDD International Conference on Knowledge</i>

	<i>Discovery and Data Mining, (KDD), Philadelphia, PA, USA, August 20-23, pages 535–541, 2006 (pp. 535–541). (“Bucilua”)</i>
EX-1034	[Reserved]
EX-1035	Fleet <i>et al.</i> , “Design and Use of Linear Models for Image Motion Analysis.” <i>International Journal of Computer Vision</i> , volume 36, issue 3, 2000 (pp. 171-193). Kluwer Academic Publishers. (“Fleet”)
EX-1036	Wulff <i>et al.</i> “Efficient Sparse-to-Dense Optical Flow Estimation using a Learned Basis and Layers.” <i>CVPR 2015: IEEE/CVF Conference on Computer Vision and Pattern Recognition, Boston, MA, USA, 7-12 June 2015 (pp. 120-130). (“Wulff”)</i>
EX-1037	Burt <i>et al.</i> “A Multiresolution Spline With Application to Image Mosaics.” <i>ACM Transactions on Graphics</i> , volume 2, issue 4, October 1983 (pp. 217-236). (“Burt”)
EX-1038	Giger <i>et al.</i> , “Gaze correction with a single webcam.” <i>ICME 2014: IEEE International Conference on Multimedia and Expo, Chengdu, China, July 14-18, 2014. (“Giger”)</i>
EX-1039	Ho <i>et al.</i> “Gaze correction using 3D video processing for videoconferencing.” <i>ChinaSIP 2015: China Summit and International Conference on Signal and Information Processing, Chengdu, China, July 12-15, 2015 (pp. 496-499). (“Ho”)</i>
EX-1040	Jain. <i>Fundamentals of Digital Image Processing</i> . Prentice-Hall, Inc., 1989 (excerpted). (“Jain”)

EX-1041	Vetterli <i>et al.</i> Wavelets and Subband Coding. Prentice-Hall, Inc., 1995 (excerpted). (“Vetterli”)
EX-1042	Dodge and Karam. Introduction to Machine Learning and Deep Learning: A Hands-On Starter’s Guide, 2017; revised 2019. Available online at https://deeplearningtextbook.org/ . (“Dodge”)
EX-1043	Goodfellow <i>et al.</i> Deep Learning, MIT Press, 2016. Available online at https://www.deeplearningbook.org/ (excerpted). (“Goodfellow”)
EX-1044	Murphy. Machine Learning: A Probabilistic Perspective, MIT Press, 2012. (“Murphy”)
EX-1045	Sonka <i>et al.</i> Image Processing, Analysis, and Machine Vision, 4 th edition, Cengage Learning, 2015.
EX-1046	U.S. Patent No. 10,043,088 (“Odry”)
EX-1047	Microsoft Computer Dictionary, fourth edition, 1999 (excerpted)
EX-1048	Internet Archive affidavit w exhibits
EX-1049	[Reserved]
EX-1050	Webpage printout at: https://link.springer.com/book/10.1007/978-3-319-46475-6 (Webpage Computer Vision – ECCV 2016)

EX-1051	Webpage printout at: https://asp-urasipjournals.springeropen.com/articles/10.1155/2010/680623 (SpringerOpen, Liu)
EX-1052	Webpage printout at: https://dl.acm.org/doi/abs/10.1155/2010/680623# (ACM, Liu)
EX-1053	U.S. Patent No. 9,338,449 to Joel Sole Rojals, Rajan Laxman Joshi, and Marta Karczewicz (“Rojals”)
EX-1054	U.S. Patent Application Publication No. 2008/0043833 A1 to Jane Perera and Joseph D. Young (“Perera”)
EX-1055	Joint Claim Construction and Prehearing Statement: <i>RealD Spark, LLC v. Microsoft Corporation</i> , WDWA-2-22-cv-00942, Dkt. 59.
EX-1056	George Wolberg, Digital Image Warping, IEEE Computer Society Press, 1990.
EX-1057	Webpage printout at: https://ieeexplore.ieee.org/document/7299098 (Learning to look up: Realtime monocular gaze correction using machine learning)
EX-1058	Webpage printout at: https://ieeexplore.ieee.org/document/6890306 (Gaze correction with a single webcam)
EX-1059	<i>U.S. Patent No. 11,523,004 to Darrel Cherry, Renee Jessome, Richard Maggard, Daniel Siddall, Yeshwanth Raja, and Eli Saber</i>

<i>EX-1060</i>	<i>Sharma et al. Convolutional Neural Network Compression via Dynamic Parameter Rank Pruning, arXiv:2401.08014v1 [cs.CV], January 2024.</i>
<i>EX-1061</i>	<i>Deposition Transcript of Dr. Eli Saber dated June 5, 2024</i>
<i>EX-1062</i>	<i>Continued Deposition Transcript of Dr. Eli Saber dated June 7, 2024 (continuation of the Deposition Transcript on June 5, 2024)</i>

I. INTRODUCTION

The Petition (Paper 1, “Pet.”) demonstrated unpatentability of challenged claims 1-14 and 16-19 based on Ganin and based on a combination of Chalom and Aslan. The arguments presented in Patent Owner’s Response (Paper 12, “POR”) fail to undermine the Petition’s unpatentability showings.

Patent Owner’s arguments with respect to the Ganin-based grounds are based on imagining claim requirements that do not exist. For example, PO argues that Ganin discloses only one machine-learning algorithm (MLA), because it discloses only one set of training data and one objective function. But that does not matter. The challenged claims of the ’985 Patent use only one set of training data and do not mention objective functions (let alone place a restriction on how many objective functions might be utilized), and the prior-art Aslan reference expressly teaches use of one objective function and one set of training data for two MLAs. *Infra* Sections II.A.1-II.A.2. PO also supposes that Ganin’s use of an “end-to-end architecture” for training its two different MLAs (coarse and fine warping modules) collapses these two MLAs into one. Not so. That semantic position is inconsistent with (i) other portions of Ganin that use the plural form “architectures” to refer to these same modules (Ex-1006, 17), (ii) Ganin’s inclusion of a lightness-correction neural network (i.e., one more MLA) in that same architecture, and (iii) the prior art demonstrating that joint training (as in Aslan)

does not somehow turn two models into one. *Infra* Section II.A.3.

With respect to the Chalom-Aslan grounds, PO spilled much ink on the motivation to combine Chalom and Aslan—focusing on allegations that Chalom solved the accuracy and efficiency problems, thereby allegedly eliminating any need to look at Aslan. But that ink was wasted. Chalom repeatedly indicates that its techniques “may” address various goals, and never suggests that it had delivered a perfect solution subject to no further improvement whatsoever. *Infra* Section III.A.3. Moreover, PO’s expert explained at his deposition that (i) Chalom expressly directs a PHOSITA¹ to look to literature for suitable compression algorithms and (ii) Aslan discloses a compression algorithm that could have compressed Chalom’s random forest. Ex-1061, 187:15-24; Ex-1062, 239:16-22. Those concessions alone dispose of PO’s anti-motivation positions—an express motivation existed that would have led a PHOSITA directly to Aslan. *Infra* Section III.A.1. While PO also alleges certain gaps in the combined Chalom-Aslan system, those allegations overlook the Petition’s detailed showings as to the combined system and, in any event, are immaterial as the Chalom-Aslan combination is certainly “suitable” and need not be the “best” system to

¹ Aspects of the record use the acronym “POSITA,” which is interchangeably used herein alongside the acronym “PHOSITA.”

demonstrate obviousness. *Intel Corp. v. PACT XPP Schweiz AG*, 61 F.4th 1373, 1380 (Fed. Cir. 2023) (noting that it is “not necessary to show that a combination is the *best* option, only that it be a *suitable* option.”). *Infra* Section III.A.

Petitioner has carried its burden and the Board should, therefore, cancel challenged claims 1-14 and 16-19.

II. GANIN ANTICIPATES CLAIMS 1-3, 5, 10, 12-14, 18 (GROUND 1)

A. Ganin discloses two MLAs

To argue that Ganin allegedly has only one MLA, PO presents two arguments seeking to add requirements to the claims that do not exist: (1) each MLA must have its own objective function, and (2) one training data set means there is only one MLA. PO’s third argument is a semantic one around Ganin’s use of the singular form, which is inconsistent with Ganin’s own use of the plural form in other places, and which inconsistency PO’s own expert could not reconcile. Each of PO’s three arguments against Ganin fails.

1. One set of training data does not mean one MLA

PO asserts that Ganin discloses only one MLA because Ganin has one set of training data. POR, 10-11. That assertion directly contradicts the claims of the ’985 Patent, which require two MLAs trained with the same training data. This is also true for the teacher-student architecture discussed in Aslan, where the teacher and student model receive the same training data. *See* Ex-1007, Fig. 1 (reproduced

below); Pet., 57.

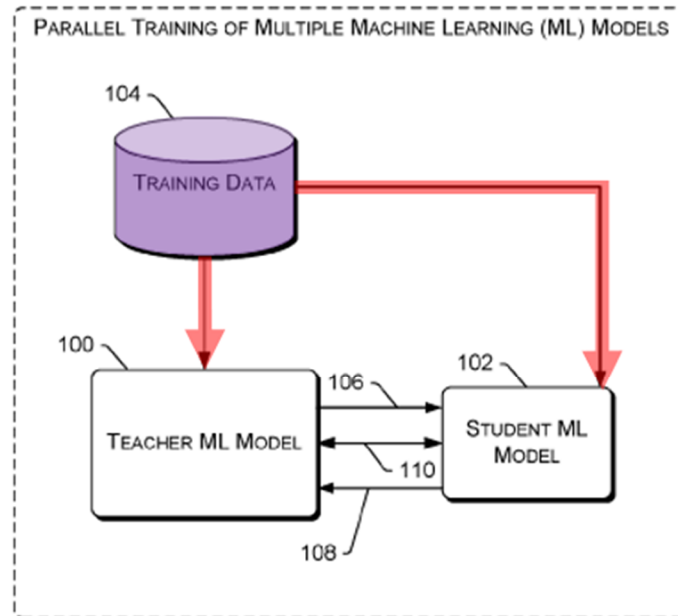


Fig. 1

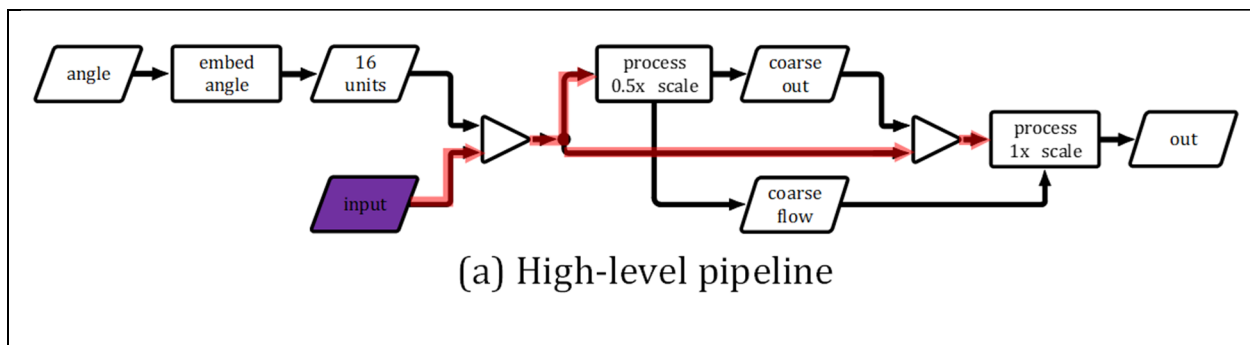
Ex-1007, Fig. 1

Accordingly, using the same training data does not necessitate a single MLA, and therefore, PO's musings about "coarse" and "fine" input/output images (POR, 11-13) are meritless.

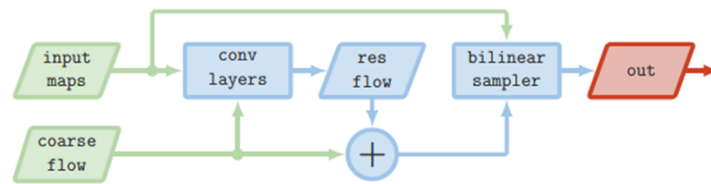
Moreover, Petitioner has not and does not contend that Ganin requires two different tasks as alleged by PO. POR, 10. Ganin discloses a single task for both modules. Ex-1006, 9 ("The latter four models are trained for **the task** of vertical gaze redirection in the range"); *see also* Ex-1003, ¶112. As explained by PO's

expert, Ganin discloses a coarse warping module and a fine warping module receiving the same input maps (i.e., training data), and the fine warping module further receiving output of the coarse warping module. Ex-1061, 175:17-177:9. Thus, Ganin discloses two MLAs that process the same training data and provide outputs at different scales. Pet., 19-20; Ex-1006, Fig. 10(a). Dr. Karam's testimony cited by PO does not indicate otherwise. POR, 11 (citing Ex-2009, 106:1-21). Dr. Karam explained that ground truths are used with an objective function to train a model (i.e., an MLA), which provides no assertion or indication that only one MLA exists in Ganin.

Regarding the Board's observation that "Petitioner appears to rely on the forwarded reference data to teach the two separate inputs for the fine warping module" (Paper 7, "Inst. Dec.", 43), PO's expert has now explained (below) how the fine warping module receives both the coarse flow (i.e., forwarded reference data) and the input maps (i.e., training data), which puts him in alignment with Dr. Karam. Ex-1003, ¶125.



Ex-1006, Fig. 10(a)



(c) 1×-scale processing module

Ex-1006, Fig. 10(c)

4 A. So you look -- you see at 1C, 10 -- this
5 figure -- it's not 1C, sorry. Figure 10(c), you see
6 that's essentially a blowup of the "process 1x
7 scale."
8 Do you see that?
9 Q. Yeah.
10 A. And it receives as input as you see the
11 output from the concatenation. So that's
12 essentially your input maps. And it also receives
13 as input, the coarse flow that you see in the coarse
14 flow box there. So you see two boxes going in that
15 one -- going in 10(c). You have the input maps, and
16 you have the coarse flow.
17 So the coarse flow, if you go back to look
18 at 10(a), is what comes out of the .5. Do you see
19 that, where it says coarse flow, and it feeds into
20 the 1x?

Ex-1061, 176:4-20

2. One objective function does not mean one MLA

PO also asserts that Ganin discloses only one MLA because Ganin has one objective function. POR, 13-14. That is incorrect.

PO's expert conceded that one objective function could be used to train multiple MLAs. Ex-1061, 14:8-17 ("Q. ...Is that something that a skilled person in this field could have done, make use of one objective function to train multiple algorithms? A. You could..."). PO's expert also indicated that the '985 Patent does not discuss how any objective function should be set up. Ex-1061, 118:18-119:7, 123:5-124:18. In fact, the '985 Patent makes no mention of an objective function at all. Further, PO's expert acknowledged that "... **Aslan describes the objective function for joint training of the first and second models,**" thus indicating (as he must) that in the pre-2017 timeframe, it was known to use one objective function to train multiple algorithms. Ex-1062, 218:15-22. *See also* Ex-1007, ¶7 ("optimizing the objective function to train the first machine learning model **and** the second machine learning model in parallel"); Ex-1003, ¶76; Ex-1061, 199:13-16; Ex-1062, 218:23-219:9.

PO's arguments requiring an MLA to have its own training data and its own objective function are not credible. PO's expert and Dr. Karam both provided explanations of machine learning algorithms that did not have these requirements. Ex-2008, ¶42 ("Put another way, a machine learning algorithm is a computer model that trains itself to perform a specific task by using training data."); Ex-1003, ¶23 ("A machine learning ("ML") algorithm (or architecture), also referred to as a machine learning model, is an algorithm (or architecture) that learns from

data to perform a task or a class of tasks.”).

Tellingly, when PO briefed the meaning of “machine learning algorithm” in District Court, PO did not try to add the extra requirements it imagines here. Ex-1055, 6 (“Proposed Construction: ‘an algorithm that is able to learn from data’”).

PO is importing limitations out of thin air to try to distinguish Ganin, which is worse than the “cardinal sin” of importing limitations from the specification.

Phillips v. AWH, 415 F.3d 1303, 1320 (Fed. Cir. 2005) (describing this as “one of the cardinal sins of patent law”). The Board should reject PO’s baseless tactic.

Medivis v. Novarad, IPR2023-00045, Paper 36, 19 (Apr. 12, 2024); *Viken*

Detection v. American Science, IPR2022-00028, Paper 61, 11-12 (May 1, 2023).

3. Ganin’s text explicitly describes plural architectures

PO asserts that “Ganin’s text repeatedly states it includes one machine learning algorithm, not two,” and emphasizes Ganin’s use of the terms “neural network,” “model,” and “architecture” to support this assertion. POR, 14. PO implies that a neural network, a model, or an architecture constitutes a machine learning algorithm, but a module does not. But Ganin uses the term “module” interchangeably with the term “neural network.” *Cf.* Ex-1006, 4 (“lightness correction neural network”) *with* Ex-1006, 17 (“lightness correction module”).

Additionally, PO’s semantic argument was undermined by its own expert. Ganin refers to its “feed-forward architecture” as having multiple neural networks

and multiple architectures. Ex-1006, 4 (the “2-scale flow NN” and the “Lightness correction NN”); Ex-1006, 17 (“[t]he architectures of the two warping modules”). When questioned on this topic, PO’s expert could not reconcile PO’s assertion with Ganin’s text, and was left to say that Ganin “...could have used better wording...” and Ganin’s own “...choice of words is... not ideal...” Ex-1061, 171:13-172:12.

4. PO’s criticism of Dr. Karam is irrelevant

PO criticizes Dr. Karam’s use of terms such as “could,” “can,” and “may.” POR, 17-18. However, the relevant portion of Dr. Karam’s declaration (Ex-1003, ¶¶115, 116) merely explained how a PHOSITA would have interpreted certain symbols in Ganin. Neither PO nor its expert contends that Dr. Karam’s relevant opinion was wrong. PO has failed to show how the cited portion of Dr. Karam’s declaration relates to any of the ’985 Patent claims, and has ignored the remainder of Dr. Karam’s declaration where she explained why Ganin teaches every feature required by the ’985 Patent claims.

B. Ganin discloses a second MLA (“MLA2”) using the same training data as the first MLA (“MLA1”)

PO does not dispute that Ganin discloses the training data claimed in elements 1[A]-1[C] (18[A]-18[C]). Rather, PO only disputes whether Ganin discloses claim elements 1[D] and 1[E] (18[D] and 18[E]). POR, 9, 18. PO’s expert confirmed that he did not opine on the other claim elements. Ex-1061,

153:12-18 (“Those [i.e., 1[E] and 18[E]] are the ones I opined on. I wasn’t asked to opine on any other elements.”).

PO contends that Ganin discloses “a single algorithm [that] uses a two-step process,” which is “not the same as having two machine learning algorithms” because “[b]etween steps one and two, there is no completed output, no corrected image.” POR, 14-15. However, none of the ’985 Patent claims require MLA1 to provide a “completed output” or “corrected image,” which is an entirely new concept introduced by PO. Therefore, PO’s arguments concerning a “half-processed, intermediary product” are baseless.

PO also contends that even if Ganin discloses two MLAs, these two MLAs require two different sets of training data. POR, 18. This contradicts the testimony of PO’s expert. Ex-1061, 154:18-20 (“Q. So it’s your opinion that Ganin only has a single training dataset? A. That is correct, as disclosed in Ganin.”). As also explained in Section II.A.1, two MLAs can share training data, as in the challenged claims here and disclosed by Aslan and Ganin.

Moreover, claim elements 1[D] and 1[E] (18[D] and 18[E]) do not require MLA1 and MLA2 to use the training data in a particular way, or even in the same way as one another, as PO’s expert acknowledged: “So Claim 1 states you’re using the same training data. So you have the same training data. Now, **how you use the data in your algorithms might differ slightly**, but you’re using the same training

dataset in a sense.” Ex-1061, 164:4-10. As described in Section II.A.1, PO’s expert understands Ganin to disclose the coarse and fine warping modules receiving the same input maps (i.e., training data), which leaves him aligned with Petitioner’s expert. Pet., 13-22 (citing Ex-1003, ¶¶111-130).

C. PO Never Addresses its Failure to Distinguish Ganin During European Prosecution

PO’s silence as to its actions during European prosecution of a related application to the ’985 Patent (Pet., 7) is also revealing. Critically, when the European examiner identified Ganin as a novelty-destroying reference (i.e., anticipatory) against claim language that is the same as that at issue in the independent claims here, PO never argued that Ganin lacked two MLAs. PO makes no attempt to explain away those actions here.

III. CHALOM-ASLAN RENDERS OBVIOUS CLAIMS 1-3, 5-6, 8-14, AND 16-19 (GROUND 3)

A. The Record Shows a Motivation to Combine Chalom with Aslan

1. Express Motivation

The express motivation to combine is straightforward. Chalom expressly instructs training its random forest classifier “using any suitable technique or techniques” (Ex-1005, 14:62-67) and compressing that classifier “using any suitable technique or techniques” (Ex-1005, 15:4-9), which would have led a PHOSITA to Aslan’s teacher-student architecture. Pet., 43; Ex-1003, ¶216. Aslan

also explicitly teaches that accurate but large models may be “**not well suited** for... for smart phones” (Ex-1007, ¶3) and proposes compressing large models into smaller models so that they “can be **more readily** deployed on computing devices with limited resources” (Ex-1007, ¶44). *See* Pet., 43-45, Ex-1003, ¶¶216-224; Ex-2009, 191:4-23.

As PO’s expert acknowledges, different techniques existed to compress Chalom’s RFC beyond just the techniques disclosed in Chalom itself. Ex-1061, 185:17-186:23. PO’s expert further concedes that for optimal compression, a PHOSITA looks to literature for guidance. Ex-1061, 187:15-24. Thus, a PHOSITA would have been motivated by Chalom’s explicit teachings to consult literature such as Aslan for techniques to compress Chalom’s RFC, e.g., using Aslan’s teacher-student architecture for compressing the student model, as PO’s expert concedes. Ex-1061, 86:18-87:3; Ex-1062, 239:16-22. Upon locating Aslan, a PHOSITA also would have known that Chalom’s RFC is an ensemble that typically “requires a lot of time and resources” for training as indicated directly in Aslan and confirmed by PO’s expert (Ex-1062, 227:3-5, 227:20-228:3), and therefore would have sought to use Aslan to address the known issues with ensembles. This all establishes an express motivation to combine, which alone suffices to establish that a PHOSITA would have combined Chalom with Aslan.

The record establishes other alternative reasons to combine, as noted below.

2. Known elements performing their ordinary functions to produce a predictable result

As noted in the Institution Decision, “[b]ecause the proposed [Chalom-Aslan] combination involves known elements performing their ordinary functions to produce a predictable result, a POSITA would have appreciated that the proposed combination is proper.” Inst. Dec., 37. PO presents no direct rebuttal to this motivation theory. PO’s expert’s recent admissions appear to reveal why PO elected not to rebut this theory. He admitted that a teacher-student architecture, as described in Aslan, was known before 2017. Ex-1061, 127:10-15. He also confirmed that the various machine learning models described in Aslan, including random forests, were known in the pre-2017 timeframe. Ex-1062, 216:6-217:3, 220:23-221:12; Ex-1007, ¶22. Thus, there appears to be no disagreement that the elements from Chalom and Aslan used in the Petition’s proposed combination were indeed “known elements.”

Further PO’s expert indicated that Aslan and Chalom both involve classifiers. Ex-1062, 217:16-218:10; Ex-1061, 135:18-136:3. In reference to Chalom’s disclosure, PO’s expert confirmed that the ordinary function of a random forest classifier in the pre-2017 timeframe is to “...take[] in as input the feature sets from the previous block, 303, and perform[] a classification and provide[] a motion vector field” (Ex-1062, 230:19-231:16) and that Aslan’s teacher-student

architecture can be used to compress such a model. Ex-1062, 239:16-22 (“Q. So is Aslan telling a POSITA in the pre-2017 time frame that its joint training techniques can be used for model compression? A. Yes”). Thus, the elements from Chalom and Aslan used in the combination perform their ordinary functions to produce the predictable result of a compressed student model for performing gaze correction. These admissions leave PO's expert aligned with Petitioner's expert, who has also explained that the Chalom-Aslan combination is nothing more than known elements performing their ordinary functions. Pet., 45-46 and 54-59 (citing to Ex-1003, ¶¶227, 257-267, 275-278, and 365-368).

3. Motivations existed to combine Chalom and Aslan for accuracy and/or efficiency gains.

Either one of the two alternative motivations described above establishes the motivation to combine Chalom and Aslan. Beyond that, the pursuit of accuracy and/or efficiency gains would have further (and alternatively) motivated the combination. PO's arguments to the contrary do not establish otherwise.

As a threshold matter, PO's dismissal of the accuracy and/or efficiency goals as motivation theories ignores the teachings of Chalom. For example, PO asserts that “[n]othing in Chalom indicates it is inaccurate or inefficient, and thus there is no reason to look to Aslan—and add another machine learning algorithm—to correct these falsified problems with Chalom.” POR, 23. PO's assertion ignores

the permissive language of Chalom's statements it is citing for this assertion, e.g.: "system 1700 **may** be embodied in varying physical styles or form factors," "device 1800 **may** be implemented as a mobile computing device," and "the interface **may** be any of ... wireless HDMI, and/or wireless HD compliant techniques." POR, 22-23 (citing Ex-1005, 22:33-37, 19:65-20:6); *see also* Ex-2008, ¶106 (PO's expert also relying on "may" statements in Chalom by citing to Ex-1005, 3:21-43, 9:50-55, 13:37-40. PO's expert explained that Chalom's statement that "[t]he techniques described herein **may** provide for high quality eye contact correction in real time," is "...essentially saying, well, it may provide for high quality eye contact correction, but **there may be some error also now and then....**" Ex-1061, 141:4-145:3; Ex-1005, 9:50-52. Thus, Chalom's use of "may" does not mean that every accuracy and efficiency issue was solved, but instead that—as PO's own expert explained—they "may" be solved but "there may be some error also now and then" for which further improvement would be helpful to at least mitigate those errors.

Even PO's expert noted that improving accuracy/efficiency is a common goal in the machine learning field. Ex-1061, 180:14-21, 182:2-24, 32:7-16, 110:23-25 ("...the idea behind it, generally speaking, is you want to make changes to improve accuracy or efficiency of a given model..."). This puts him in agreement with Petitioner's expert. Ex-2009, 158:2-4, 159:7-12, 162:12-18 ("You

improve up to a certain degree. Does this mean that you reached the perfect quality? Not necessarily.”). Chalom simply does not discourage a PHOSITA from seeking to further advance accuracy and/or efficiency goals and, in any case, “the normal desire to improve upon what is already generally known” is a recognized motivation too. *Jazz Pharmaceuticals Inc. v. Amneal Pharmaceuticals, LLC*, 895 F.3d 1347, 1363 (Fed. Cir. 2018). For this reason alone, PO’s arguments against the accuracy and/or efficiency motivations are easily dismissed.

PO also advances certain arguments against incorporating the Chalom system into a teacher-student architecture. These arguments are not persuasive.

First, PO argues that “adding another MLA does not improve accuracy,” and “[i]nstead, a POSITA would improve accuracy in other ways.” POR, 23. But existence of other ways to improve accuracy/efficiency does nothing to prevent a PHOSITA from using Aslan’s teacher-student architecture. *See e.g., In re Fulton*, 391 F.3d 1195, 1200 (Fed. Cir. 2004) (“our case law does not require that a particular combination must be the preferred, or the most desirable, combination described in the prior art in order to provide motivation for the current invention.”). Indeed, PO’s expert concedes that there existed many ways to improve accuracy, such as tweaking the model or changing/adjusting parameters, in addition to supplying additional training data. Ex-2008, ¶45; Ex-1061, 109:25-110:11. PO’s expert also indicated that use of a teacher-student architecture improves accuracy

and/or efficiency. Ex-1061, 86:18-87:3. That puts him in alignment with Petitioner's expert (Ex-1003, ¶¶51-52) and the prior art (Ex-1007, ¶8). Therefore, PO's discussion of "other ways" to improve accuracy is irrelevant.

Second, PO argues that Chalom-Aslan "does not result in improved efficiency or accuracy" because it "increas[es] complexity with more or larger models (which reduces efficiency and [] teach[es] incorrect gaze correction parameters (which reduces accuracy)." POR, 24-25. This assertion ignores that a given course of action often has simultaneous advantages and disadvantages. *See, e.g., Medichem, S.A. v. Rolabo, S.L.*, 437 F.3d 1157, 1165 (Fed. Cir. 2006) ("[A] given course of action often has simultaneous advantages and disadvantages, and this does not necessarily obviate motivation to combine.").

The assertion is also technically unfounded. During training, as Dr. Karam explained, use of a teacher model can make training of the student model more efficient because the teacher's knowledge allows the student model to converge faster. Ex-2009, 178:14-25. During runtime, the student model is expected to provide more prediction accuracy than if it is trained without a teacher (*i.e.*, the student model's accuracy is improved by learning from the teacher model) and to execute faster than the teacher model (*i.e.*, the teacher model's efficiency is improved by being compressed into the student model). *See e.g.*, Ex-1007, ¶44 (the student model is "a compressed form" of the teacher model).

Third, PO incorrectly argues that Chalom-Aslan's teacher and student models receive "the same input and [have] the same construction." POR, 25-26. To the contrary, Chalom-Aslan's student model receives the training data **and** the output from the teacher model, which the Board correctly recognized. Inst. Dec., 36 ("Petitioner then proposes modifying Chalom's system with Aslan's teacher-student MLAs to train the two MLAs **with the same input data** to produce a motion field output, **as well as to provide the motion vector correction from the teacher MLA to the student MLA for further refinement.**"). Moreover, by setting up "fewer and/or less complex decision trees," the student model will necessarily be more compact than the teacher model. Pet., 44.

Fourth, PO argues that "[i]f a POSITA desired a more efficient way to deploy Chalom, they would reduce the size of the model by having fewer trees and branches, or compress the model by selecting the most probable trees and branches." POR, 26. However, this is exactly what the teacher-student architecture avoids—simply using a less complex model sacrifices accuracy, while the teacher-student architecture maintains the accuracy of the smaller student model by learning from the more accurate teacher model. *Cf.* Ex-1001, 2:17-43 *with* Ex-1007, ¶¶4, 8. Thus, a PHOSITA would have preferred using Aslan's teacher-student architecture over PO's theory of just using a smaller model. *See also* Ex-2009, 175:24-176:15.

Finally, PO argues that Chalom-Aslan “does not increase accuracy since it would result in horizontal gaze correction parameters being taught to vertical gaze correction models and vice versa.” POR, 26. PO’s argument is based on an incorrect assumption that “Chalom employs different models, each one to correct for a different potential gaze direction.” POR, 26. To the contrary, Chalom explicitly discloses that **“contact correction module 204 may be capable of implementing eye contact correction for multiple orientations or relative positions** between camera 104 and display 102.” Ex-1005, 10:10-14; *see also* Ex-1005, 10:26-31 (**“a single eye contact correction module ... to provide multiple eye contact corrections each corresponding to different relative positions between camera 104 and display 102.”**); Ex-1061, 194:16-18 (“you could have them all in one bigger module, so to speak, for multiple orientations.”). Thus, when implemented as a single eye contact correction module, PO’s alleged risk of model mixing, *i.e.*, “putting the upward gaze correction model into a teacher-student relationship with the left or right gaze correction models,” does not exist. POR, 26. Moreover, even if Chalom employs different models for different gaze directions as PO suggests, Aslan teaches the task learned by the student model “can be the same task” as the task learned by the teacher model. Ex-1007, ¶25.

For any (or all) of the alternative reasons provided above, a motivation plainly existed to combine Chalom with Aslan. PO’s arguments to the contrary are

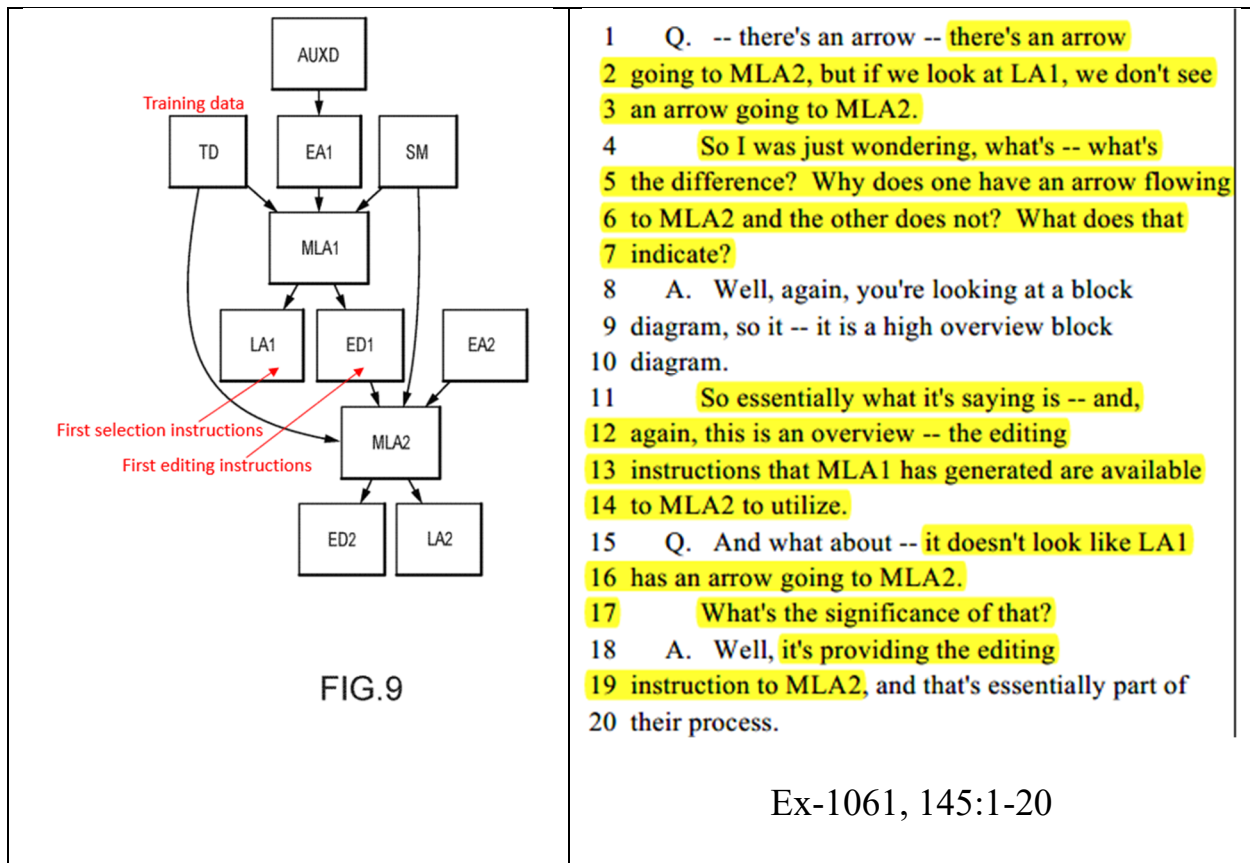
not credible, as established above.

B. Chalom-Aslan discloses a second MLA using the first reference data as required by 1[E]

PO argues that the claimed second machine learning algorithm must receive not only the first editing instructions, but also the first selection instructions. POR, 28-29. The Petition, supported by Dr. Karam’s testimony, addressed how and why the first reference data in Chalom-Aslan would have included the recited first selection instructions. Pet., 61; Ex-1003, ¶283 (“Chalom’s trained RFC provides ‘selection instructions for selecting editing instructions [e.g., optimal motion vector field] for a particular input patch from editing instructions [e.g., motion vector fields generated during training].’”).

However, PO’s additional requirement that the first selection instructions must be passed to MLA2 is incorrect. It finds no support in PO’s expert’s testimony, nor in the written description of the ’985 Patent. PO’s expert described this in connection with Figure 9 of the ’985 Patent:

Fig. 9 of the ’985 Patent	PO expert’s testimony
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The '985 Patent explains that “MLA1 outputs first selection instructions LA1 and first editing instructions ED1,” (Ex-1001, 17:5-6) but those first selection instructions are not passed to the MLA2. Ex-1001, 17:9-12 (noting that the “second machine learning algorithm MLA2 additionally receives the first editing instructions ED1,” and never indicating that the first selection instructions are passed to MLA2). Thus, claims 1 and 18 should be understood to not require passing of the first selection instructions or the claims would be invalid under § 112 for lacking written-description support and/or enablement. *Code200, UAB v. Bright Data*, IPR2022-00353, Paper 38, 30 (July 6, 2023).

Furthermore, the first reference data is described twice in claim 1: (i) 1[D] requires that it comprise “editing instructions for adjusting the digital representation of the head region for a range of possible digital representations of the head region”, and (ii) 1[F] requires that it comprise “**first** editing instructions for a range of possible configurations of the target feature” and “first selection instructions.” Thus, it appears that the claim differentiates between the first reference data (comprising editing instructions) that is generated by MLA1 and used by MLA2, and the first reference data (comprising **first** editing instructions and **first** selection instructions) with intended uses for runtime purposes. Pet., 59-60; Ex-1003, ¶¶280-281. PO’s additional requirement that the first selection instructions must be passed to MLA2 would seem to necessitate three different things being passed from MLA1 to MLA2, namely: “first selection instructions” recited in 1[F], “editing instructions for adjusting the digital representation of the head region for a range of possible digital representations of the head region” recited in 1[D], and “first editing instructions for a range of possible configurations of the target feature” recited in 1[F]. PO does not argue that two different types of editing instructions are passed to MLA2, which confirms that PO is simply cherry-picking aspects of 1[F] and ignoring other aspects.

Therefore, for reasons explained in the Petition, Chalom-Aslan discloses a second MLA using the first reference data (e.g., motion vector fields generated by

the teacher model) as required by 1[E]. *See* Pet., 54-59; Ex-1003, ¶¶256-274; Ex-2009, 148:1-10 (“if the second [MLA] uses the first editing instruction, it does satisfy the claim that it’s using the first reference data.”).

C. Chalom-Aslan combination was a simple and routine matter

PO claims that “Petitioner fails to sufficiently explain its Chalom-Aslan combination such that a POSITA could determine precisely what information passes between teacher and student models and how it operates” and contends that a PHOSITA is left to “follow the instructions provided in Aslan.” POR, 30, 32. However, PO never argues that any of those changes would be outside the knowledge and skill of a PHOSITA or would require undue experimentation.

PO’s argument is also belied by the ‘985 Patent itself, which omits “precisely what information passes between teacher and student models and how it operates,” instead leaving implementation details up to a PHOSITA’s common or background knowledge in the art. Ex-1001, 10:49-67 (“[a]ny suitable machine learning technique may be applied ...”); *id.*, 11:1-6 (pointing to prior literature for implementation details); *id.*, 11:21-22; *id.*, 18:21-24 (“editing instructions herein is understood to encompass **any data** ...”); *id.*, 17:42-45 (“may use reference data generated using other methods.”); *id.*, 22:31-33 (“[a]ny of various known techniques may be used to perform the updating of the second machine learning algorithm MLA2.”). This confirms that a PHOSITA does not need to be told how

to do those same things that the '985 Patent omits describing. To the extent these details must be explained, then the claims of the '985 Patent lack enablement.

Finally, the Petition adequately explains the Chalom-Aslan combination (Pet., 44-47, 58) and Dr. Karam's declaration provides details as to how the teacher and student models in Chalom-Aslan interact. *See, e.g.*, Ex-1003, ¶¶218-232, 269-272. Thus, a PHOSITA would not have struggled to implement the Chalom-Aslan combination and certainly would have had a "reasonable expectation of success" in doing so. *In re Magnum Oil Tools*, 829 F.3d 1364, 1381 (Fed. Cir. 2016).

1. Chalom's motion vector fields are suitable for use in Aslan's teacher-student architecture

PO also contends that Chalom and Aslan are not combinable because "Chalom performs a gaze correction task [which uses motion vector fields], while Aslan performs an image classification task [which uses a class or label]." POR, 27. This contention relies on the premise that "classes/labels are **usually** integers (such as a number or index) and represent one dimension, whereas "motion vectors are **typically** expressed via decimal numbers...." POR, 27; Ex-2008, ¶119. But PO's expert undermined this premise by admitting that motion vectors may be expressed with integers. Ex-1062, 251:2-24.

Moreover, a PHOSITA would have been motivated to implement Aslan's image classification techniques for Chalom's image-editing context at least

because determining, using machine learning, an optimal motion vector field for a given eye region is still an image-classification task. Pet., 43; Ex-1003, ¶¶215, 43-50, 58-65. Contrary to PO's assertion, Dr. Karam never agreed that "motion vector fields and classes/labels are vastly different in structure and function." POR, 28. While motion vector fields and classes/labels may be different in dimension (Ex-2009, 199:8-200:19), Chalom's motion vector fields "are classes/labels themselves." Ex-1003, ¶215.

As PO's expert concedes, a random forest classifier (RFC) is an "algorithm that you would use to do classifications in a sense... mostly used for classifications." Ex-1061, 75:5-10. Yet, Chalom discloses using an RFC to generate motion vector fields. Therefore, a PHOSITA would have found it natural and would not have had difficulty utilizing Chalom's motion vector fields in Aslan's teacher-student architecture, even though Aslan's teacher-student architecture is described in the context of image classification.

Just as the displacement vector field in the '985 Patent is provided to MLA2 for training (Ex-1001, 9:6-18), Chalom-Aslan's motion vector fields are also provided to the student model for training. If Chalom's motion vector fields are not suitable for use in a teacher-student architecture, then the '985 Patent itself is proposing an unsuitable and non-enabled system. PO's position, which undermines the '985 Patent, is not credible and should be rejected—it was well

within a PHOSITA's skillset to utilize Chalom's motion vector fields with Aslan's teacher-student architecture.

2. PO misrepresents Aslan's objective function

PO also misrepresents the Aslan reference when contending that, in Chalom-Aslan, it is the "objective function" that is being passed between the teacher and student models. POR, 32. That is not what Aslan teaches. Aslan teaches using an objective function to pass information, as opposed to passing the objective function itself (or "an error assessment made during training of the algorithm" as PO contends). *See, e.g.*, Ex-1007, ¶39 ("passing information between the models 100 and 102 *via* the objective function"); Ex-2009, 105:14-20 ("If you're passing information from the teacher and... you want to use this information to teach the student, you have to then **include it somehow in your optimization**. And, typically, this is a term in your objective function...").

It is the teacher's motion vector fields that are passed between the teacher and student models in Chalom-Aslan, which discloses MLA2 (*i.e.*, student model) using reference data (e.g., editing instructions) from MLA1, thereby teaching 1[E]. Pet., 54-59.

3. Chalom-Aslan discloses different first and second reference data

PO contends that the first reference data and the second reference data in

Chalom-Aslan are the same because “the Chalom-Aslan combination uses the same inputs, provided to the same modules, which would return the same outputs (i.e., the same ‘reference data’).” POR, 36. This is incorrect, as the teacher and student models need not be the same and the inputs are not the same (i.e., Chalom-Aslan’s student model also receives the output of the teacher model (like MLA2 in the ’985 Patent)). Pet., 41-45, 56-63; Ex-1003, ¶¶269-272, 275-286; Ex-1007, ¶¶28, 45.

PO also takes Dr. Karam’s testimony out of context. POR, 36-37. While Dr. Karam indicated that the ’985 Patent claim language does not require the first and second reference data be different (which is true) (Ex-2009, 120:7-14), she never asserted that the first and second reference data in Chalom-Aslan are the same—they are not, as explained above.

IV. PO RAISES NO ARGUMENTS AS TO PATENTABILITY OF THE ADDITIONAL LIMITATIONS OF CLAIMS 2-14, 16-17, AND 19

The Petition’s unpatentability showings as to the limitations of claims (2-14, 16-17, and 19) are unrebutted. Pet., 26-38 (Ganin-based anticipation challenge to dependent claims 2-3, 5, 10, 12-14), 38-41 (Ganin-Liu obviousness challenge to claims 16 and 19), 63-80 (Chalom-Aslan obviousness challenge to claims 2, 3, 5, 6, 8-14, 16-17, and 19), and 80-83 (Chalom-Aslan-Grau obviousness challenge to claim 4) and (Chalom-Aslan-Pace obviousness challenge to claim 7). Accordingly,

these claims are unpatentable along with independent claims 1 and 18.

V. CONCLUSION

Challenged claims 1-14 and 16-19 are unpatentable and should be cancelled by the Board.

Dated: June 18, 2024

Respectfully Submitted,

/ Alexander B. Stein /

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CERTIFICATION OF COMPLIANCE WITH TYPE-VOLUME LIMITS

This brief includes 5,546 words, as counted by Microsoft Word, and is therefore in compliance with the limit of 5,600 words established by 37 C.F.R. 42.24(c)(1). Accordingly, pursuant to 37 C.F.R. 42.24(d), lead counsel for the Petitioner hereby certifies that this PETITIONER’S REPLY TO PATENT OWNER’S RESPONSE TO PETITION complies with the applicable type-volume limits.

Dated: June 18, 2024

Respectfully Submitted,

/ Alexander B. Stein /
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CERTIFICATE OF SERVICE

Pursuant to 37 C.F.R. 42.6(4), lead counsel for Petitioner hereby certifies that a complete and entire copy of **PETITIONER'S REPLY TO PATENT OWNER'S RESPONSE TO PETITION** and **Exhibits 1059-1062** were sent on June 18, 2024, via email on Patent Owner's counsel of record in this proceeding:

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