

Neurala Overview
6/2017

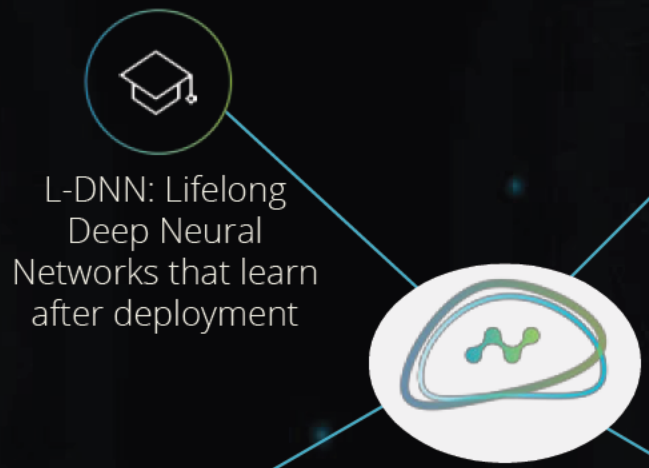
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Neurala

- *The vendor of the Neurala Brain:* 10 yrs. old *software* company
- Team: 35 people, strong expertise in Neural Networks/Deep Learning
- Early and pioneering IP (GPU computing, 2006) considerable head-start in Neural Network deployment on GPUs
- Experience in *building* and *commercializing* AI
- $25M of R&D and private investment

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The Neurala Brain



L-DNN: Lifelong Deep Neural Networks that learn after deployment

Fastest at the Edge, thin, local & low-power

Autonomous perception & collision-free navigation & obstacle avoidance (no Wi-Fi, GPS)

Smart tagging to streamline data generation for DNN

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Our history: tech built on GPUs on NASA requirements

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What NASA asked us for

- Give us a 'brain' for a Mars Rover
- No Wi-Fi connection, no GPS
- Fit on a 'brain' on a single GPU
- Use only a passive camera & IMU
- Learn 'as you go': learn what's in the environment, and update robot perceptions and maps

What we did

- Lifelong Deep Learning: L-DNN
- Emulates 'whole brains' in software
- No need of active sensors: inexpensive cameras are OK
- Beyond object recognition: collision avoidance, navigation, planning

Market needs that the Neurala Brain uniquely satisfies

Deploying NASA technology on everyday devices



CONSUMER ELECTRONICS

$ 10.0b+

- Learn, recognize and react to new classes of objects on-the-fly after deployment
- Engaging and interacting devices
- Location awareness
- Satify privacy concerns (no cloud)



AUTONOMOUS VEHICLES

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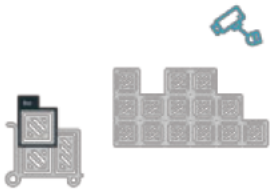
- Very fast on device intelligence
- Learn on-the-fly based on new use cases (e.g., misclassifications)
- Fast processing



DRONES

$ 11.0b+

- Learn very specific object of interests (e.g., rust on a cell tower, safe areas to land, anomalies)
- Learn to follow safely
- Avoid (or seek) obstacles



SMART DEVICES

TBD

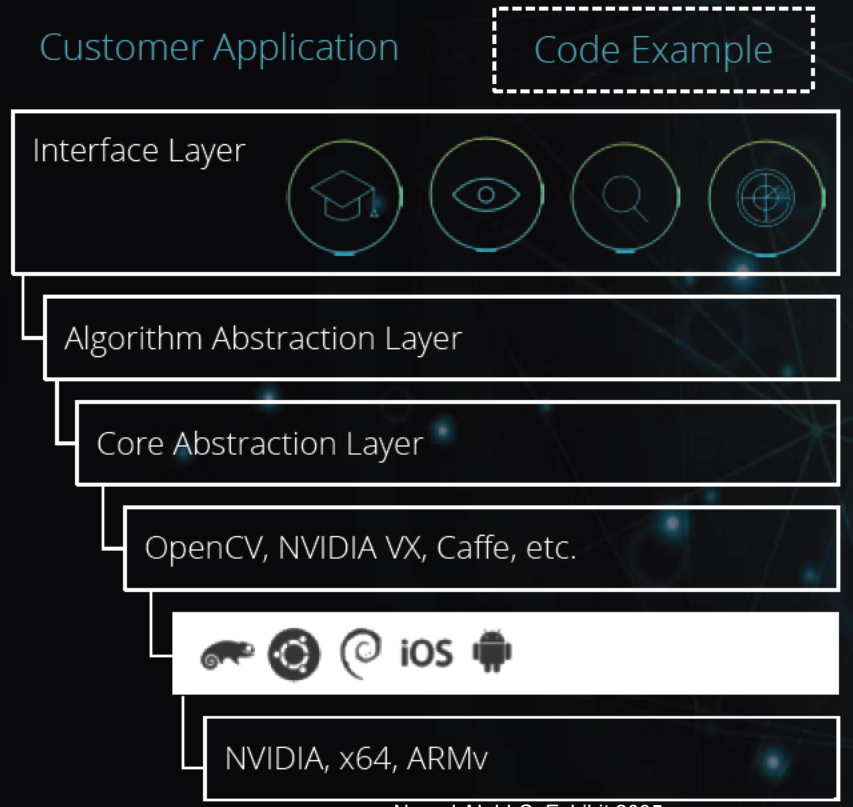
- Learn something new (e.g., a person to find, a new product to pick, an abandoned backpack) often without cloud support
- Inspect items in production
- Recognize, follow and track

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Our solution: Brains For Bots SDK™

Brains For Bots™ is a Software Development Kit for building smart machines AI architectures. Based on Neurala's Lifelong DNN (L-DNN™), the AI that learns after deployment, It sits between the Customer Application and the device OS to enable:

- Conitinuous learning at the Edge
- Learning, recognition, tracking, and finding objects in the video stream
- Fast Edge execution speed and optimal use of CPU and GPU (if available)
- Software modularity
- Wide compatibility with different processors



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Enables applications that require learning after deployment



Unique differentiation (not availble in other frameworks):

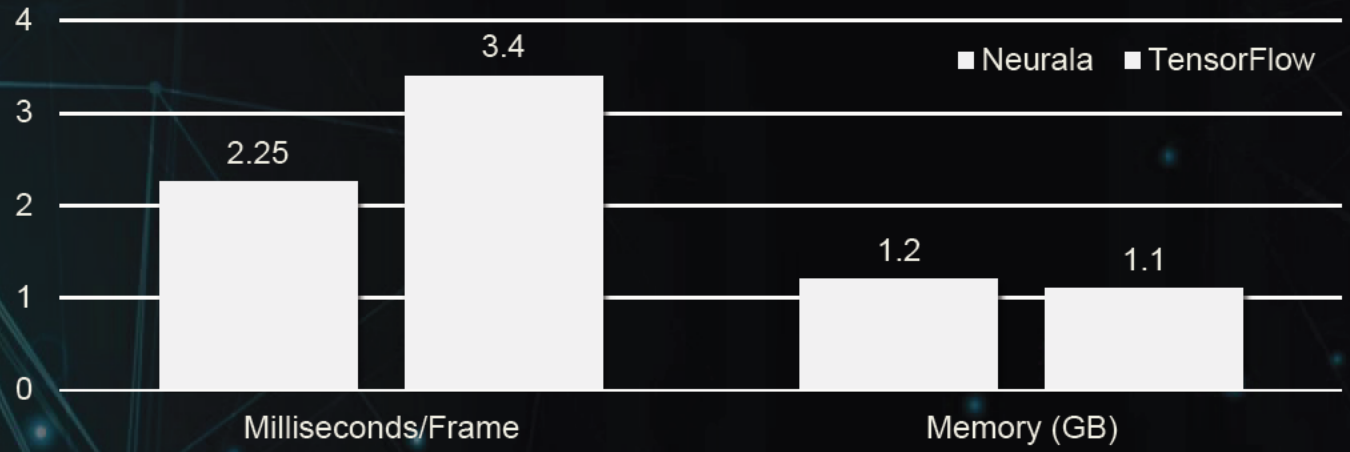
With Lifelong Deep Neural Networks (L-DNN) technology, Neurala's software is the 1st of its kind to learn in real-time, on the device, like humans do.

- *No need for long training & servers*
- *Does not require Cloud connection*

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And we are *fast:* 51% faster than TensorFlow

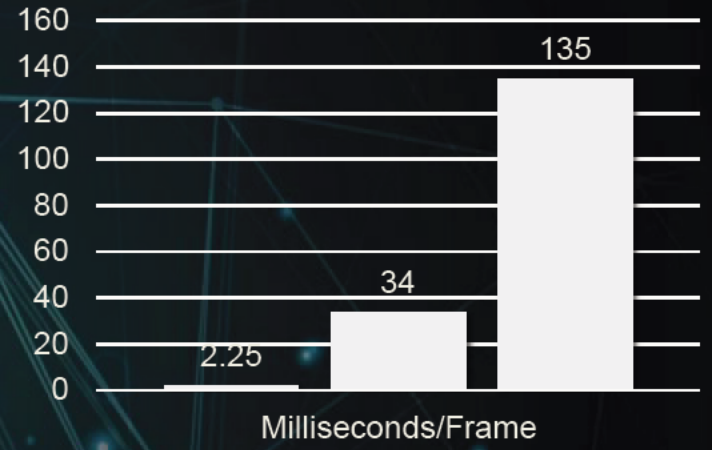


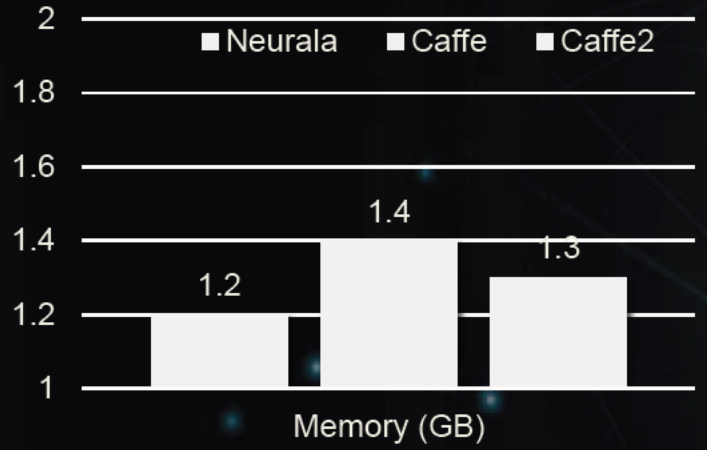
- Neurala inference time is 51% faster than TensorFlow
- Using just 100MB more memory (basically free)

CALCULATION using GPU.

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..... and 600% faster and lighter than Caffe



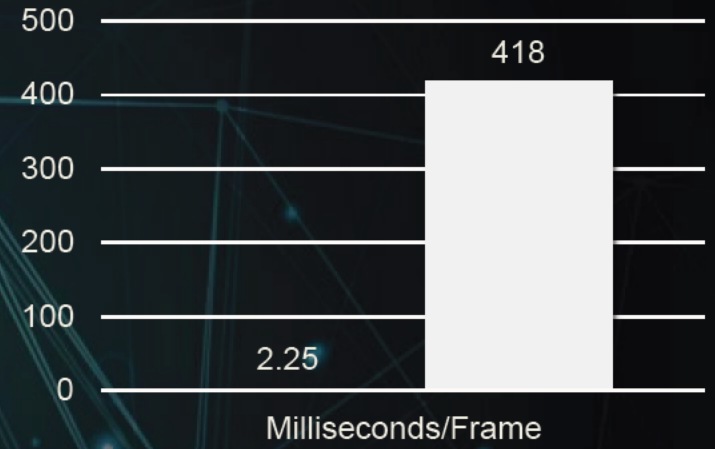


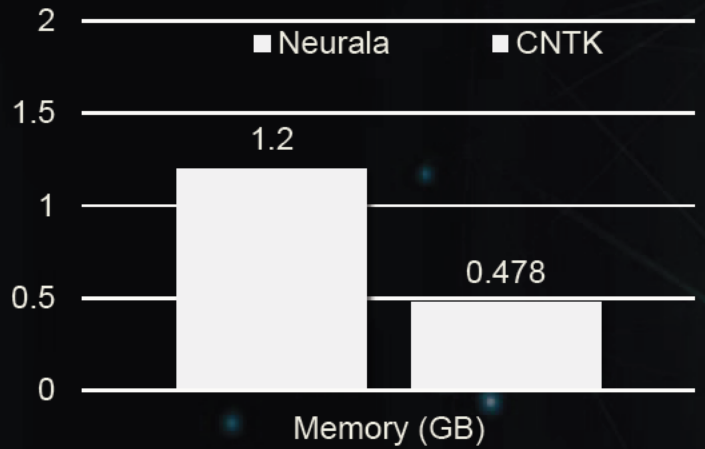
- 60x faster than Caffe2
- Using a little less memory (basically free)

CALCULATION using GPU.

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.... and faster than Microsoft/CNTK





- 186x faster on GPU
- Using more memory (basically free)

CALCULATION using GPU. Microsoft/CNTK is so slow because it saves memory by allocating chunks and hence must ask for memory again and again. But, GPU processors like the NVIDIA Jetson TX1 have plenty of available memory and does not need to be managed tightly.

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Growing & early IP portfolio

Neurala IP dates back to 2006, where we patened a method for running difference and differential equations on GPUs (US 8,648,867) Since then, Neurala has grown a patent, trade secret, and trademark portfolio ranging from using GPUs for Deep Learning and Neural Networks, sensory (vision, audition, and multimodal) perception, spatial navigation, collision avoidance, and user interfaceand smart tagging to build and deploy brains for intelligent devices.

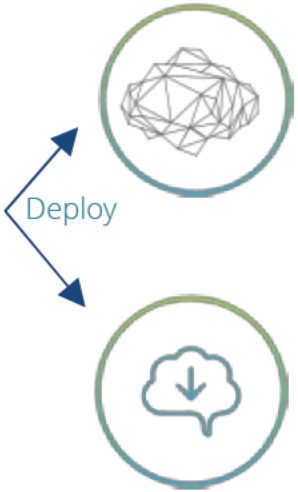
Patent Portfolio:

- 3 US Utility Patents
- 5 Foreign Design Patents
- 13 Pending Patent Applications:
  - 2 US provisional applications
  - 1 PCT application
  - 1 Canadian patent application
  - 3 European patent applications
  - 1 Korean patent application
  - 5 US utility patent applications.

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Building a Neurala Brain for a smart machine

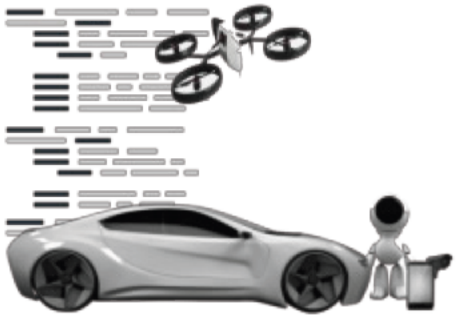




BrainNet*

Runs a Neurala Brain on Neurala's or customer cloud

** Neurala's or hosted server*



BrainBuilder and SMART Tagging

Streamline data tagging based on patent-pending tech, Builds a Neurala Brain based on specific data & needs of the customer

Brains For Bots SDK™

Enables users to embed a custom Neurala Brain for deployment on a target device with C ++ API.

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Built with Brains For Bots SDK™

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Example: selfie dronie



- 1st DNN-powered AI for drones
- Early 2016
- App store and Google Play

Built with Brains For Bots SDK™

Example: obstacle detection for automotive



- US and EU OEM and Tier 1 suppliers
- Use case: obstacle avoidance for self-driving vehicles, drive assist, ground truth for large datasets
- Requirements: speed, lifelong learning for new use cases (e.g., recognize driver's home, parking, etc)

Built with Brains For Bots SDK™

Example: inspections with drones



- Ccustomers: drone manufacturers, telecom & energy companies, logistics
- Use case: inspection of telecommunication towers, solar panels, roofs, power lines
- Requirements: onboard intelligence, speed, accuracy, refine learning over time

Built with Brains For Bots SDK™

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Example: low-cost smart toy



- Low-cost smart toy producers
- Other customers: Smart device manufacturers, camera manufacturers
- Use case: interactive toys, local intelligence without cloud support

Built with Brains For Bots SDK™

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In collaboration with Air Shepherd and Lindbergh Foundation



- Drone for anti-poaching
- Persistent surveillance
- Analyze in real-time RGB and IR data
- Requirements: speed, high FPS, refine learning over time

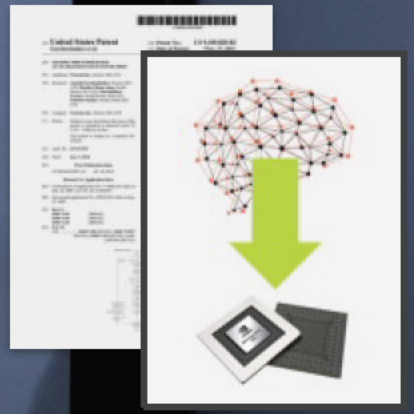
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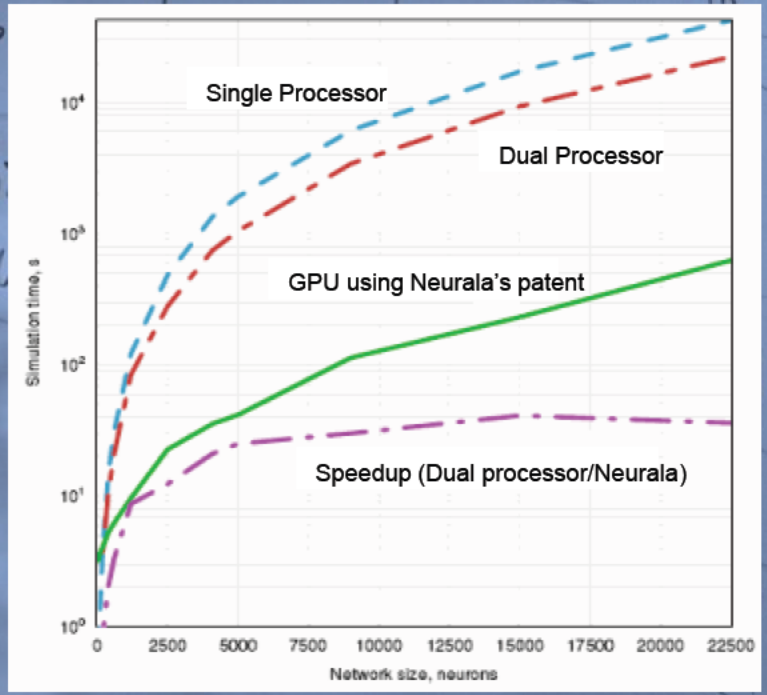
Core premise of entire company: *we could run AI on GPUS*

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- Started programming GPUs in **2 BC**
  (BC = Before **C**UDA – 1st release on 6/2007)
- Solved a key problem: hardware limitation made AI deployment impractical
- U.S. Patents 8,648,867 and 9,189,828 (2006) while solving this problem



This chart made us believe Neurala could be a business



(link to original blog post)

All ‘power uses’ require nVidia GPU

If our customers want high performance, we tell them ‘get nVidia’



CONSUMER ELECTRONICS

- Advanced robots/drones that self-localize, perceive, and learn at the EDGE

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AUTONOMOUS VEHICLES

- Automotive use cases where learning at the Edge and fast processing unlock new use cases

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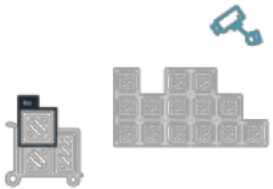


DRONES

- Professional drones for inspection, logistics, ...

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SMART DEVICES

- Learn something new (e.g., a person to find, a new product to pick, a bag that has been abandoned) often without cloud support
- Recognize, follow and track

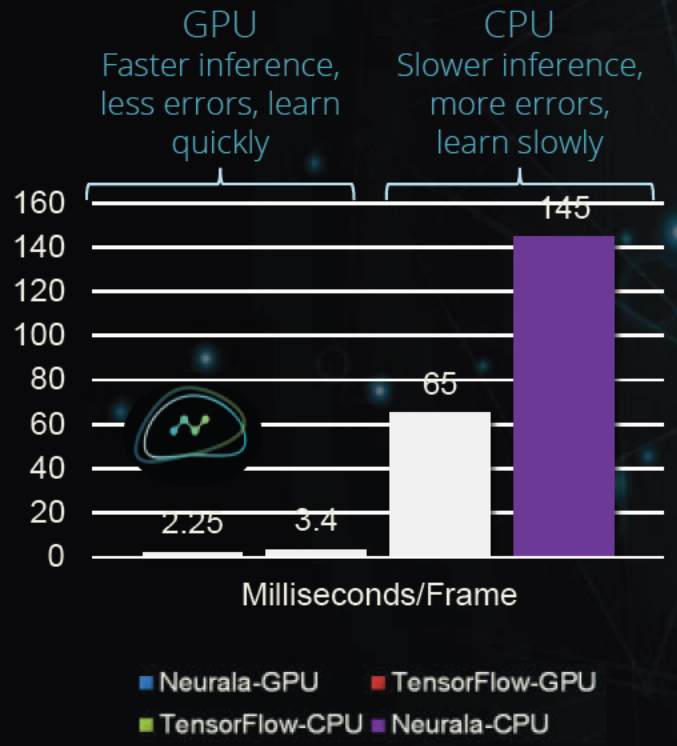
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Neurala: shifting customers from CPU ⇒ GPU

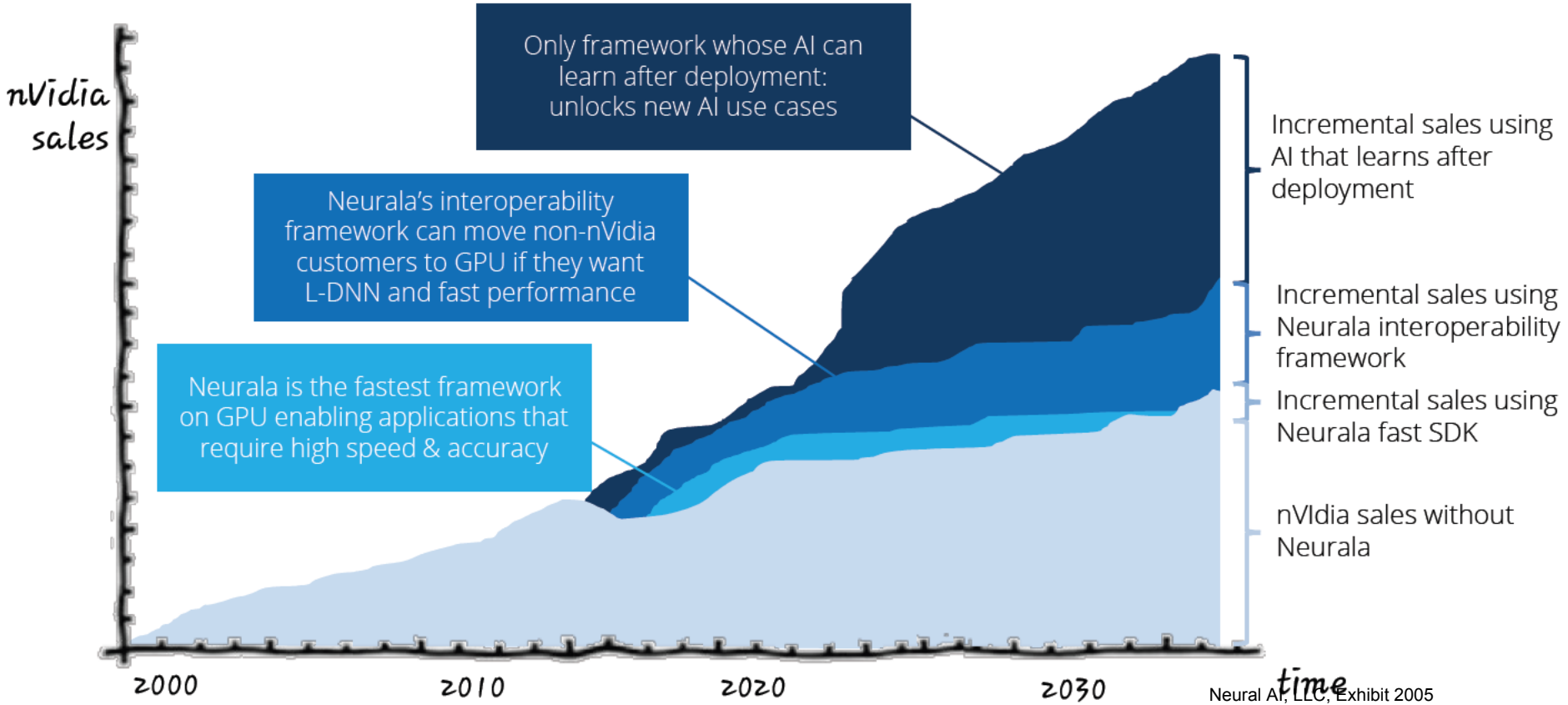
- Remember: more processing power = more speed & accuracy (these are tradeoffs)
- GPU systems offer significant performance advantages over CPU systems (using about the same memory)
- By using GPU, Neurala unlocks high-valued applications where inference & learning speed and accuracy are mission critical.
- These include:
  - Automotive: high FPS & precision
  - Drone inspections: speed and accuracy
  - Industrial applications: very accurate smart cameras
  - Personal robots with Edge intelligence & learning



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We can work together in at least 3 ways



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Neurala in the news



























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