What's Changing?

What Makes This a Unique Era for Computer Vision?

Deep Learning
- Algorithms that work
- Ability to address diverse applications

Big Data
- Ability to train deep neural networks

Cheap, Energy- Efficient Hardware
- Widespread deployment

Cloud Compute
- Simplifies development, deployment and scaling

Capital, Talent
- Fuel innovation, development, deployment and scaling
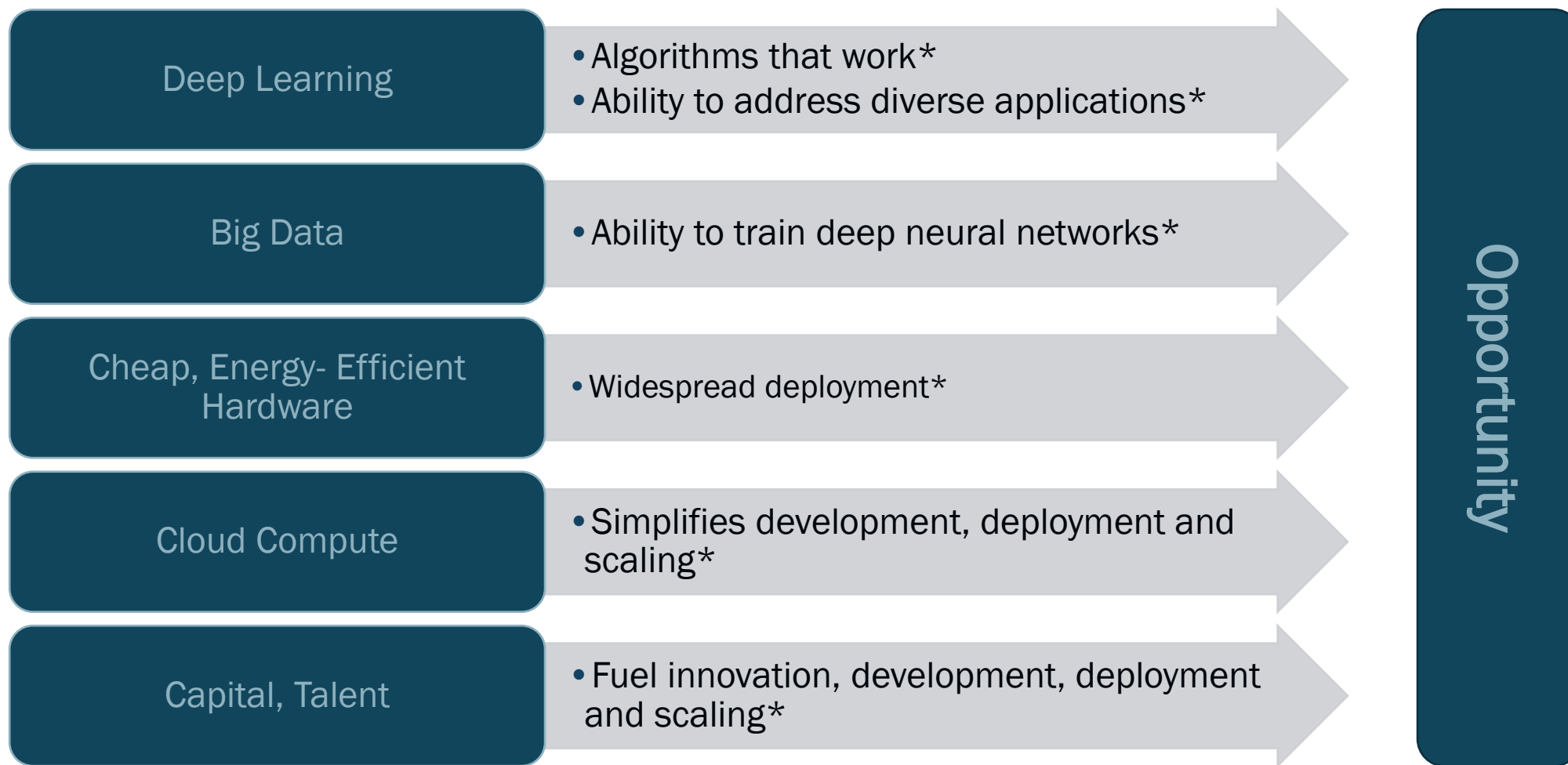
Opportunity

edge ai + vision ALLIANCE™
Inspiring + empowering innovators to design systems that **perceive + understand**
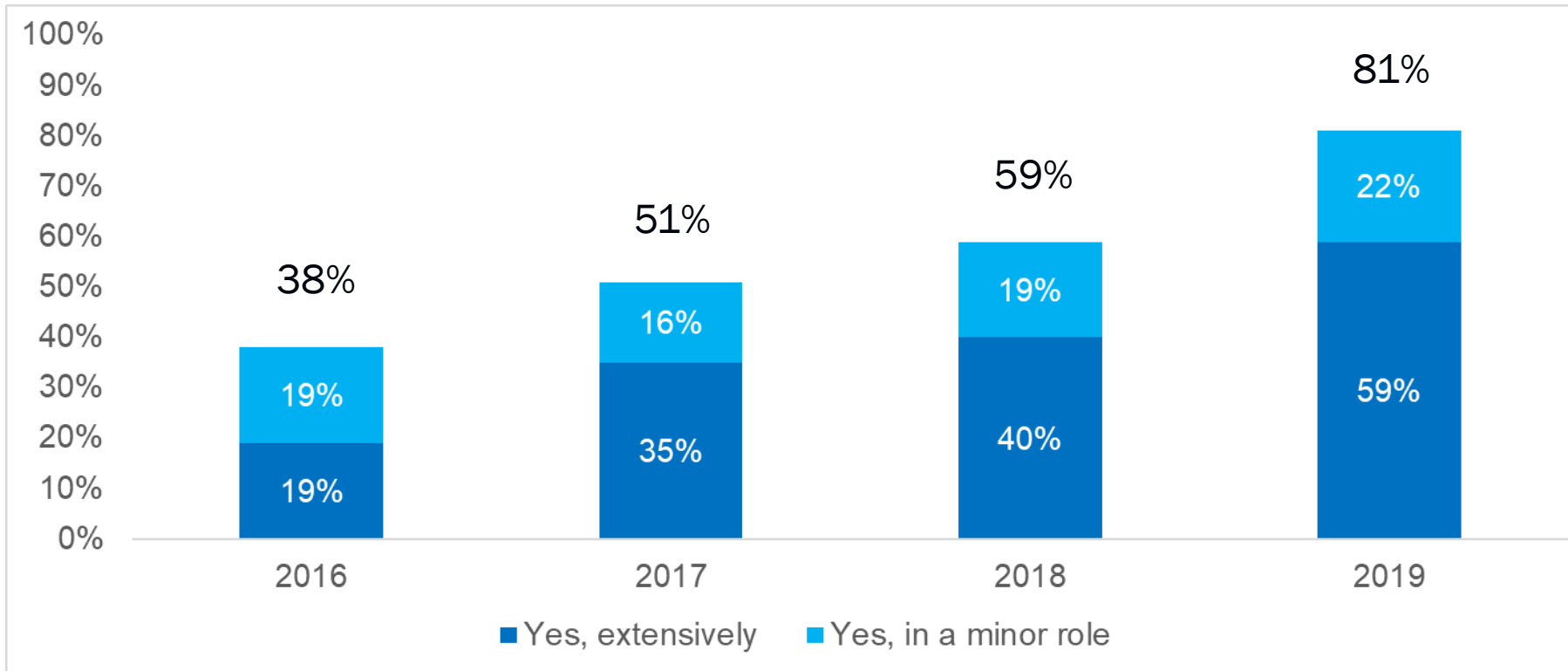
What Makes This a Unique Era for Computer Vision?

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Opportunity
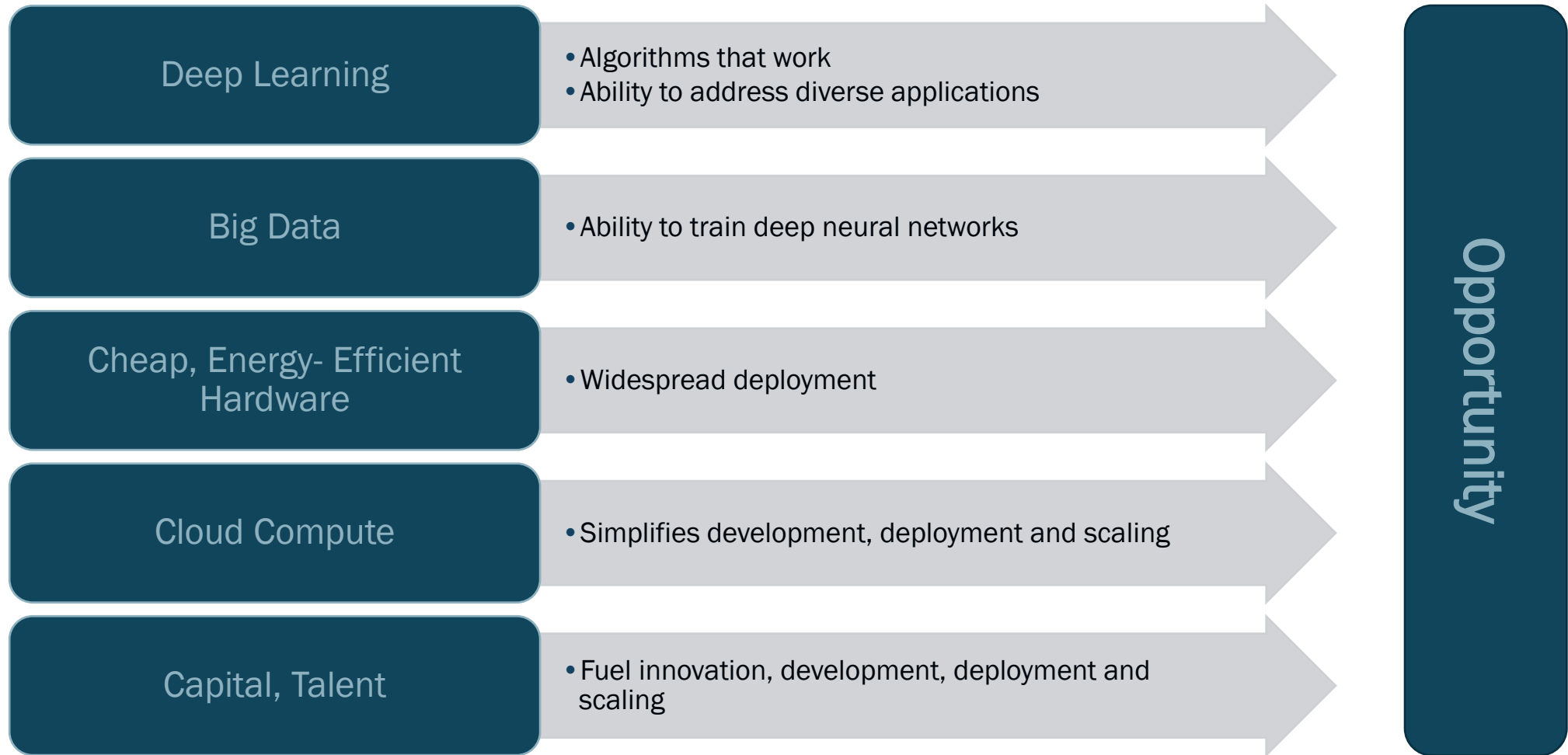
* See rest of presentation...

Use of Neural Networks in Vision Applications

Source: Edge AI and Vision Alliance, *Computer Vision Developer Survey, Oct. 2019*
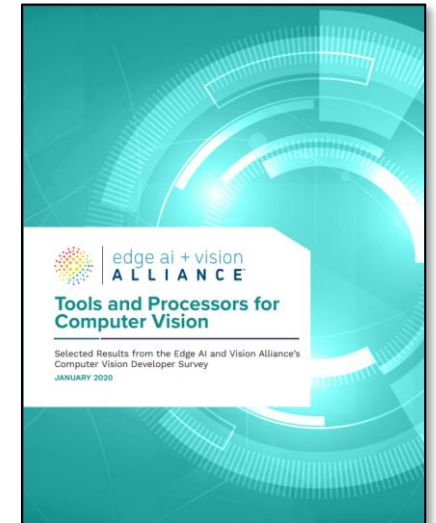
bit.ly/
DeveloperSurvey
WhitePaper2020

A Golden Era of Embedded AI Processors
(From the Embedded Vision and Visual AI Industry Map)

© 2020 Edge AI and Vision Alliance

https://bit.ly/VisionIndustryMap

Drivers of Trend Towards Edge Computing

Bandwidth

Latency

Economics

Reliability

Privacy

Drivers of Trend Towards Edge Computing

Bandwidth

Latency

Economics

Reliability

Privacy

Bandwidth

Latency

BLERP

Economics

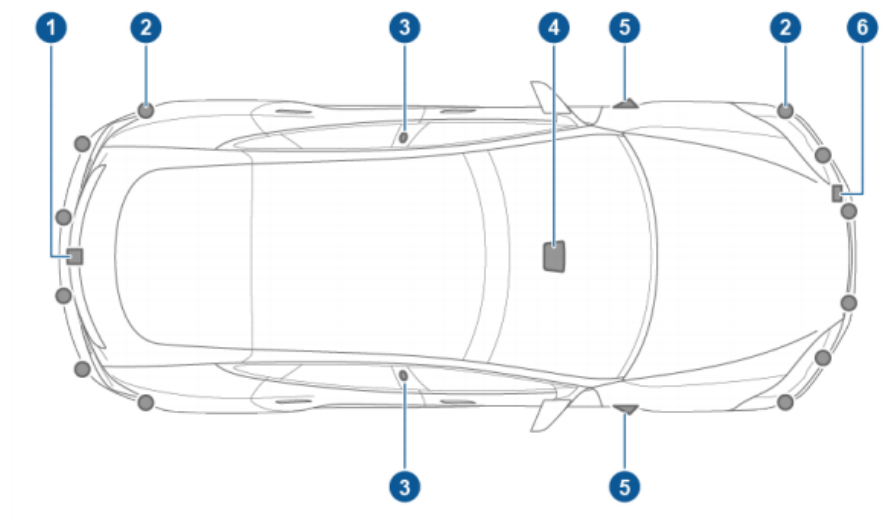**Reliability**

Privacy

The Edge

OrCam

Compology

iRobot

10

The Edge

Blue River Technology

ultrasoundtechnicalschools.com

Tesla (Model S -- 8 cameras + ultrasonic sensors and radar)

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The Edge

Kdminer.com
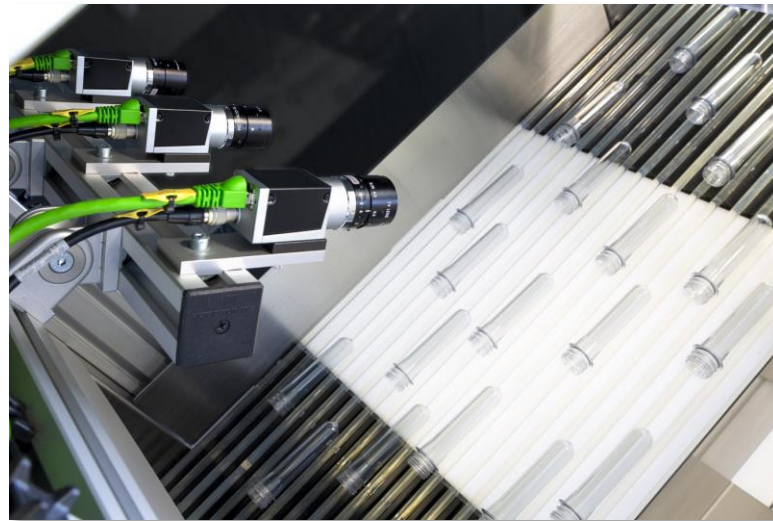
intravis.com

wdrb.com

Nick Statt / The Verge

Hortdaily.com

Nimbleplanet.com

secure-transportation.co.uk

Paul Sullivan

wsj.com

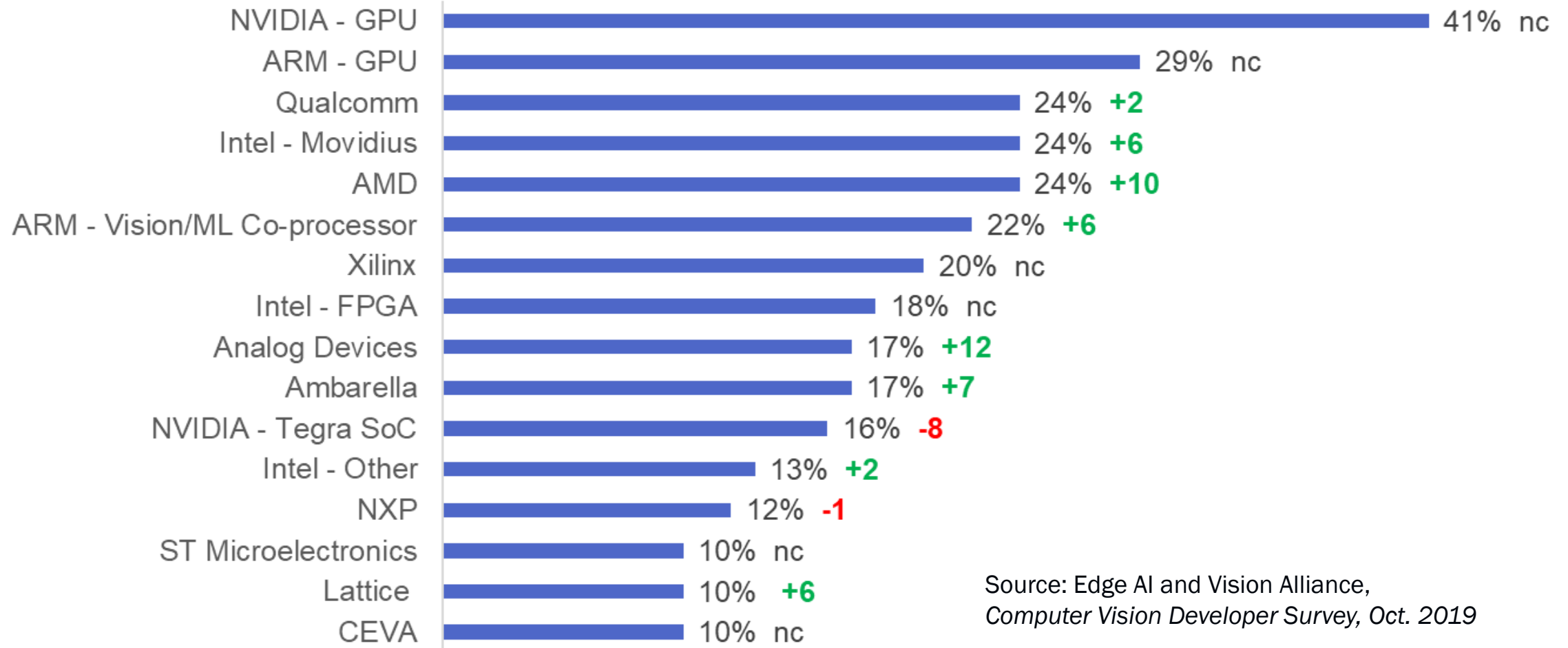13

OrCam

Compology

iRobot

secure-transportation.co.uk

wsj.com

Paul Sullivan

14

Processors Used for Medical Vision Applications
(Excluding CPUs)

Processor	Percentage	Change
NVIDIA - GPU	41%	nc
ARM - GPU	29%	nc
Qualcomm	24%	+2
Intel - Movidius	24%	+6
AMD	24%	+10
ARM - Vision/ML Co-processor	22%	+6
Xilinx	20%	nc
Intel - FPGA	18%	nc
Analog Devices	17%	+12
Ambarella	17%	+7
NVIDIA - Tegra SoC	16%	-8
Intel - Other	13%	+2
NXP	12%	-1
ST Microelectronics	10%	nc
Lattice	10%	+6
CEVA	10%	nc

Source: Edge AI and Vision Alliance,
Computer Vision Developer Survey, Oct. 2019

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Processors
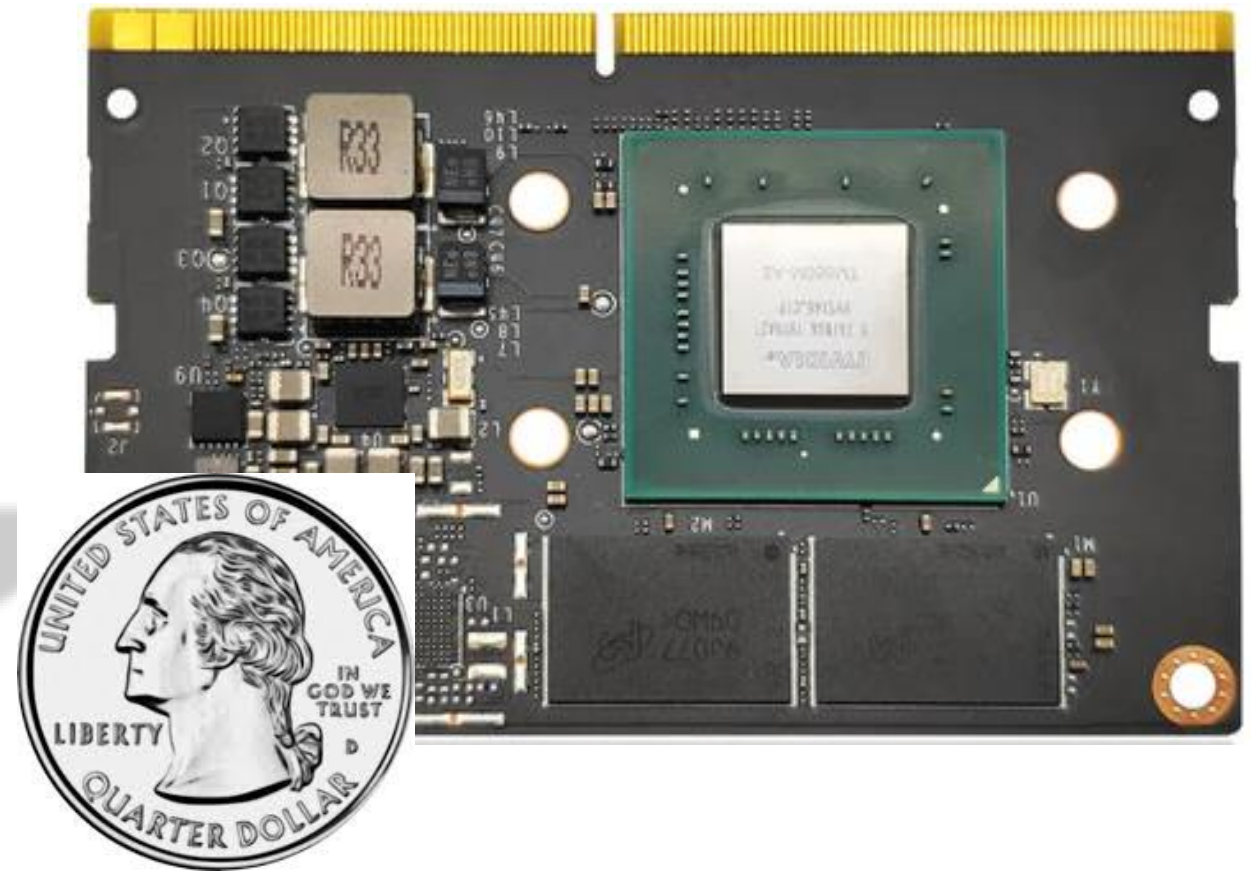
Image: iconspng.com

Image: aliexpress.com

Building Blocks

Frameworks		Simulators	
Processor Modules		Reference Designs	Libraries
Processors	Sensors		
ISPs	Optics		Compilers
Memory	Light Sources		Algorithms & Networks
Camera Modules			
Tools-as-a-Service		Training Data & Labeling	

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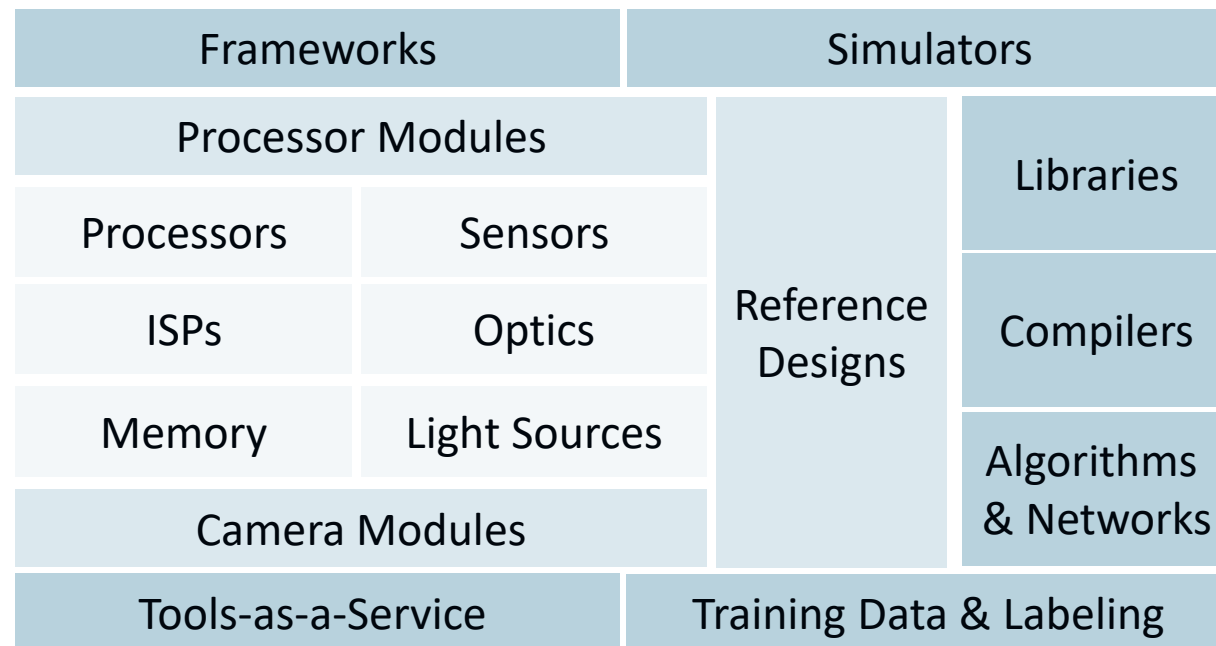
Challenge: Many Technology Choices
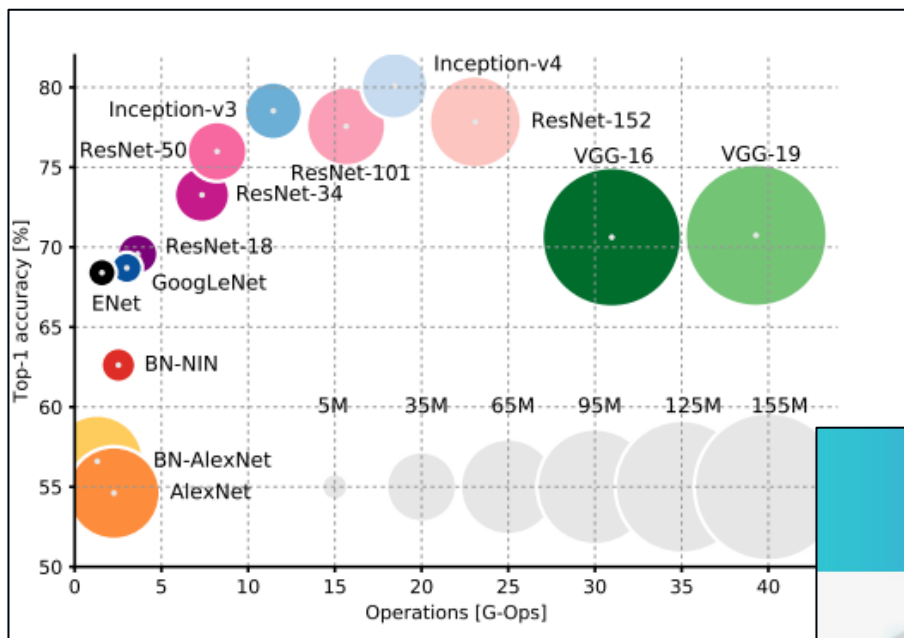
Top 8 Deep Learning Frameworks

TensorFlow · Keras · mxnet · PyTorch

Caffe · Microsoft Cognitive Toolkit · DL4J · ONNX

maruti techlabs

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Images: Canziani, Culurciello, Paszke; Maruti Techlabs; Edge AI and Vision Alliance
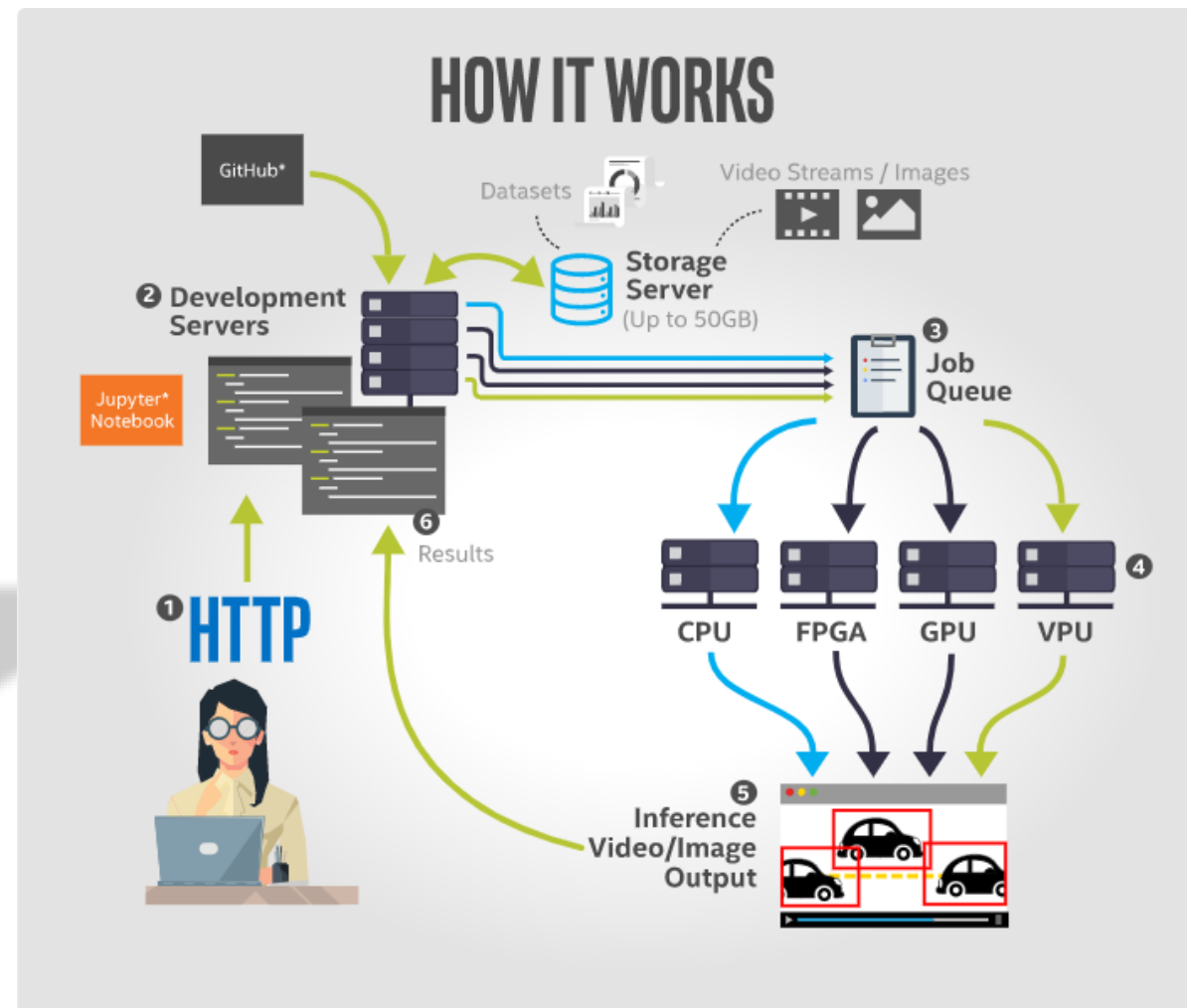
Image: intel.com

Most Challenging Areas of Computer Vision Product Development

Area	Percentage	Change
Algorithm implementation/optimization	54%	▲ 1%
Algorithm design	53%	▼ 2%
Dataset curation	34%	▲ 10%
Dataset annotation	32%	▲ 7%
Hardware design	31%	▼ 2%
*Identifying the right hardware platform for deployment	30%	
Dataset sourcing	29%	▲ 6%
Product testing/validation	26%	▼ 2%
Software integration	24%	▼ 4%
Other	2%	▼ 1%

Ranked as one of top three

*Answer Option Added in 2019
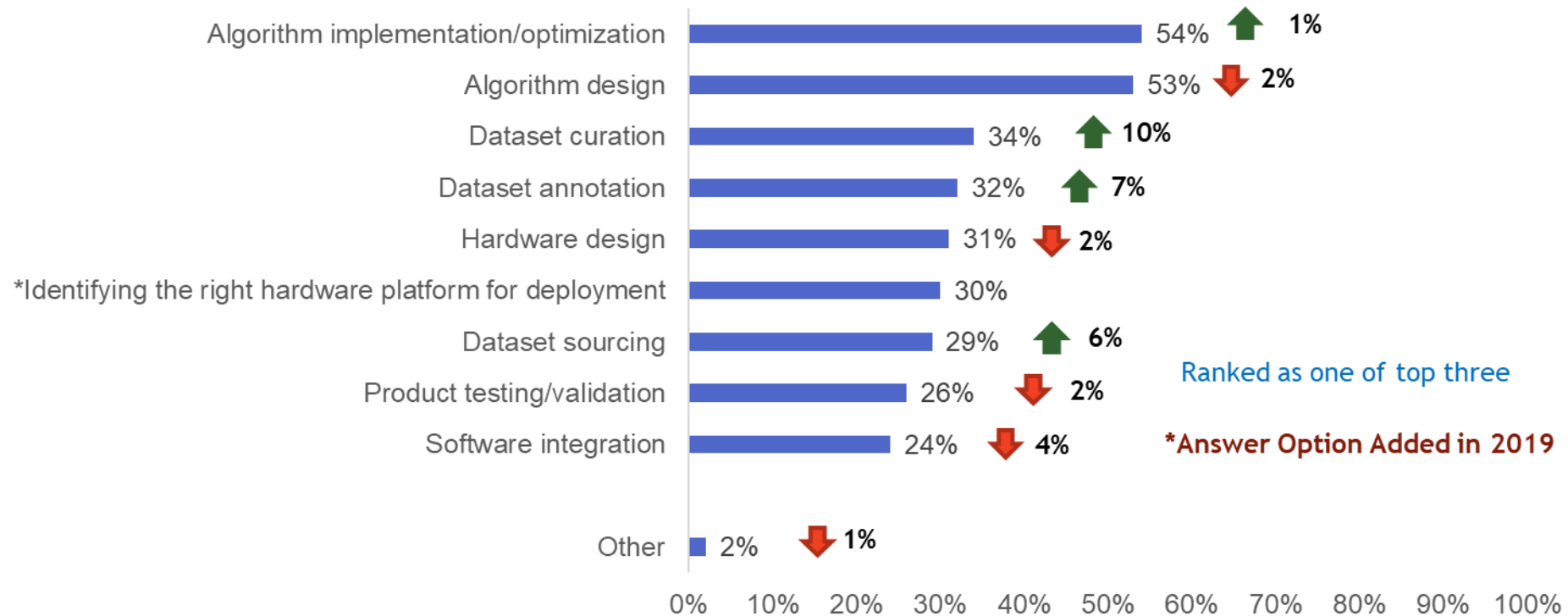
Source: Edge AI and Vision Alliance, *Computer Vision Developer Survey, Nov. 2019*

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Other	2%	▼ 1%

Ranked as one of top three

*Answer Option Added in 2019

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Source: Edge AI and Vision Alliance, *Computer Vision Developer Survey, Nov. 2019*

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Synthetic Data and Data Augmentation

Visual AI and Privacy
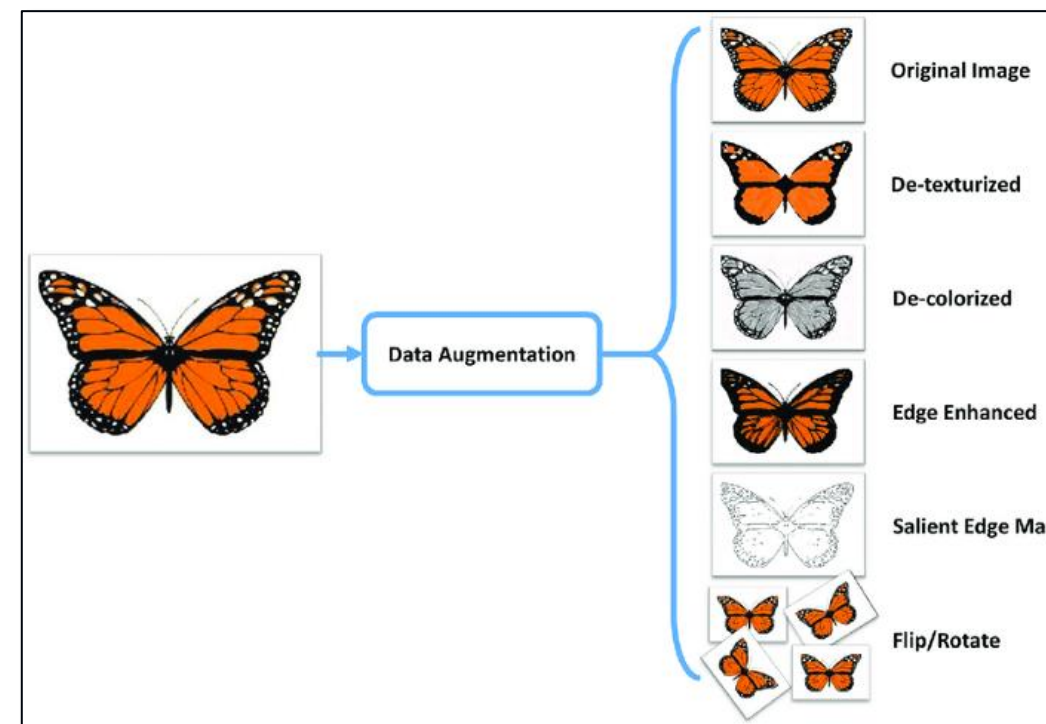
cpb.gov

Theverge.com
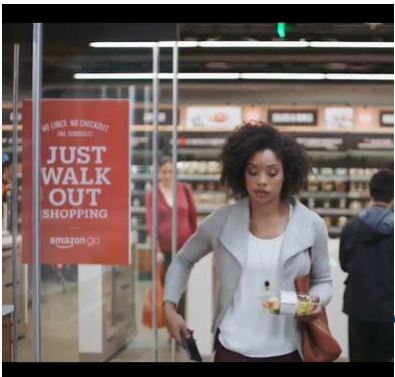
Amazon

BUSINESS INSIDER

Homeland Security is walking back its plans to use facial recognition on US citizens traveling internationally

Aaron Holmes
Dec 6, 2019, 11:43 AM

- The Department of Homeland Security will not require traveling US citizens to participate in a facial recognition screening, the agency announced Wednesday.
- The announcement reverses a DHS proposal last week that would have mandated that all US citizens have their faces scanned when traveling internationally.
- Facial recognition scanning is already a requirement for non-citizens who travel in the US.

The Department of Homeland Security is changing course on a policy introduced last week that would have required all US citizens traveling internationally to have their faces scanned and added to a biometric database.

DORSEY™
always ahead

POTENTIAL IMPACTS OF PRIVACY REGULATION AND LITIGATION ON VISION TECHNOLOGY

10

Bob Cattanach, Dorsey & Whitney

Design for Privacy

John Velasco

Coolblue.nl

Parametric.ch

John Velasco

Design for Privacy

John Velasco

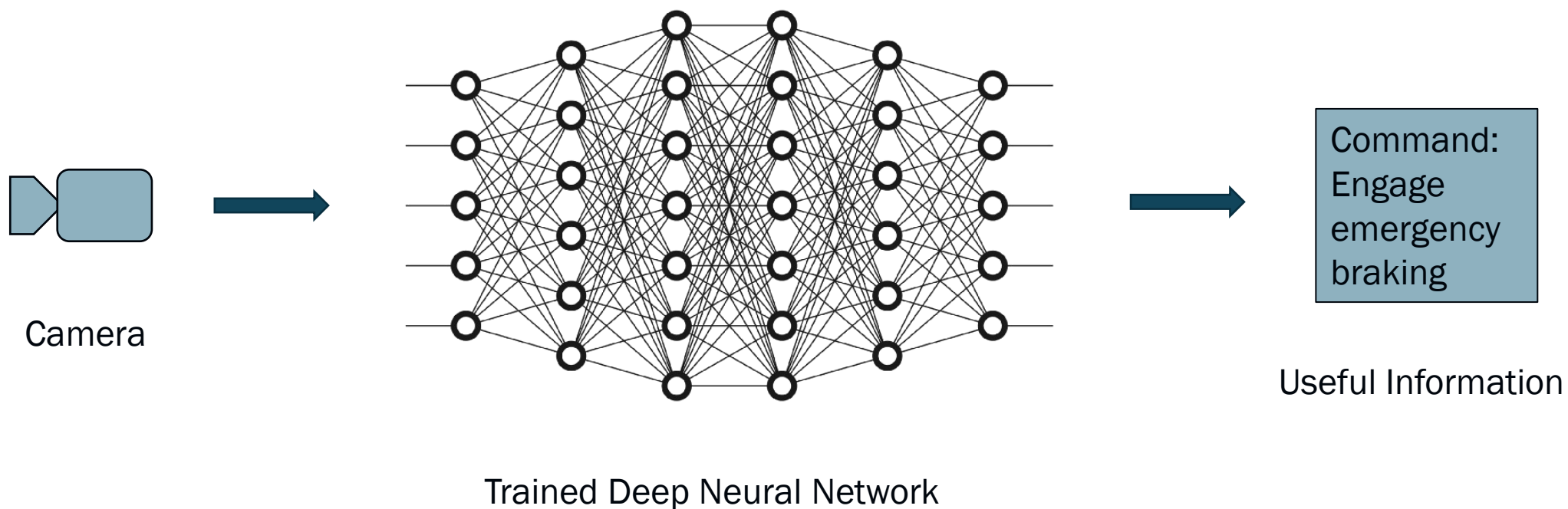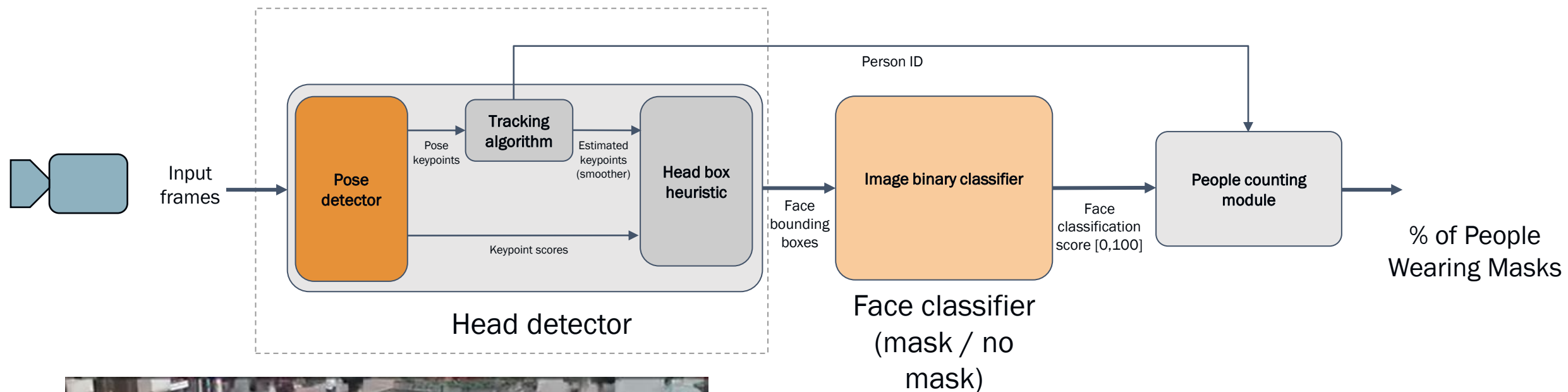Coolblue.nl

Parametric.ch

Algorithms — What We Imagine

Camera

Trained Deep Neural Network

Command: Engage emergency braking

Useful Information

Image: freeCodeCamp.org

Typical Composite Real-World Algorithm
Estimating % of People Wearing Masks

Input frames → **Pose detector** → Pose keypoints → **Tracking algorithm** → Estimated keypoints (smoother) → **Head box heuristic**

Keypoint scores → **Head box heuristic**

Person ID

Head detector

Face bounding boxes → **Image binary classifier** → Face classification score [0,100] → **People counting module** → % of People Wearing Masks

Face classifier (mask / no mask)

Classified: 29 / 98
With Mask: 8 [27%]

Source: Tryolabs
(diagram modified)

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tryo·labs

Commercially Licensed Algorithms

Semantic Segmentation   Filter
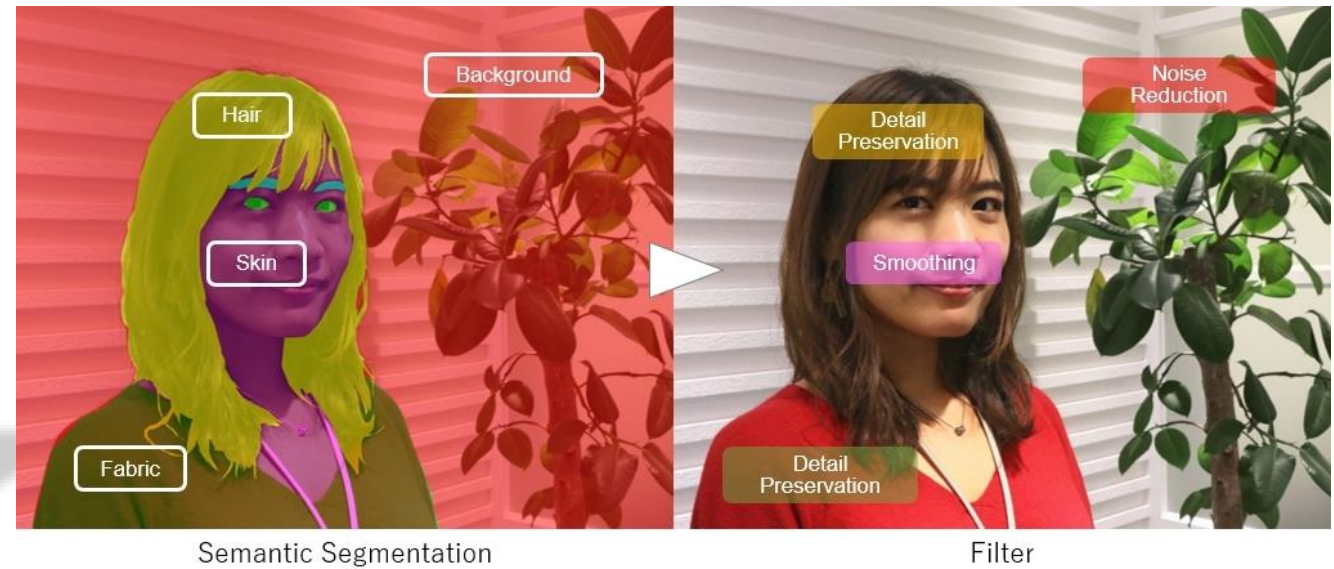
Image: Morpho

Components to Solutions

Frameworks		Simulators	
Processor Modules		Reference Designs	Libraries
Processors	Sensors		
ISPs	Optics		Compilers
Memory	Light Sources		
Camera Modules			Algorithms & Networks
Tools-as-a-Service		Training Data & Labeling	

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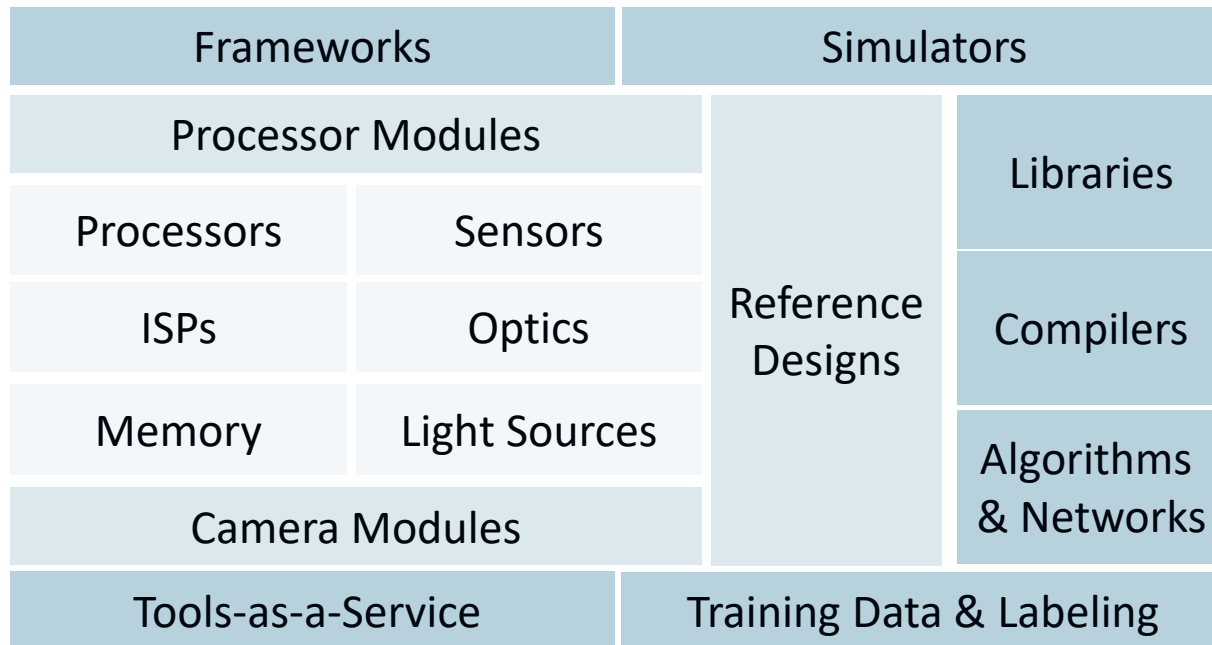
Components to Solutions

Components to Solutions

Construction	Mining	Logistics	Retail
People Detection and Tracking		Indoor Robot Perception	Agriculture
Frameworks	Simulators		
Processor Modules	Reference Designs	Libraries	Home Healthcare
Processors	Sensors		
ISPs	Optics	Compilers	
Memory	Light Sources		
Camera Modules		Algorithms & Networks	
Tools-as-a-Service	Training Data & Labeling	Motor Vehicle Perception	Refuse/ Recycling
Inspection			
Manufacturing	Clinical Healthcare	Motor Vehicles	

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Domain-specific Platforms

WINNER

2020 VISION PRODUCT OF THE YEAR

Best Automotive Solution

Horizon Robotics
Journey 2

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Matrix	Tool Chain	Autonomous Driving
ADAS	JOURNEY	DMS
Matrix 360° Perception	Mapping	HIL/Data Collection Tools

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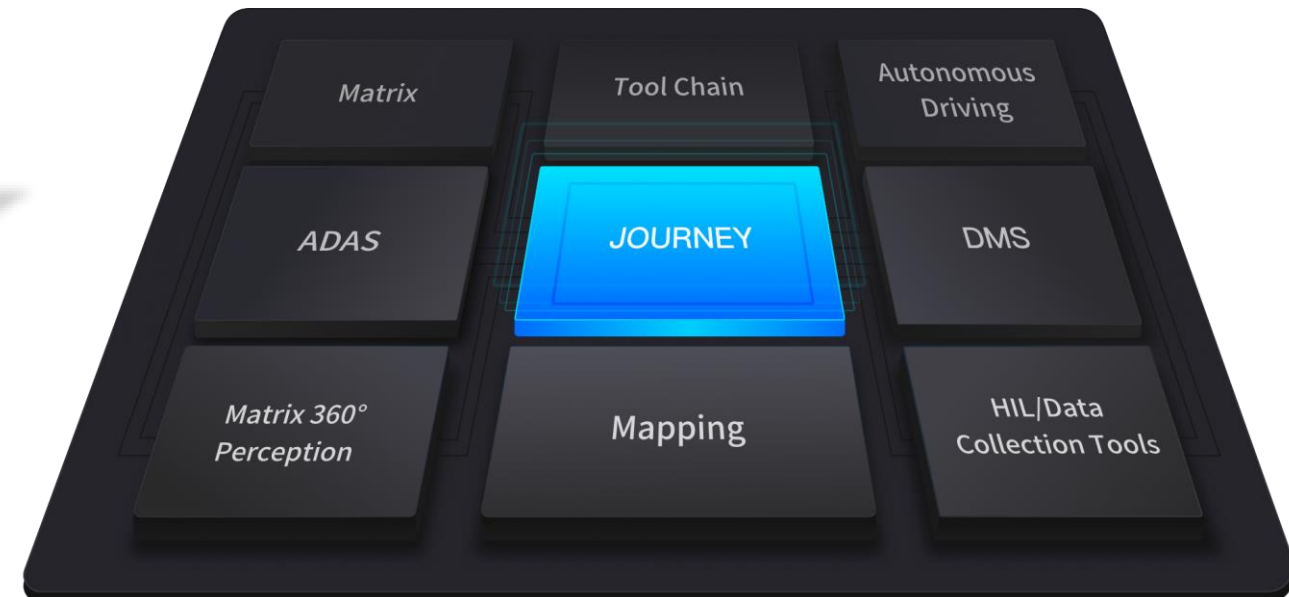
Depth Sensing Proliferates

Image: appleinsider.com

Image: pcc.disam.etsii.upm.es
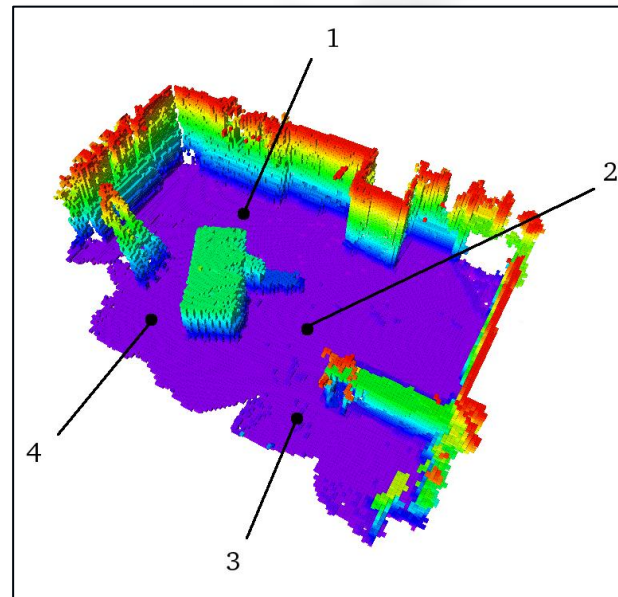
Image: Skydio via highways.today

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Use of 3D Perception in Products

Source: Edge AI and Vision Alliance, *Computer Vision Developer Survey, Nov. 2019*

Sensor Innovation
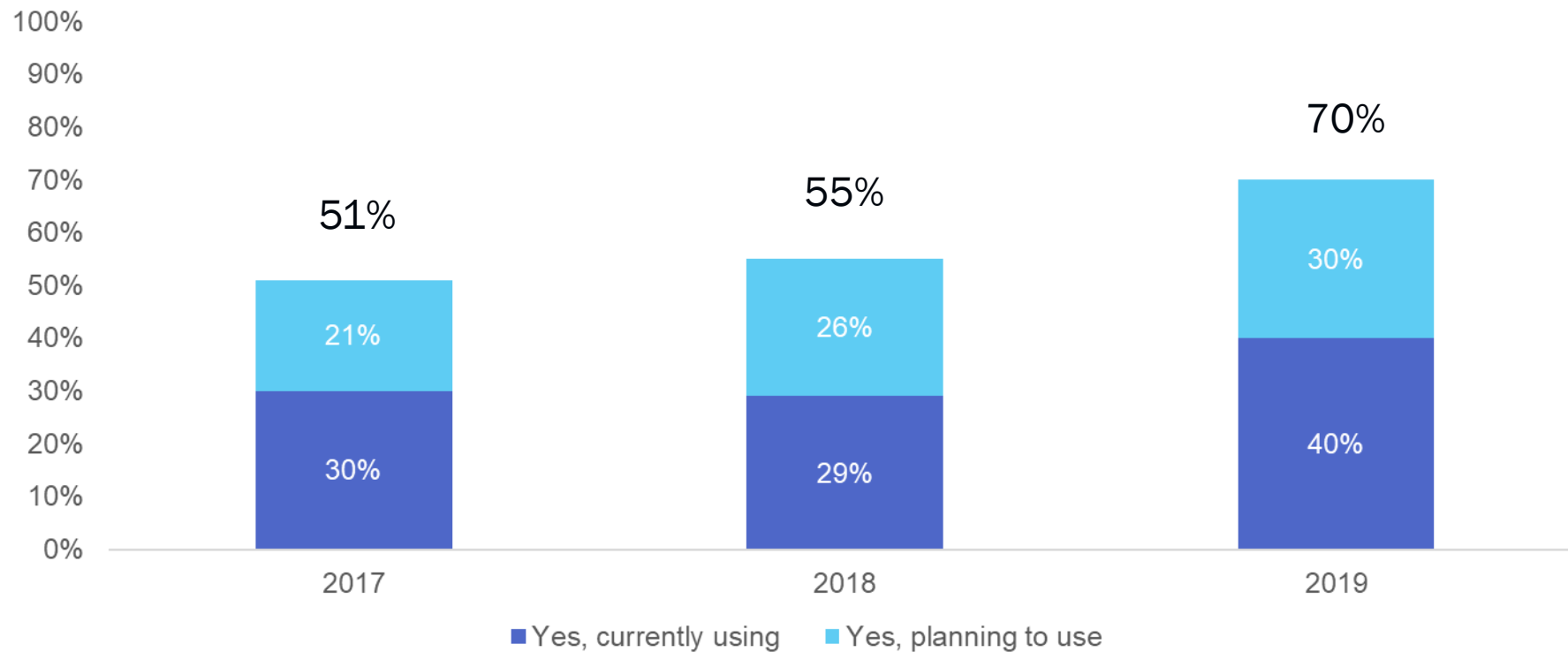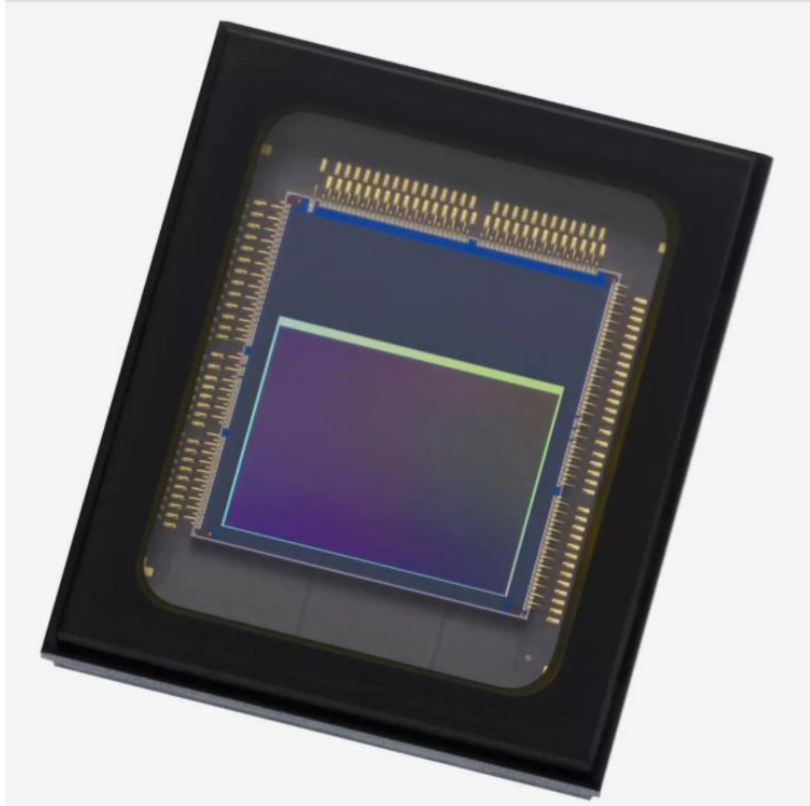
Image: techspot.com

Image: imveurope.com

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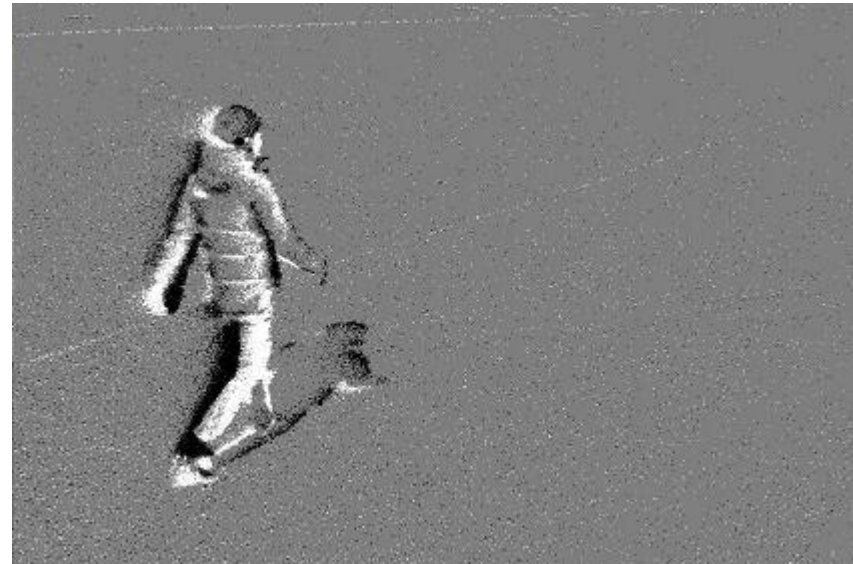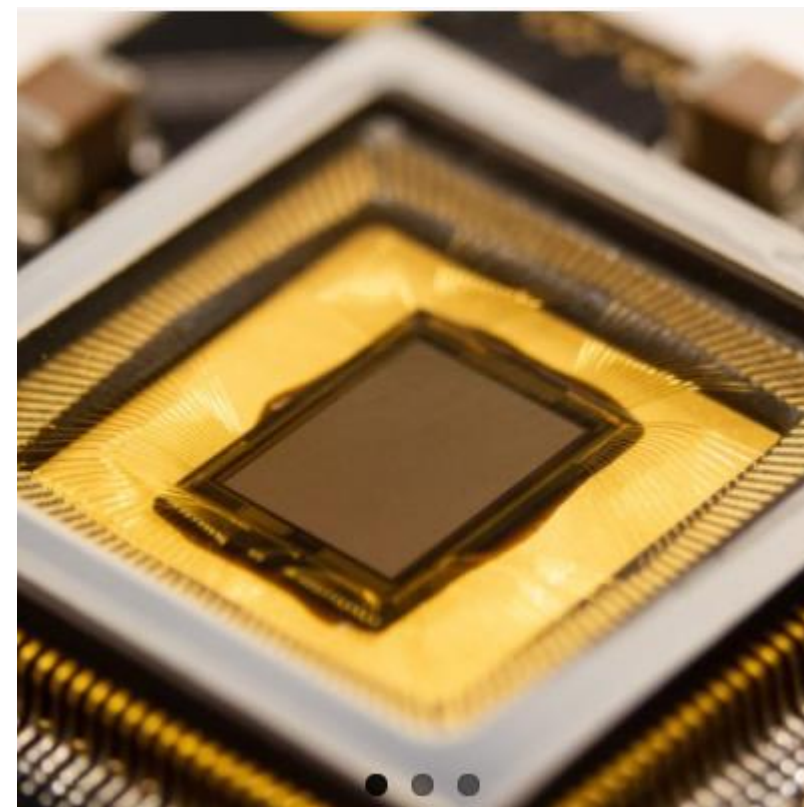
Applications and Opportunities

Applications: Autonomous Machines
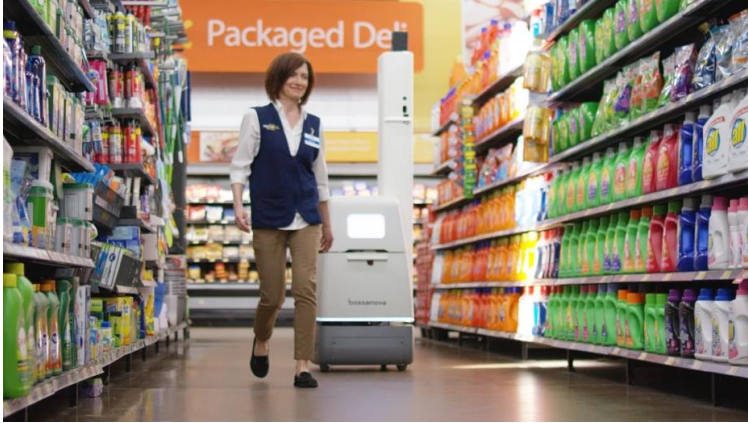
Source: Bossa Nova Robotics

Source: Seegrid

Source: iRobot

Source: Restoration Robotics

Source: Blue River Technology

Source: Knightscope

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Skydio Self-Piloting Drone Surveys Roofs
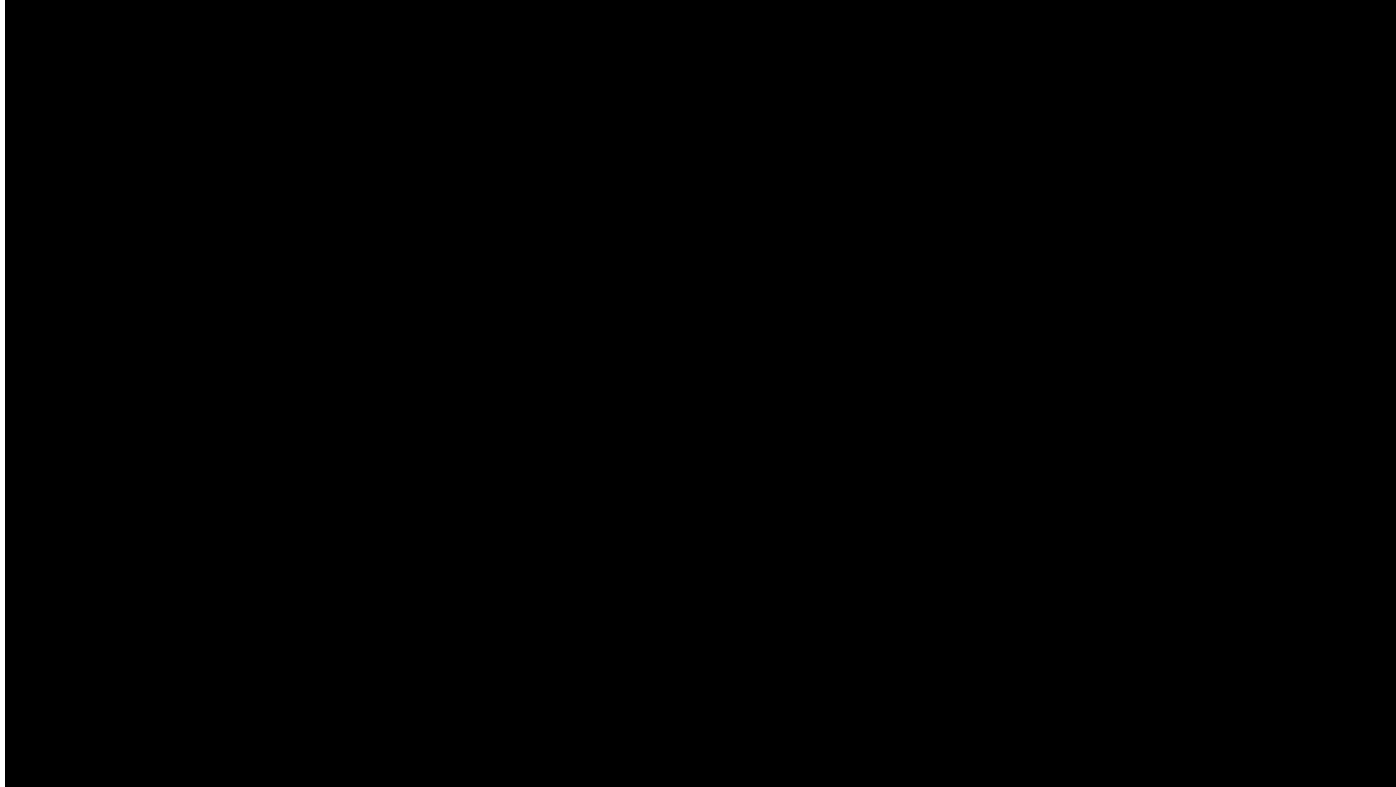
https://www.youtube.com/watch?v=MSy_06aOBzg

Applications: Smart Spaces

Source: Petcube

Source: cpb.gov

Source: Compology

Source: Ringdoorbell.eu

Source: Orbital Insight

Source: Identified Technologies
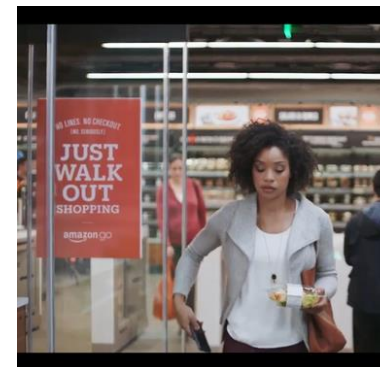
Source: Amazon

Source: Hortdaily.com

https://www.youtube.com/watch?v=mQ6wN0pUsVY

Applications: Health and Safety

Source: VirtuSense

Source: Opternative

Source: HeartFlow
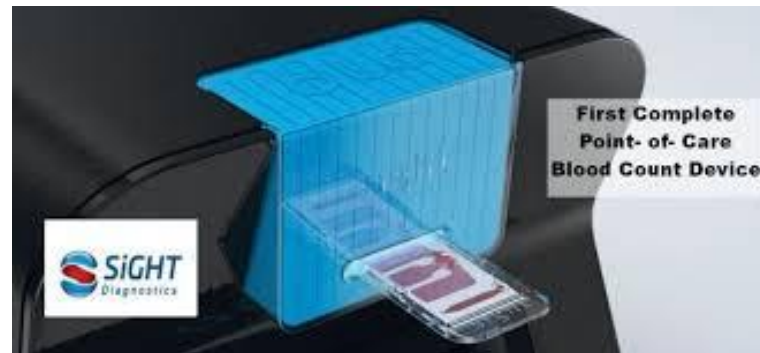
Source: Sight Diagnostics

Source: Reflexion Health

Millie Fit: Your AI Pilates Trainer

https://www.youtube.com/watch?v=RYhWvJgIcsE

The Edge AI and Vision Alliance

The **Edge AI and Vision Alliance** is a partnership
of 100+ leading technology and systems companies

We inspire and empower product developers to create
better products using computer vision and edge AI

- For free educational resources, visit
  www.edge-ai-vision.com and sign up for
  our newsletter

We help companies find their best opportunities in this burgeoning industry

- For membership info, contact us: info@edge-ai-vision.com

Take-Aways

- Computer **vision**/visual AI deployment at the **edge** is accelerating rapidly

  - Fueled by deep learning and rapid improvements in processors, sensors, tools, platforms

- There are numerous huge opportunities to improve lives and industries, and build businesses

  - At the solution, platform and component levels

- There are many serious challenges:

  - Data

  - Overwhelming range of choice in components

  - Assembling robust solutions—not just trained DNNs

  - Avoiding reinventing the wheel

- We are entering a golden era of practical computer vision

  - Take advantage of it! Go out and make something!

Edge AI and Vision Alliance Members

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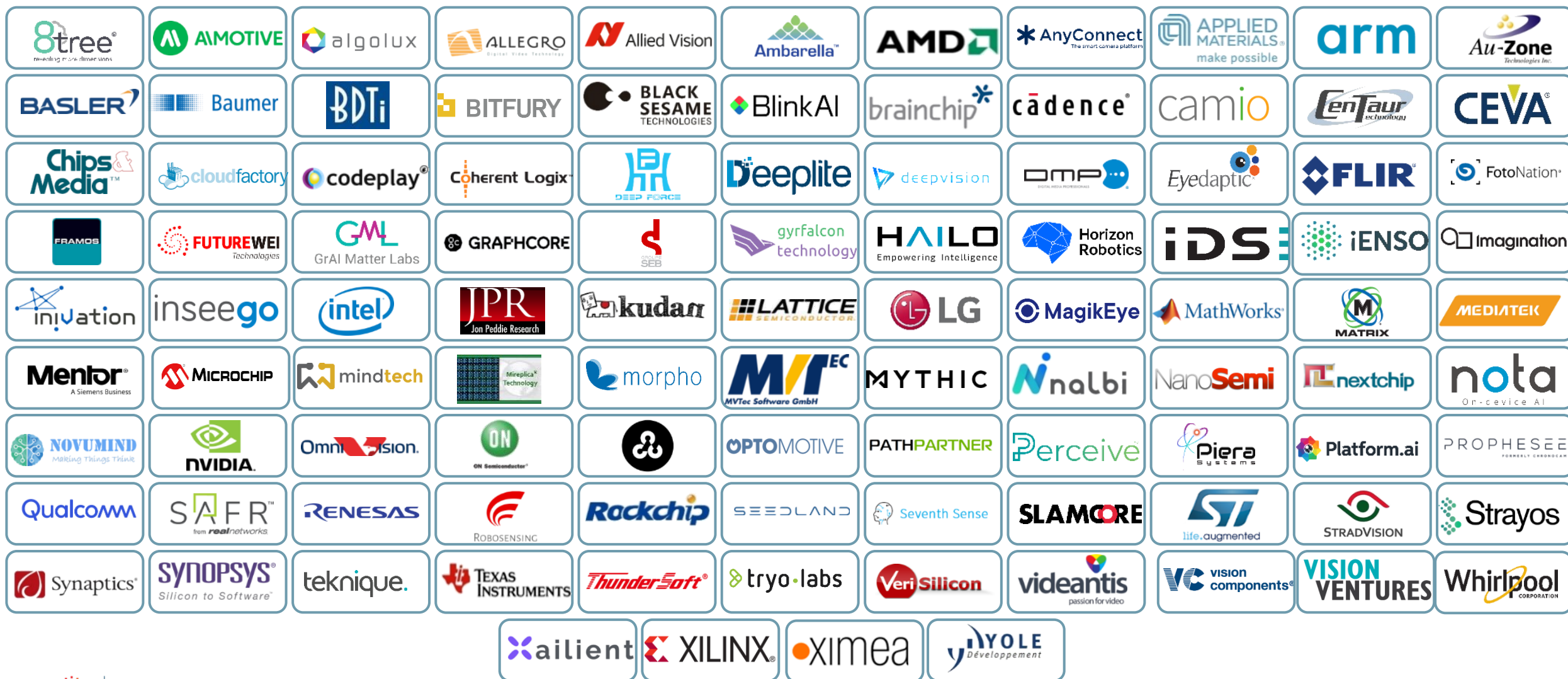
Questions?

Email me for:

- Questions

- Information about how your company can become a Member of the Edge AI and Vision Alliance

Jeff Bier
Founder, Edge AI and Vision Alliance
Chairman, Embedded Vision Summit
President, BDTI

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