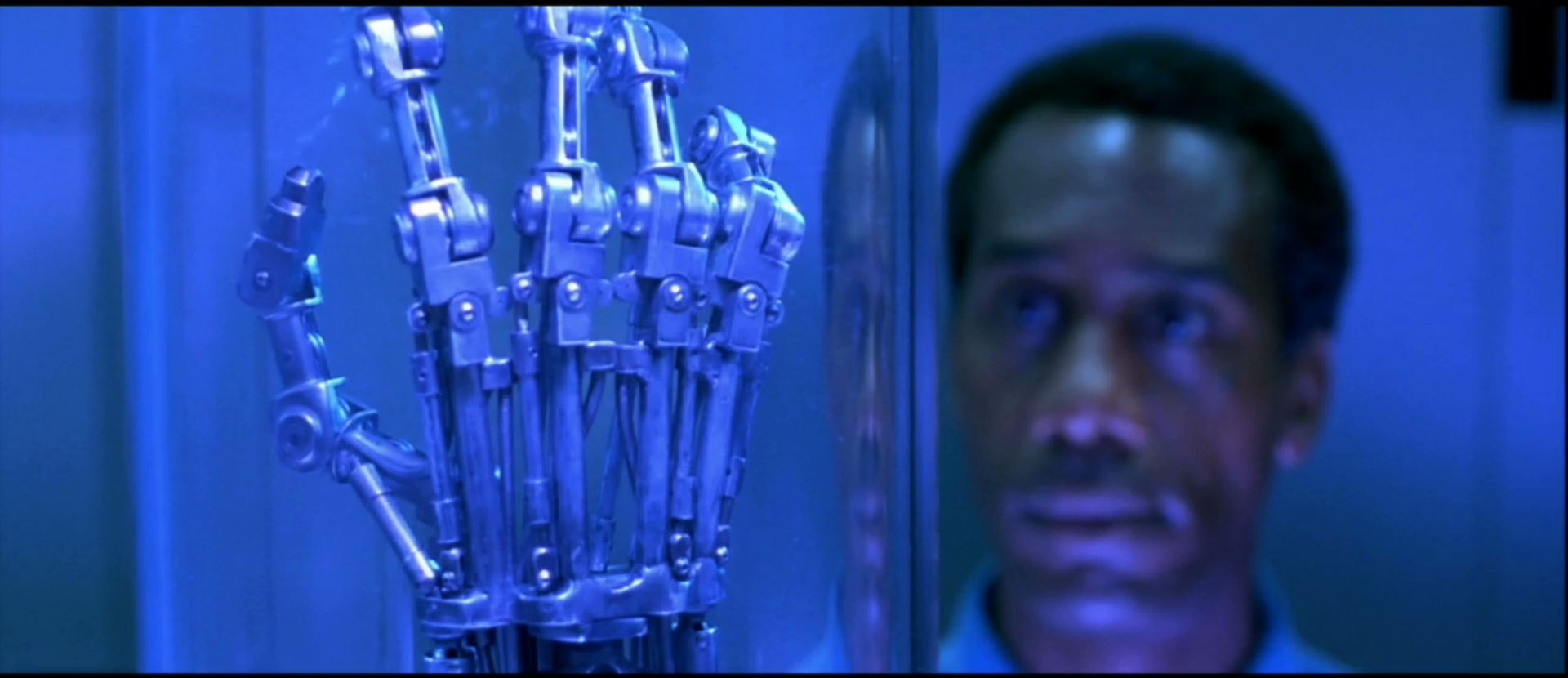
SKYNET

NEURAL NET-BASED ARTIFICIAL INTELLIGENCE

CYBERDYNE SYSTEMS CORPORATION

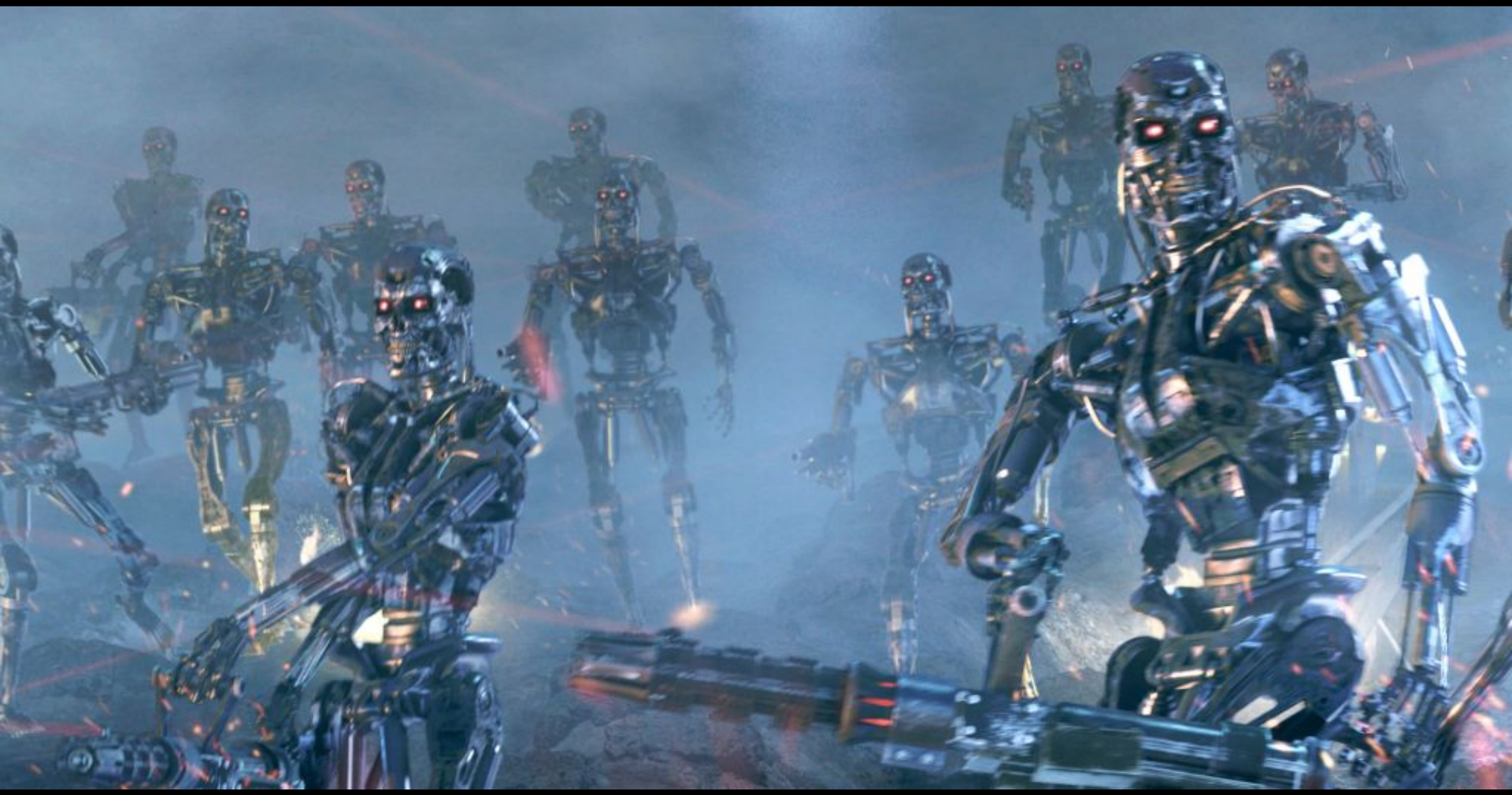


August 4, 1997: Skynet goes online

August 29, 1997, 2:14am ET: Skynet gains ‘consciousness’


U.S.

August 29, 1997: Judgement Day




CURRENT DATE: 09.10.1999
TARGET DATE: 2007
ENABLED
CODE SEQUENCE
ACCESS DTA
APPEND/RESET

Terminator (1984)

What ‘features’ does T-800 have?

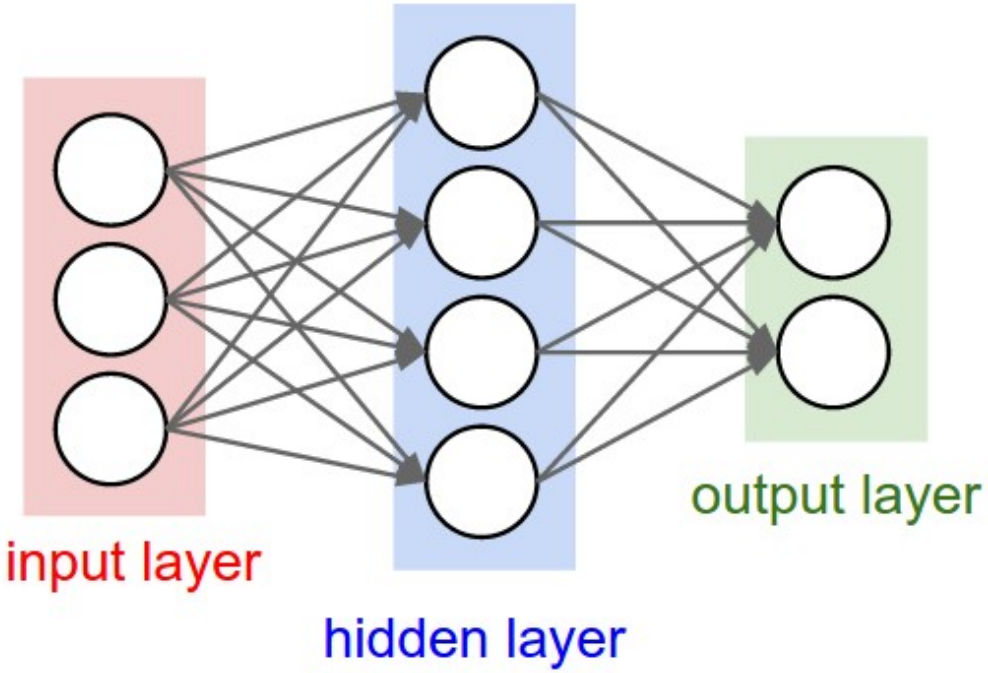
What ‘features’ does T-800 have?

- Vision/Perception
- Speech
- Motion/Planning
- Object Manipulation
- Self-Repair
- Goal-directed Exploration
- Social Skills
- ~~Ethics/Morality~~

Back to our timeline..

1960's (1st Wave)

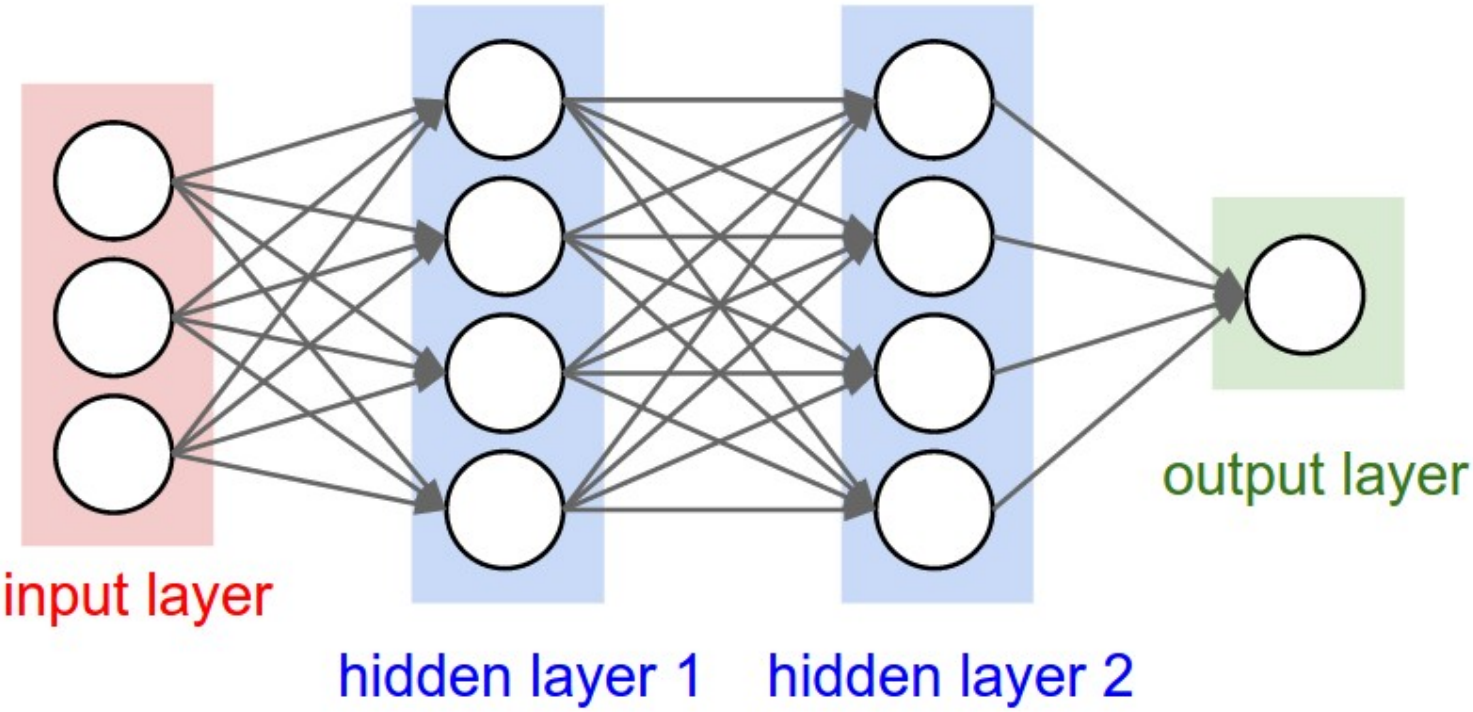
- **Single Layer networks**



- **XOR problem killed research for two decades**

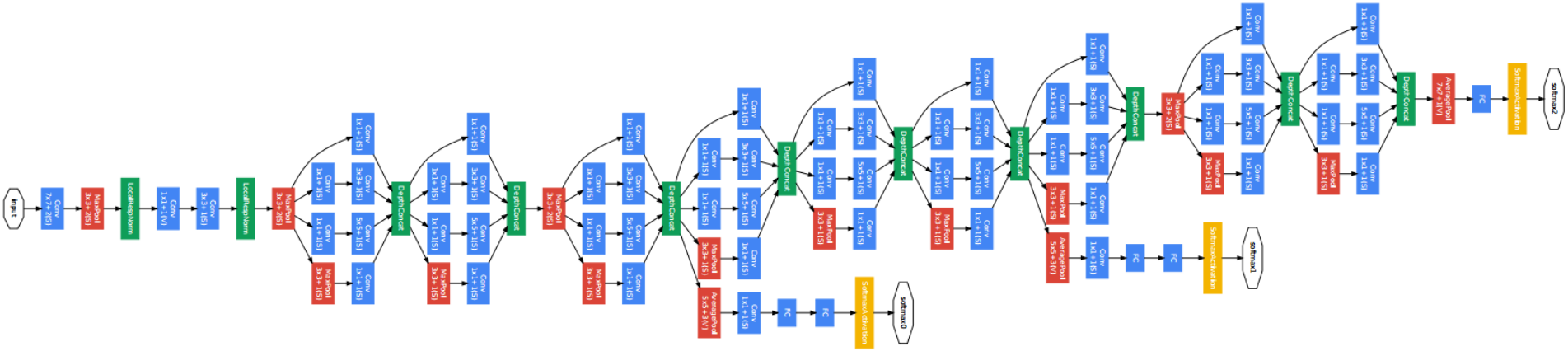
Mid-1980s (2nd Wave)

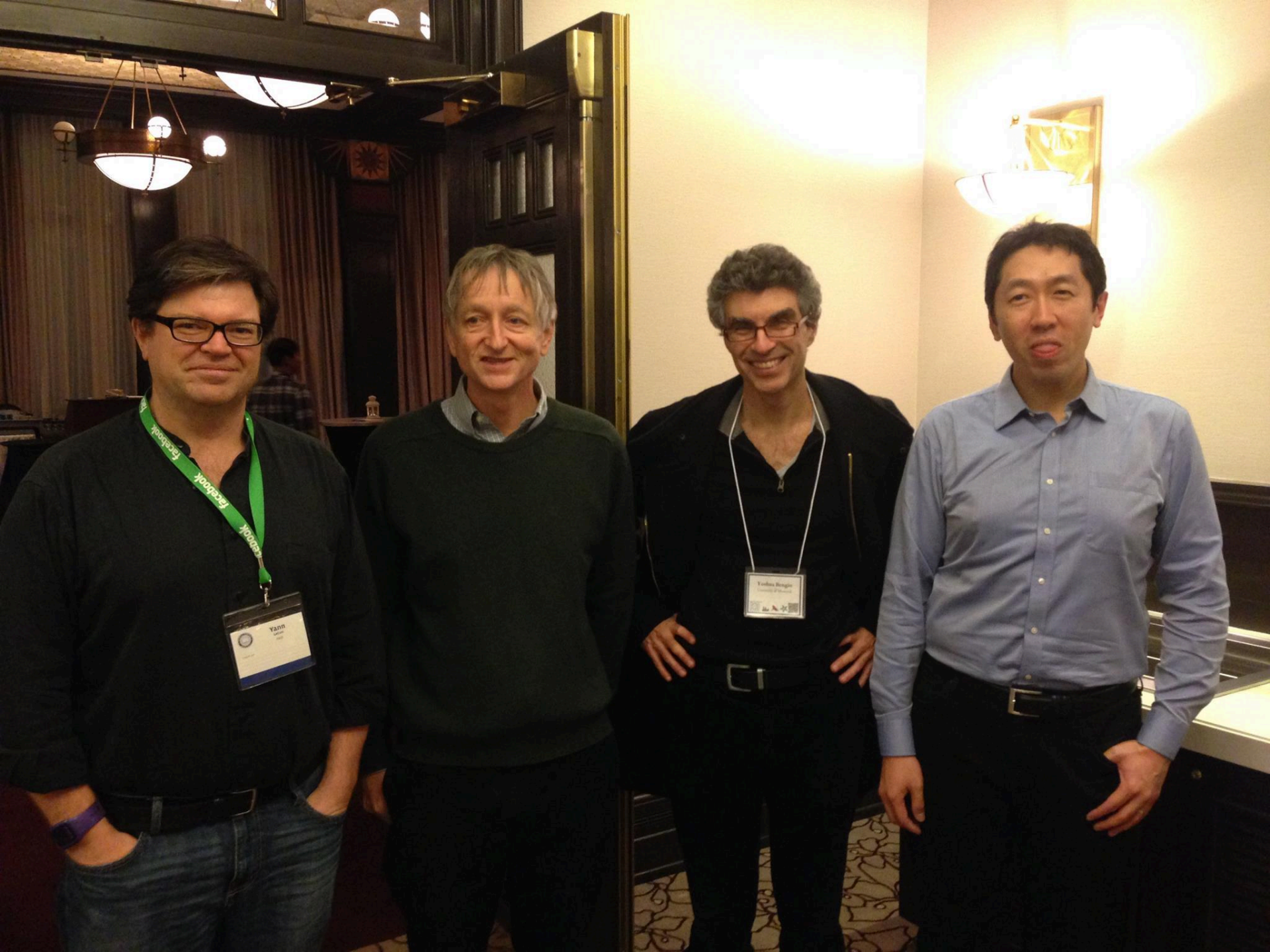
- **Multi-layer networks**
- **Backpropagation algorithm**

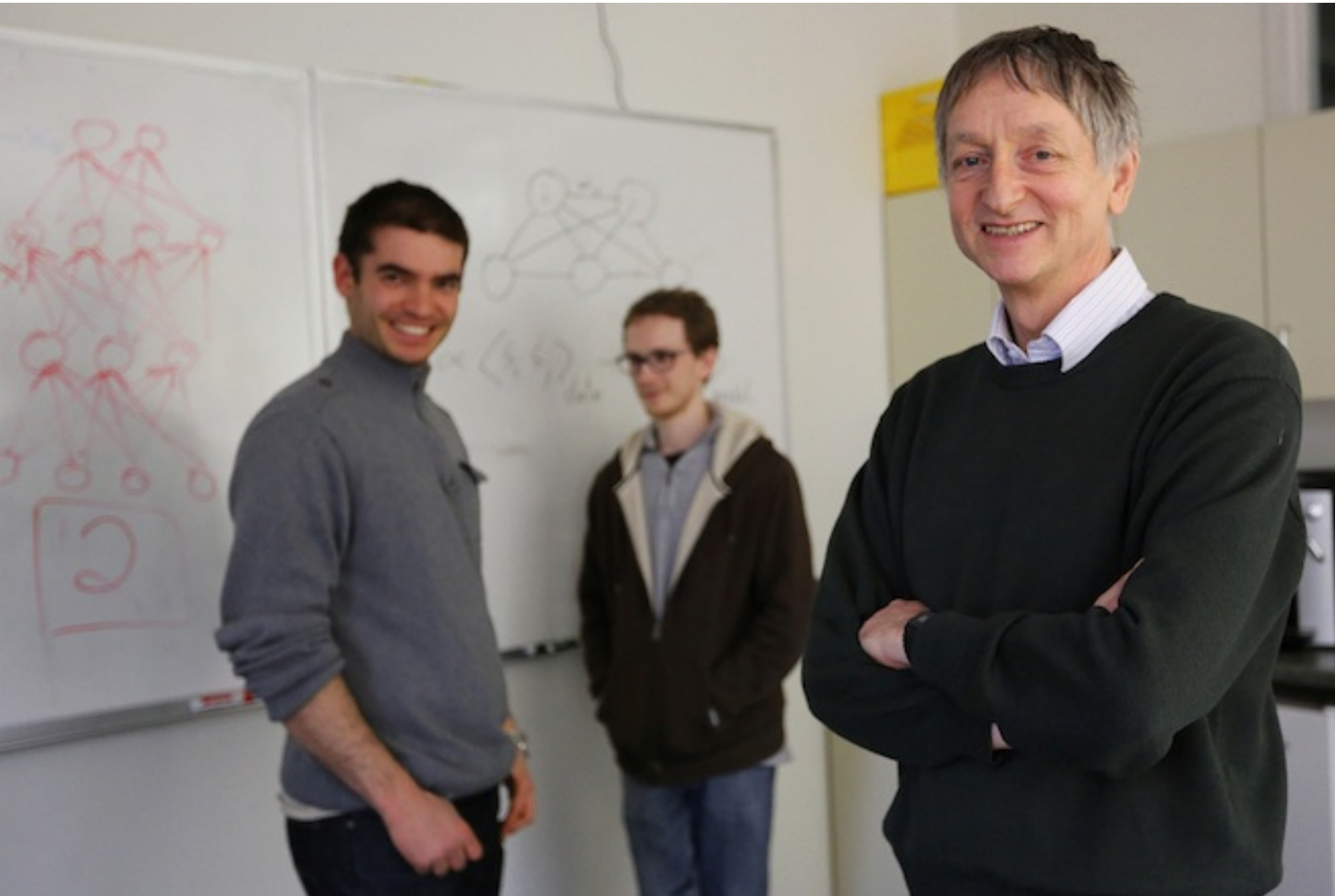


2010s (3rd Wave)

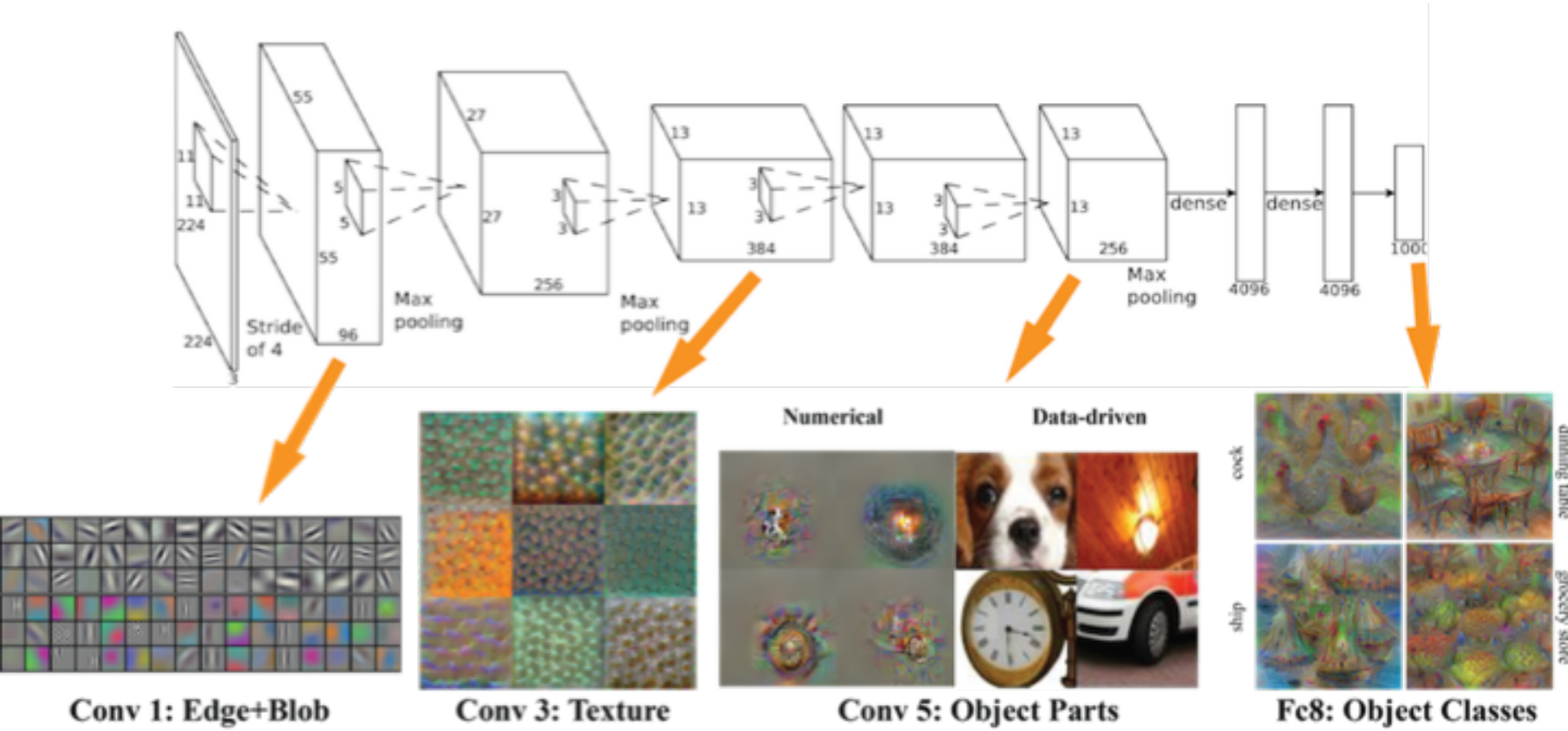
- **Big Data**
  - O(M) labeled images
- **Big Compute**
- **‘Deep’ Learning**



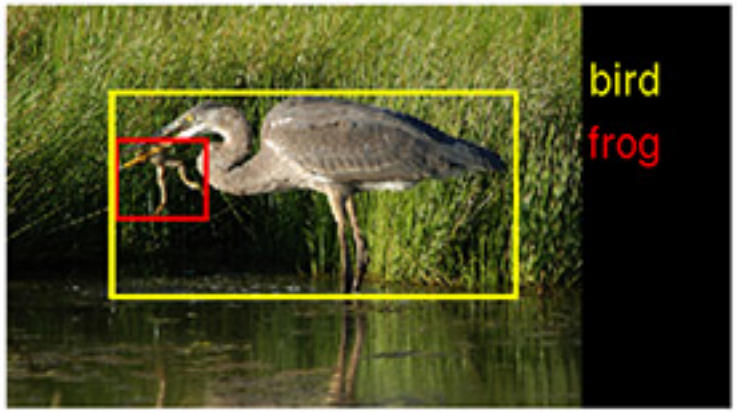

facebook
Yann
Yoshua Bengio

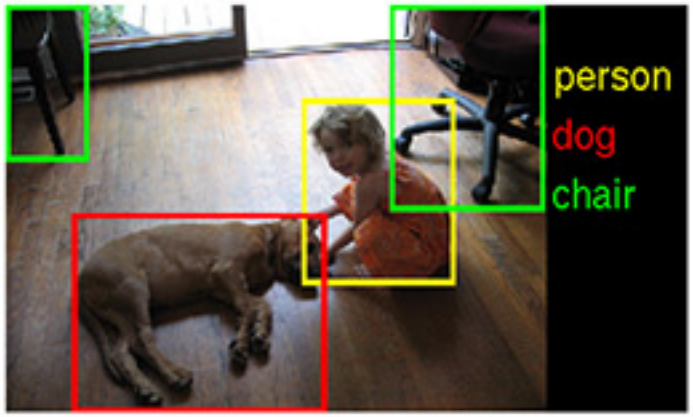


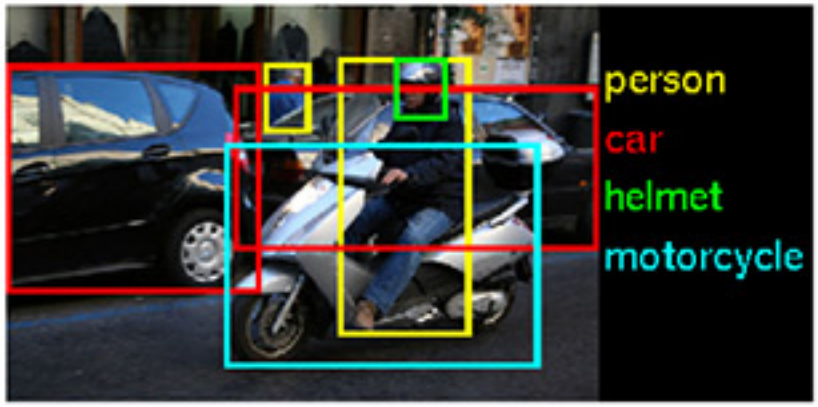
ImageNet Architecture



Deep Learning for Computer Vision

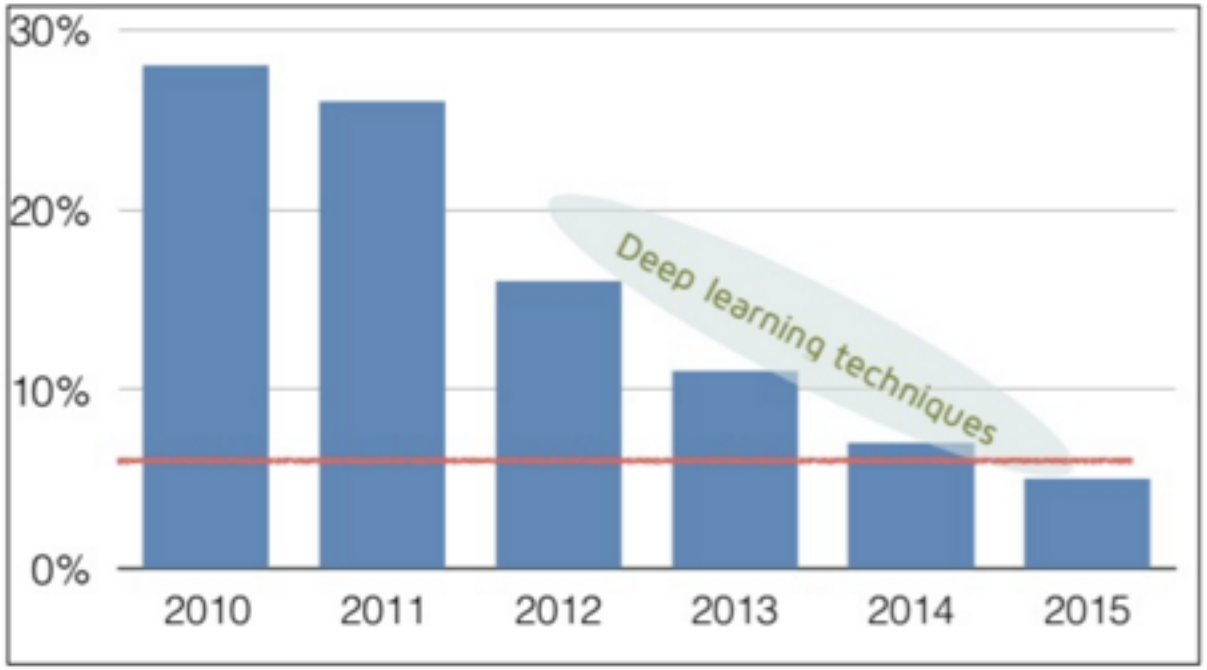






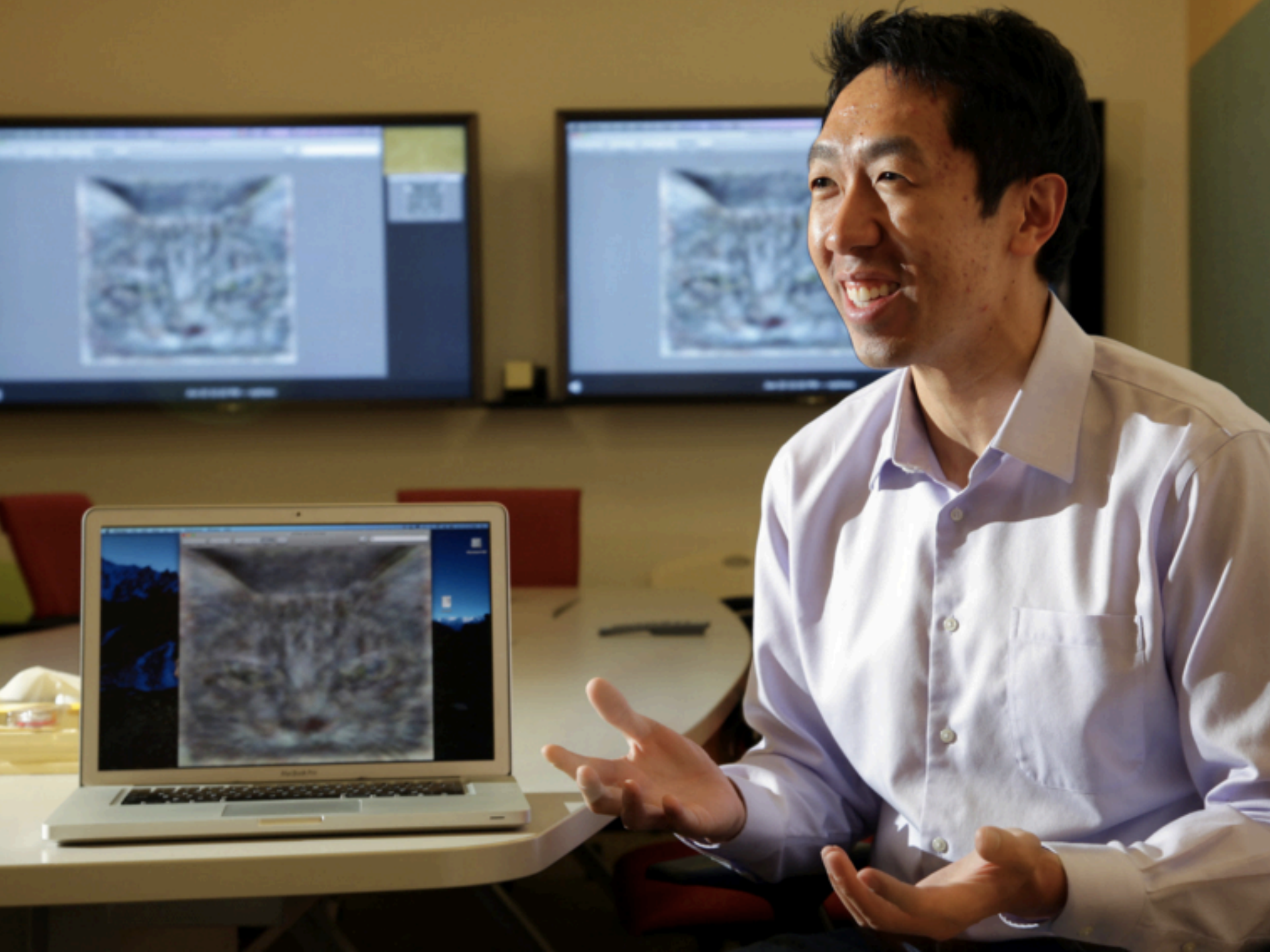
Imagenet ILSVRC Challenge

Error rate[1]

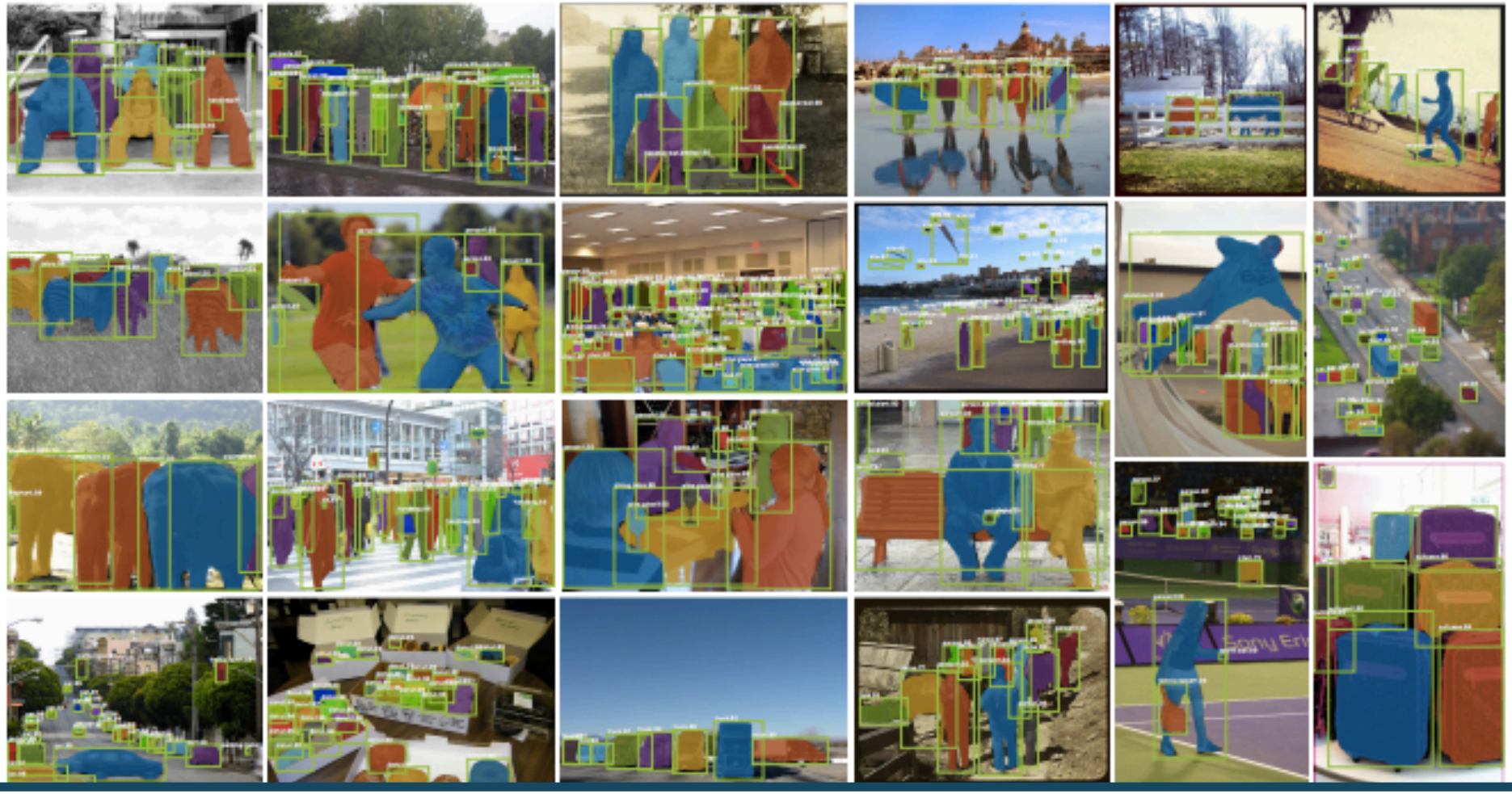


human performance

1: ImageNet top 5 error rate
Source: ImageNet

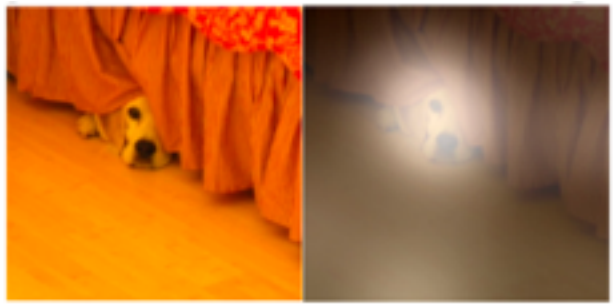


Deep Learning for Segmentation



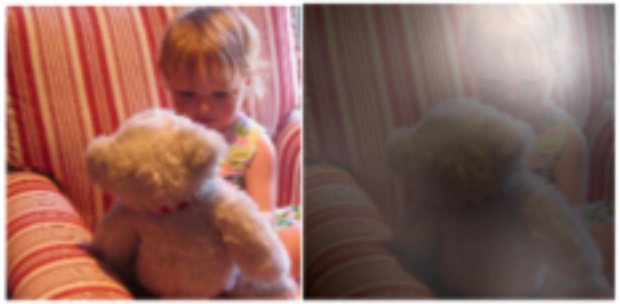
Deep Learning for Caption Generation

A woman is throwing a frisbee in a park.

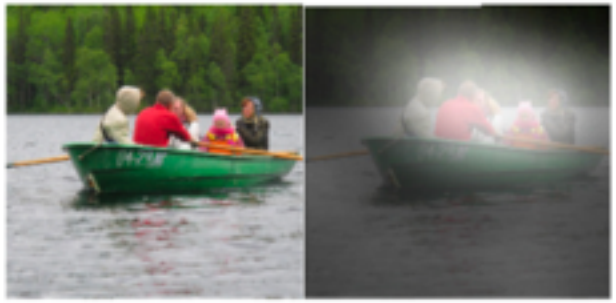


A dog is standing on a hardwood floor.

A stop sign is on a road with a mountain in the background.



A little girl sitting on a bed with a teddy bear.

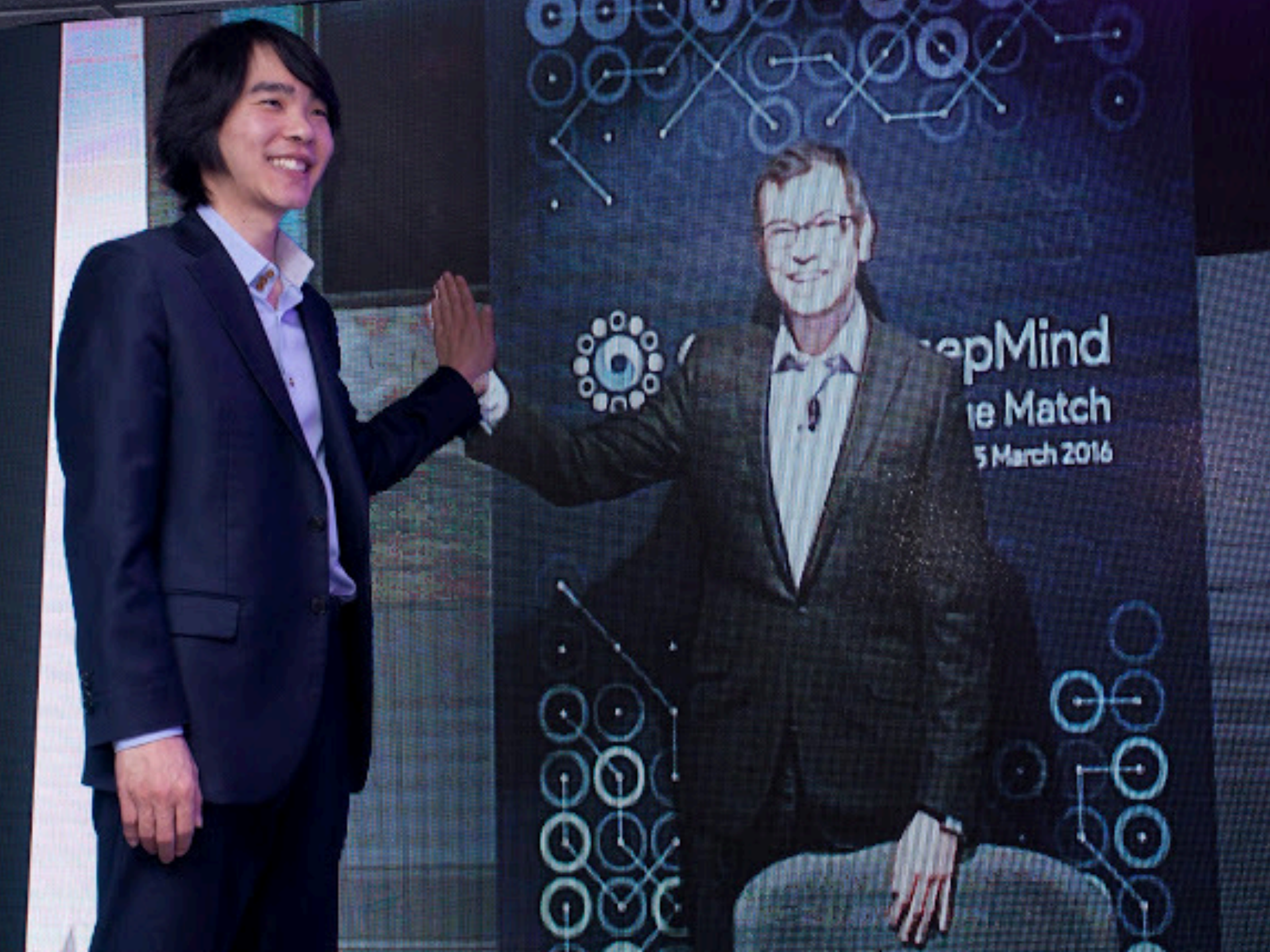


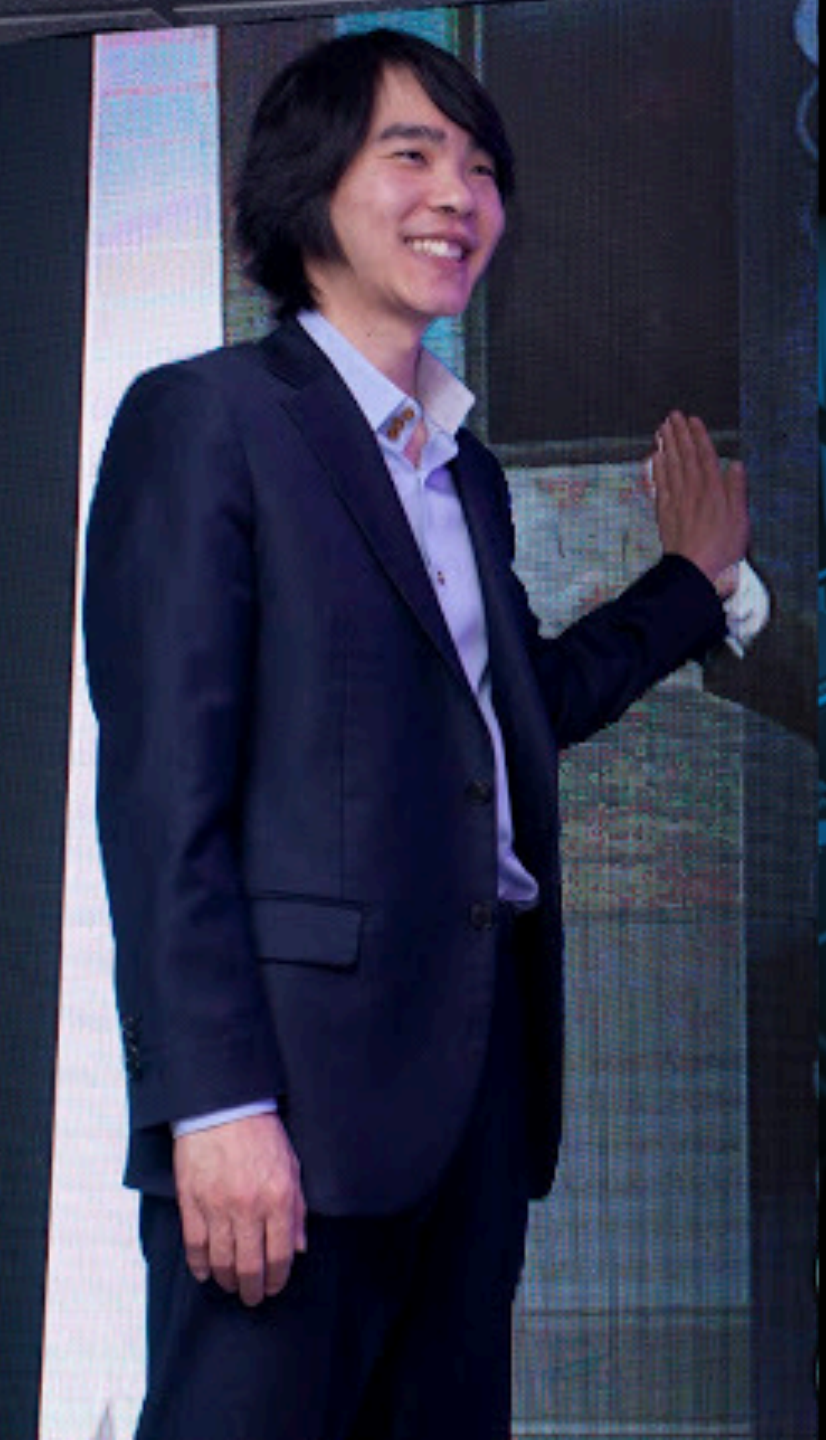
A group of people sitting on a boat in the water.

A giraffe standing in a forest with trees in the background.

Deep Learning for Speech

Google Assistant


epMind
le Match
5 March 2016




nature
THE INTERNATIONAL WEEKLY JOURNAL OF SCIENCE
At last — a computer program that can beat a champion Go player PAGE 484
ALL SYSTEMS GO
CONSERVATION
SONGBIRDS À LA CARTE
Illegal harvest of millions of Mediterranean birds
PAGE 452
RESEARCH ETHICS
SAFEGUARD TRANSPARENCY
Don't let openness backfire on individuals
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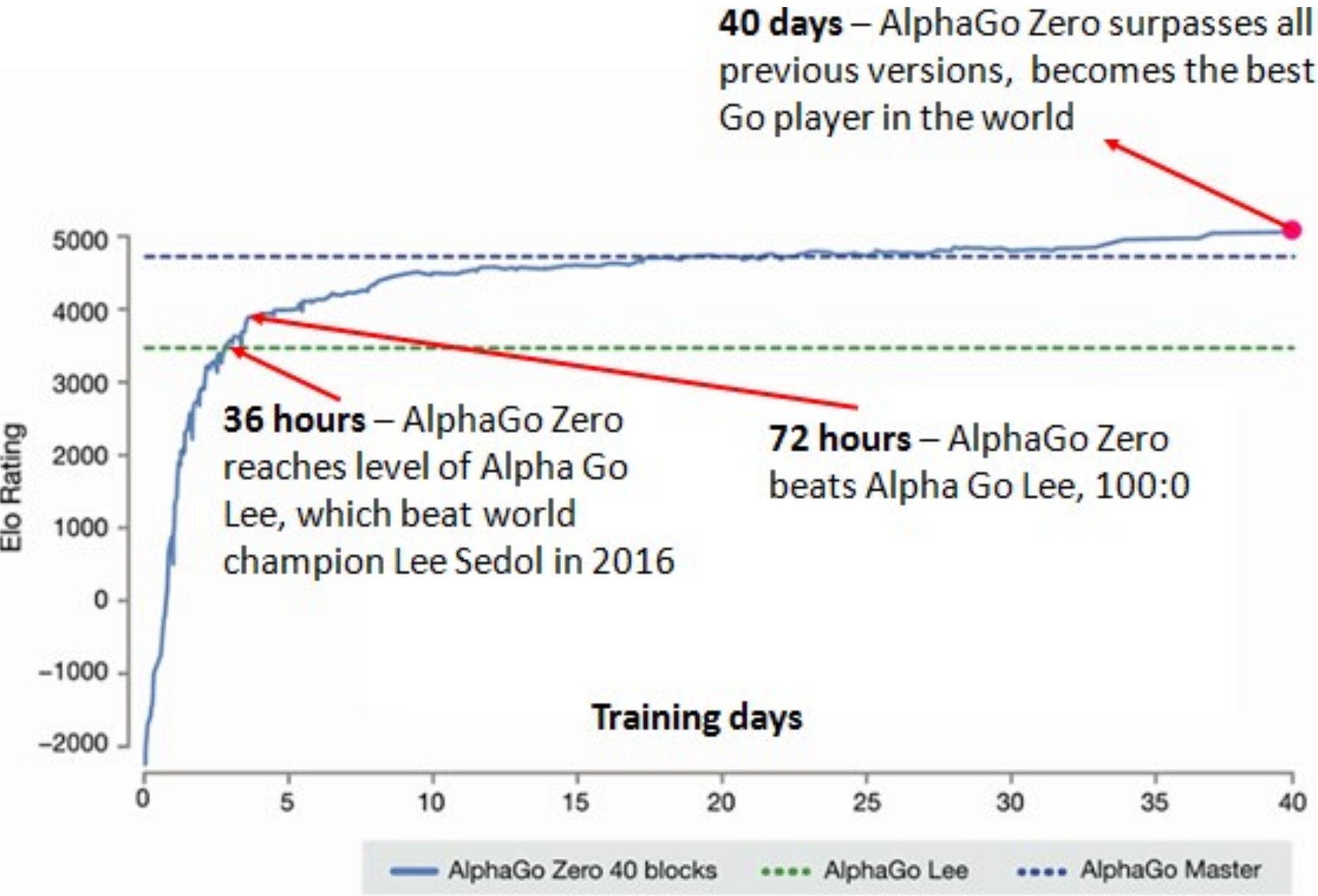
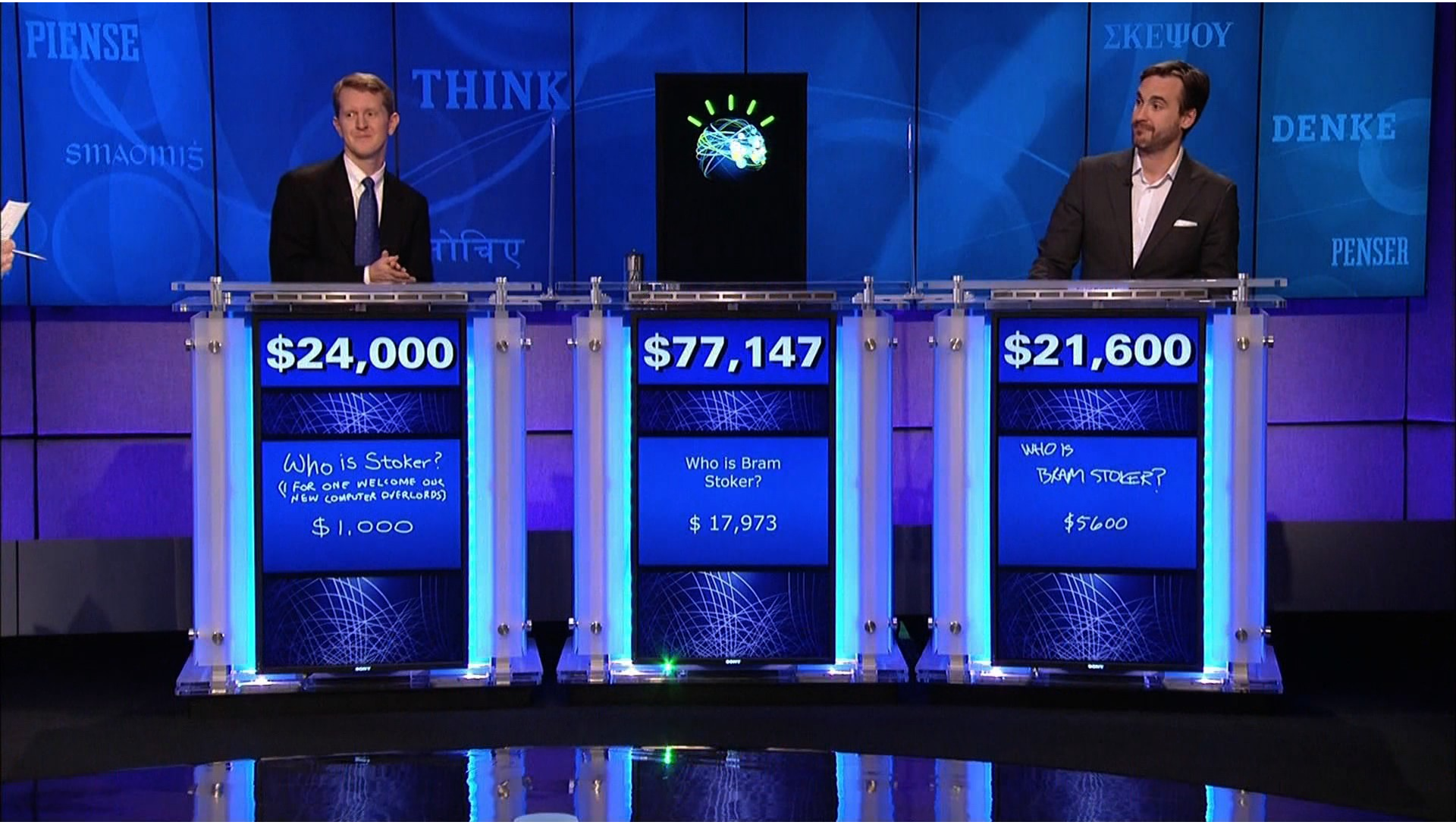
POPULAR SCIENCE
WHEN GENES GOT 'SELFISH'
Dawkins's calling card 40 years on
PAGE 462
NATUREASIA.COM
28 January 2016
Vol. 529, No. 7587

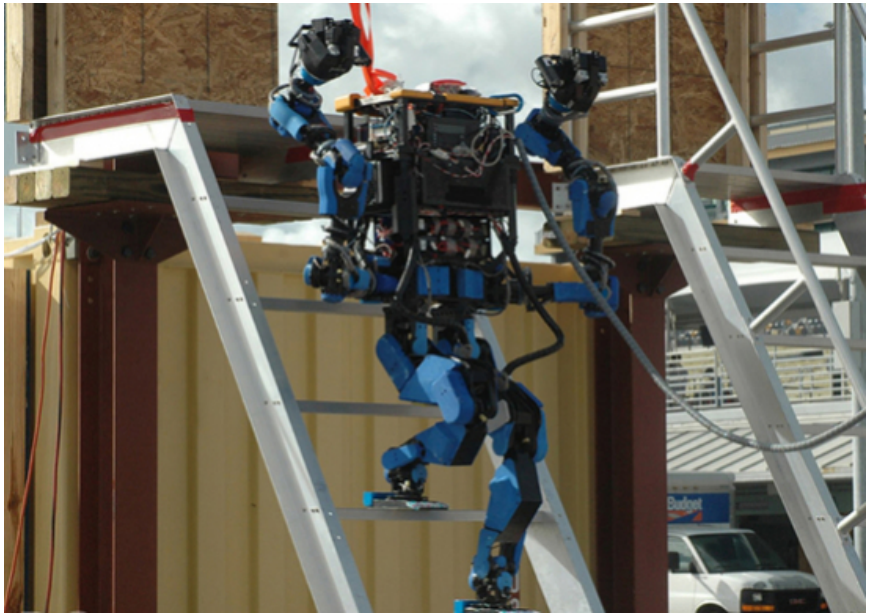

40 days – AlphaGo Zero surpasses all previous versions, becomes the best Go player in the world
36 hours – AlphaGo Zero reaches level of Alpha Go Lee, which beat world champion Lee Sedol in 2016
72 hours – AlphaGo Zero beats Alpha Go Lee, 100:0
Elo Rating
5000
4000
3000
2000
1000
0
−1000
−2000
Training days
0
5
10
15
20
25
30
35
40
AlphaGo Zero 40 blocks
AlphaGo Lee
AlphaGo Master

IBM Watson

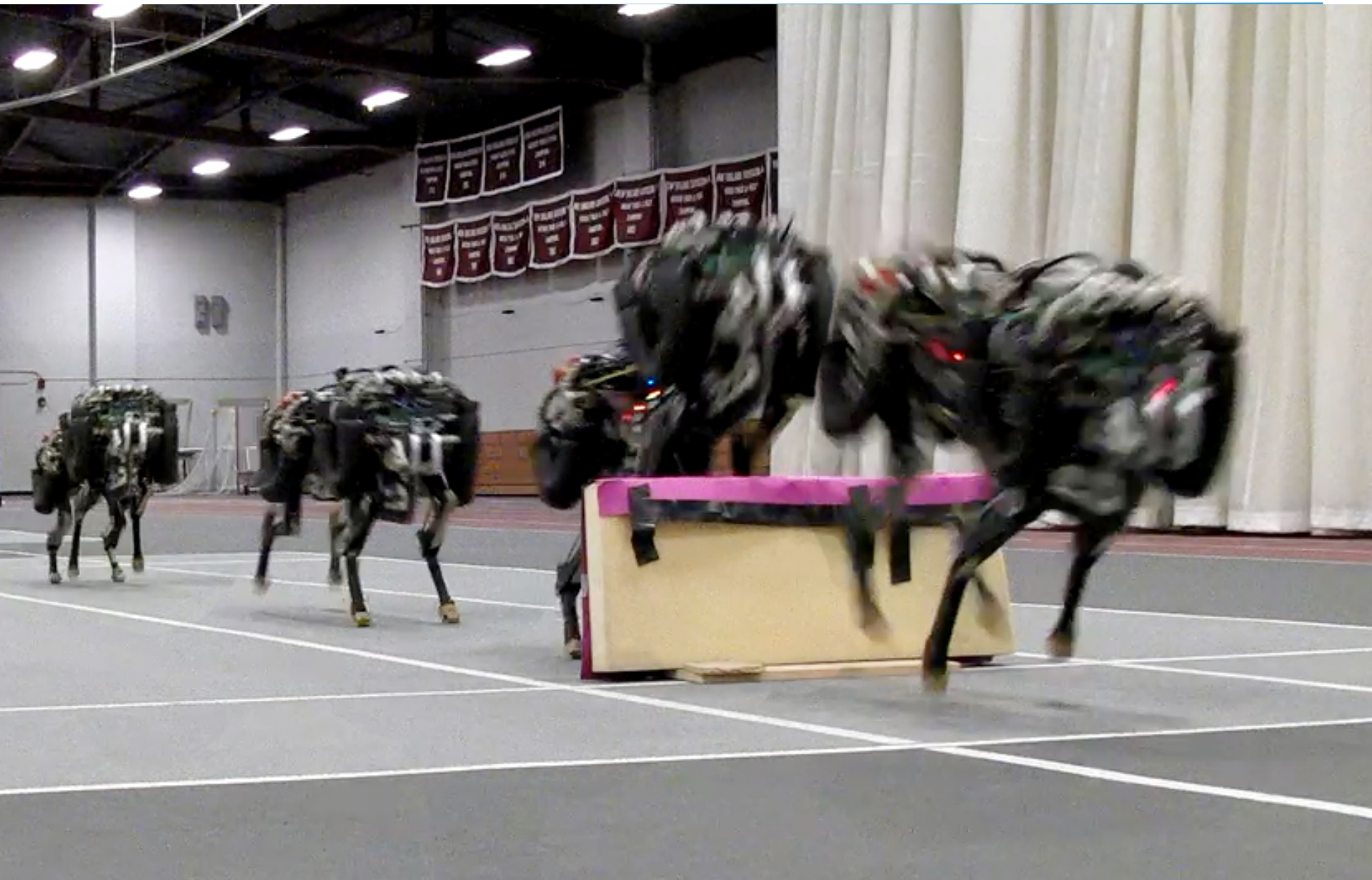

PIENSE
THINK
ΣΚΕΨΟΥ
DENKE
PENSER
$24,000
Who is Stoker?
(I FOR ONE WELCOME OUR NEW COMPUTER OVERLORDS)
$1,000
$77,147
Who is Bram Stoker?
$ 17,973
$21,600
WHO IS BRAM STOKER?
$5600

IBM Project Debater

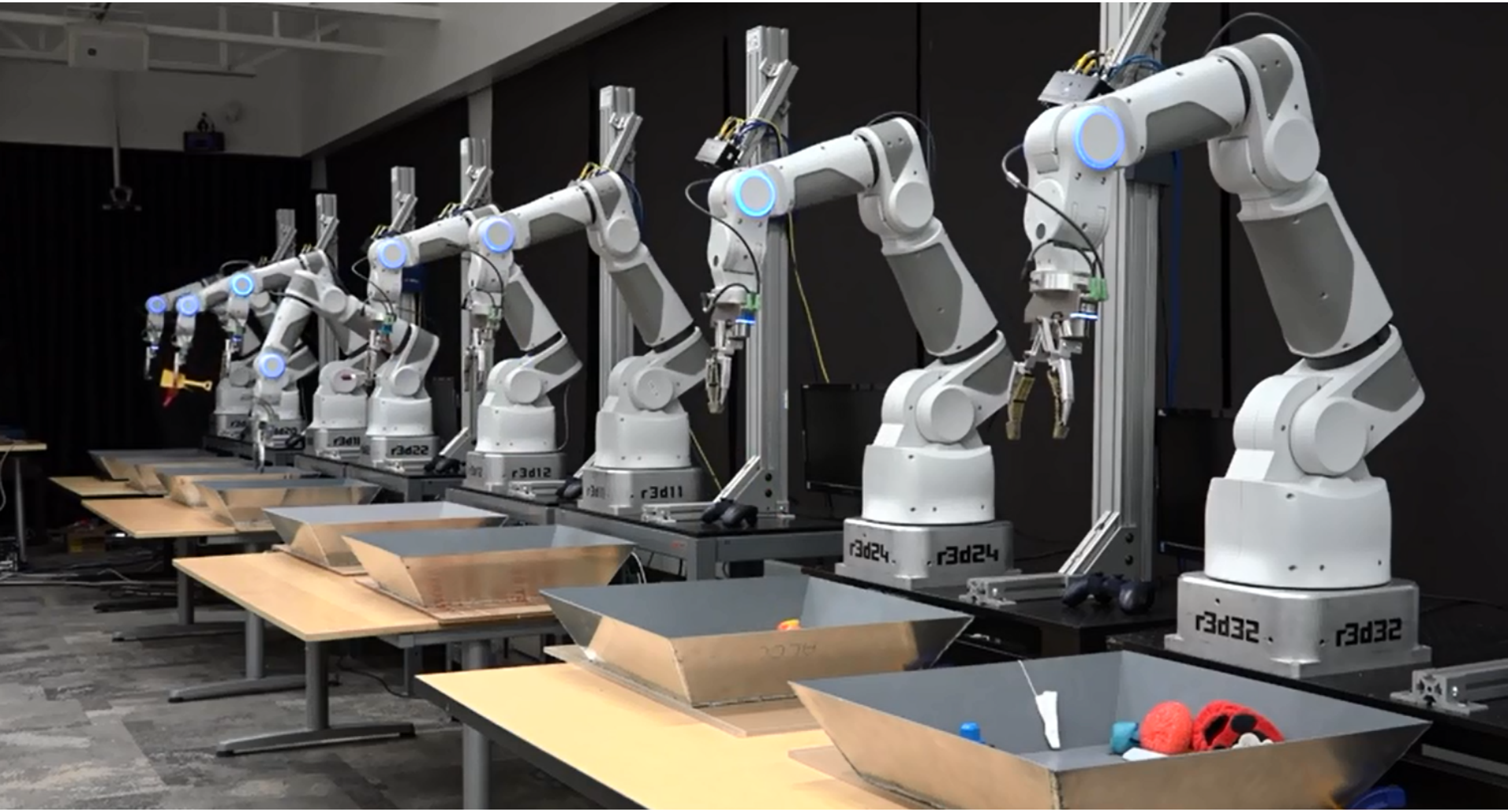
DARPA Robotics Challenge



MIT Cheetah



Object Manipulation



Object Manipulation

DARPA Autonomous Driving Challenge

Deep Learning for Self-Driving Cars

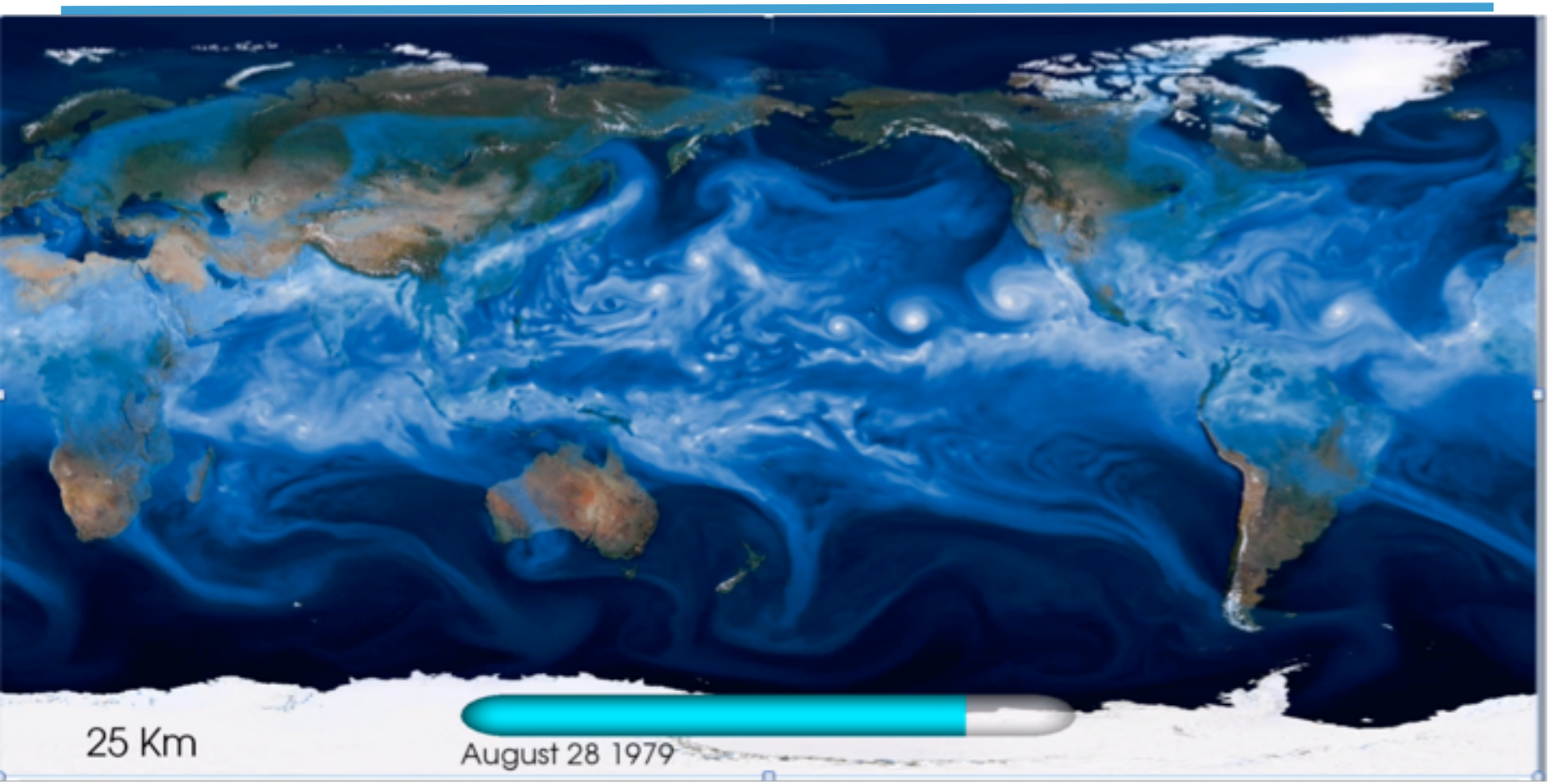
Some Failures…

Can Deep Learning Work for Science?

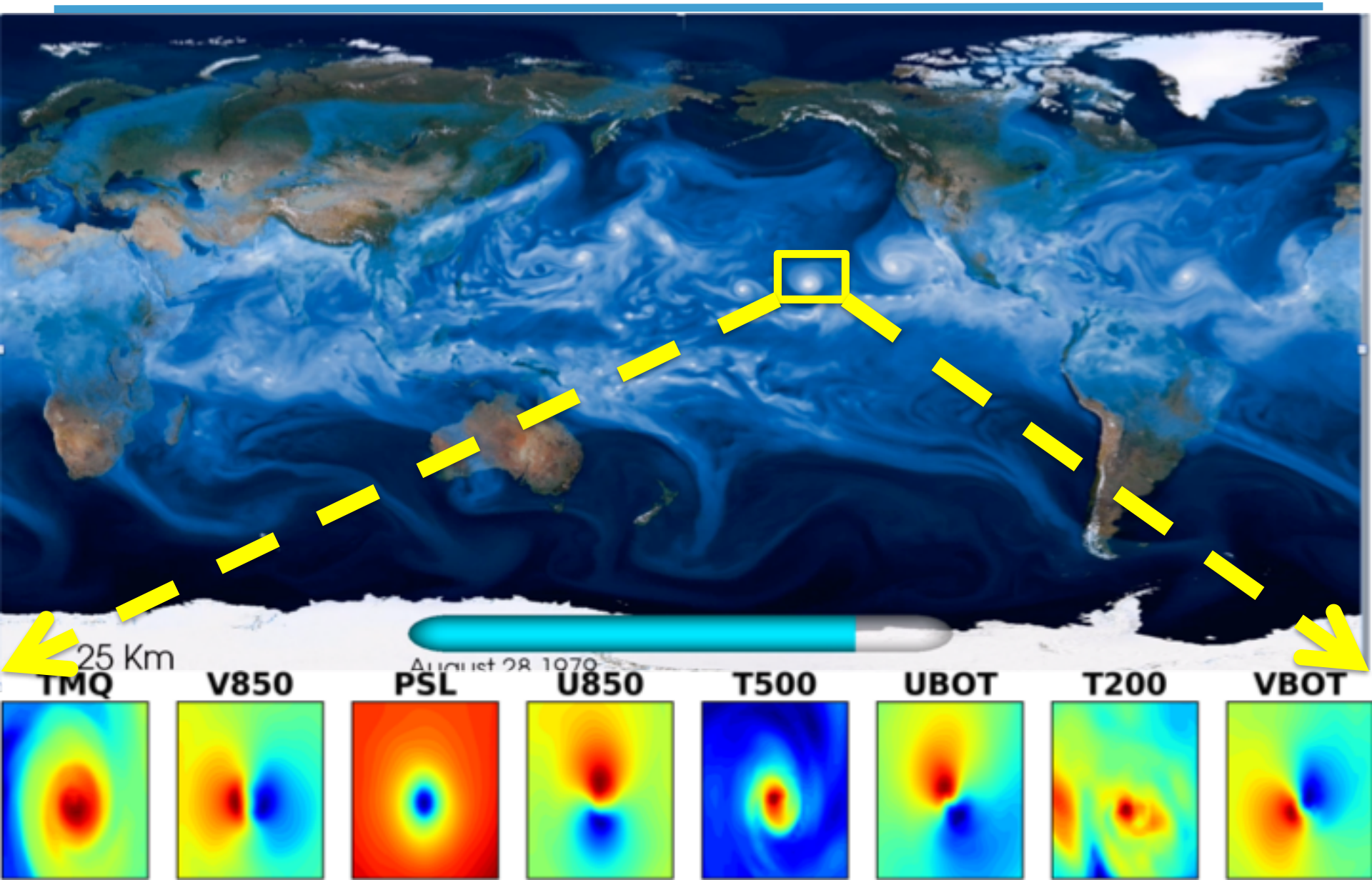
- **Similarities**
  - Tasks:
    - Pattern Classification
    - Regression
    - Clustering
    - Feature Learning
    - Anomaly Detection

- **Differences**
  - Unique attributes of Scientific Data
    - Multi-channel / Multi-variate
    - Double precision floating point
    - Noise and Artefacts
    - Statistics are likely different

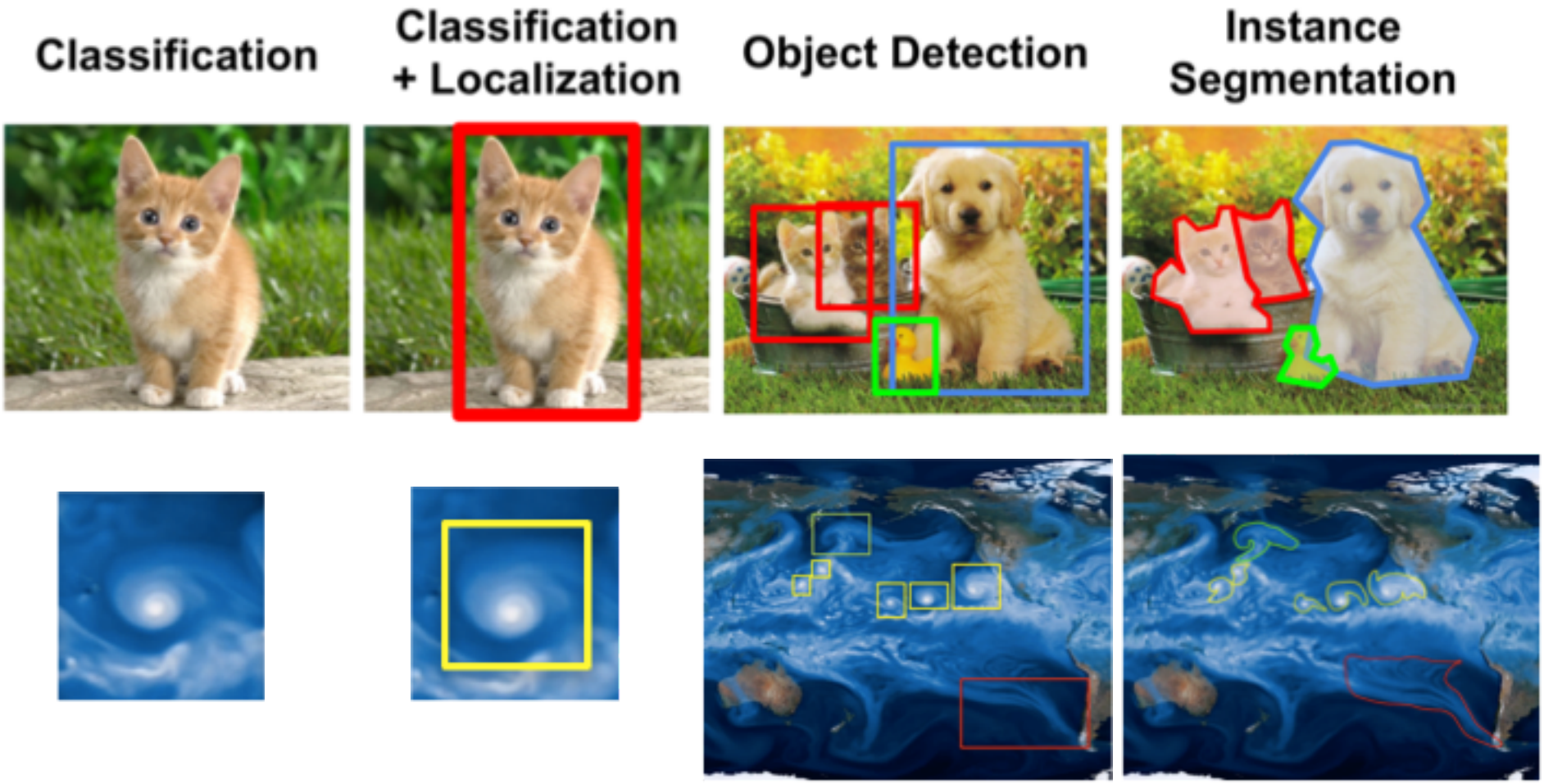
CAM5 0.25-degree simulation data



Challenge: Multi-Variate Data

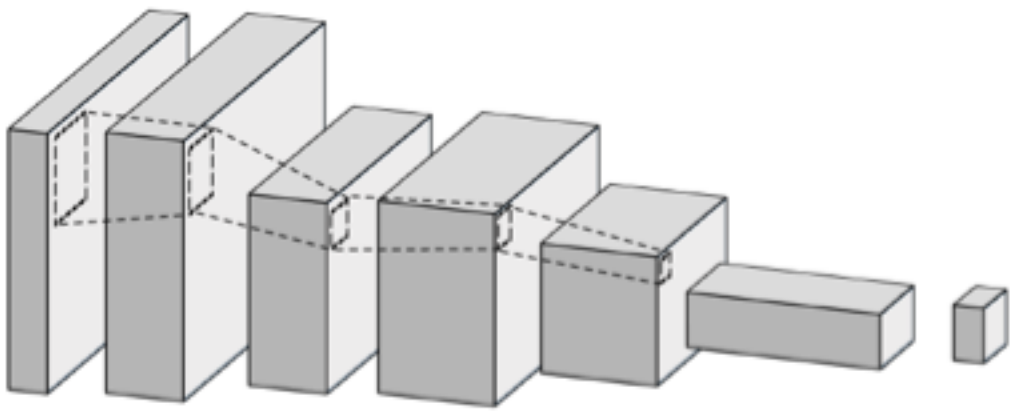


Climate Science Tasks



Supervised Convolutional Architecture

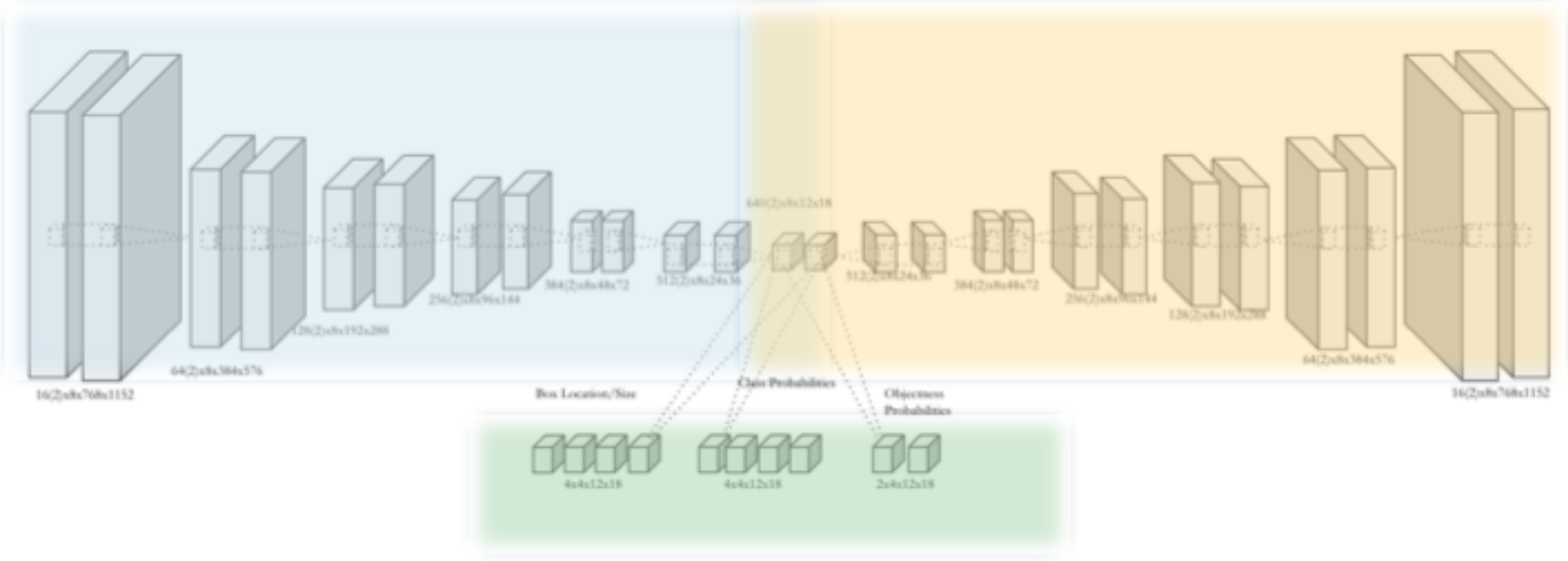
	Logistic Regression	K-Nearest Neighbor	Support Vector Machine	Random Forest	ConvNet
	Test	Test	Test	Test	Test
Tropical Cyclone	95.85	97.85	95.85	**99.4**	**99.1**
Atmospheric Rivers	82.65	81.7	83.0	88.4	**90.0**
Weather Fronts	**89.8**	76.45	90.2	87.5	**89.4**



Input Convolution Pooling Convolution Pooling Fully connect Class score

Semi-Supervised Convolutional Architecture (NIPS'17)

Encoder **Decoder**

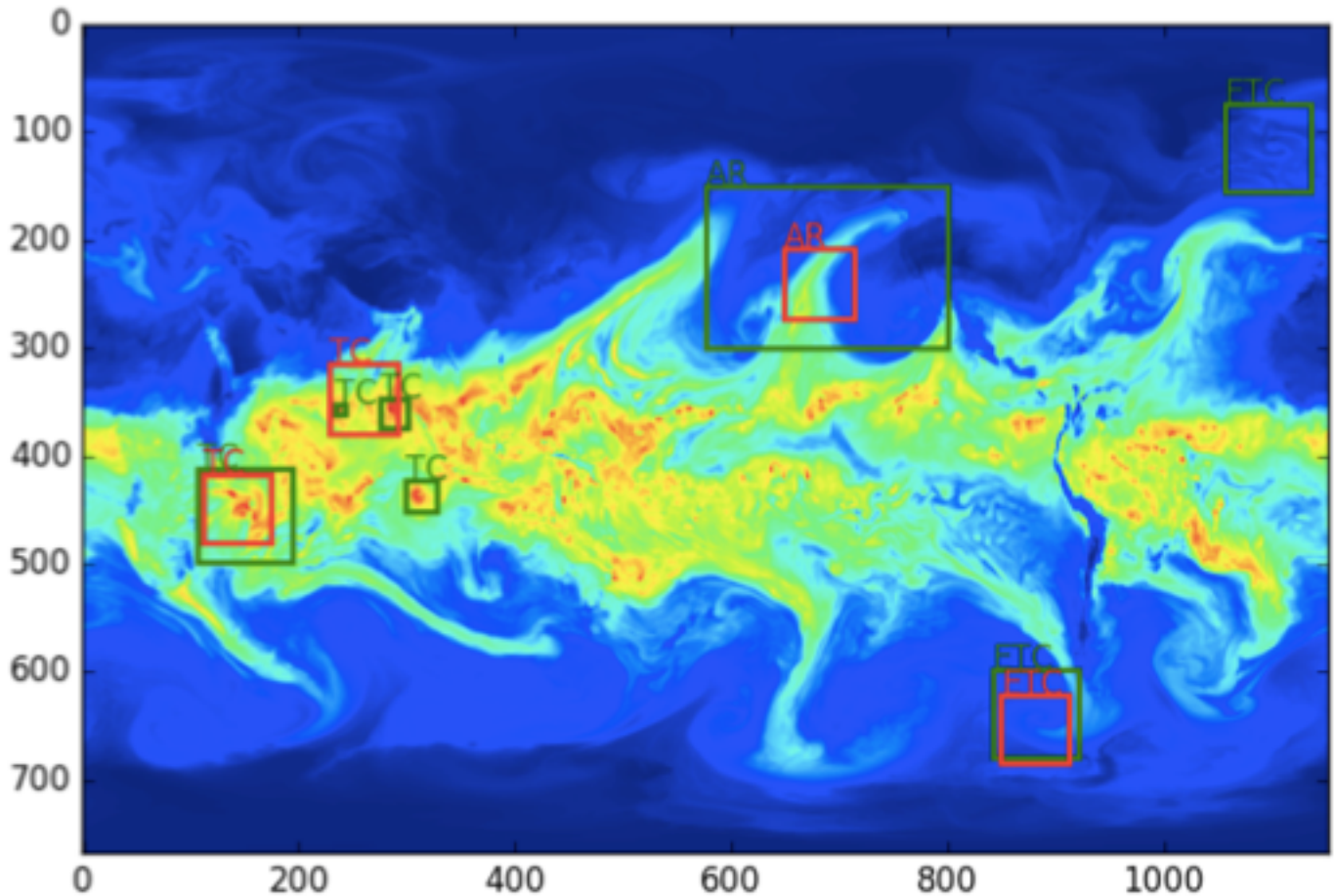


Classification + Bounding Box Regression

Contributors: Evan Racah, Chris Pal, Chris Beckham, Samira Kahou, Tegan Maharaj. *MILA*

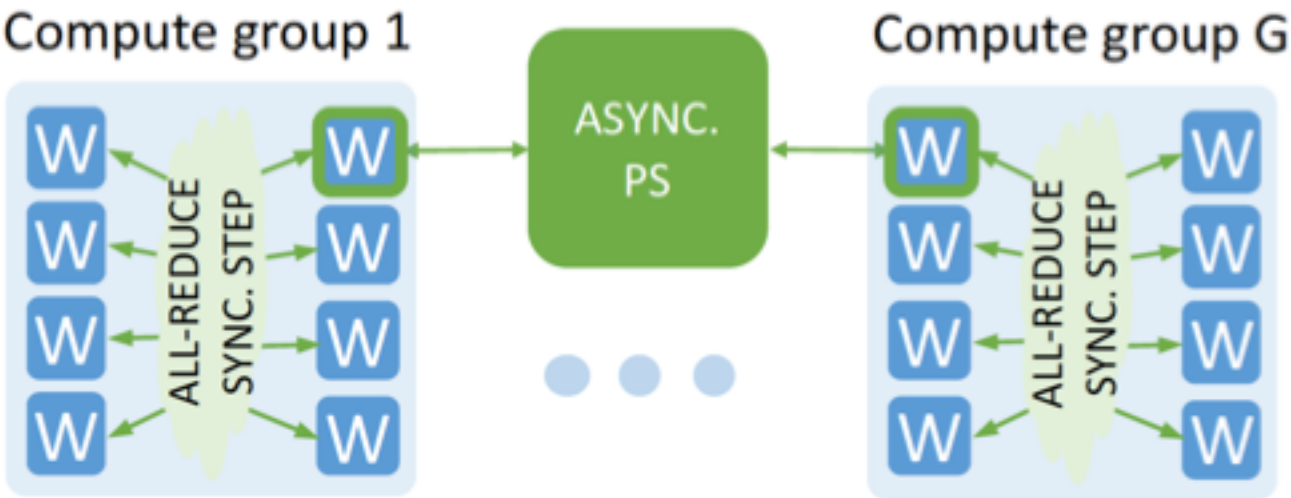
Classification + Regression Results

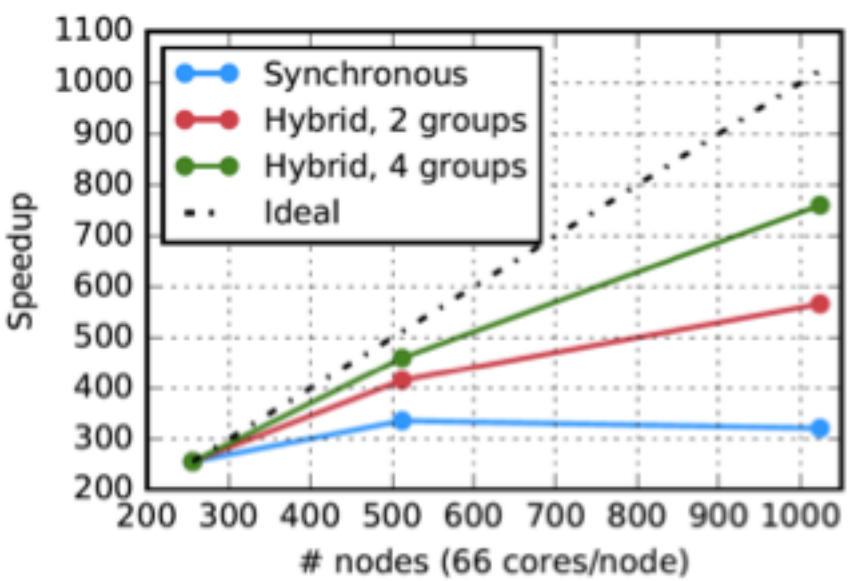
Ground Truth
Prediction

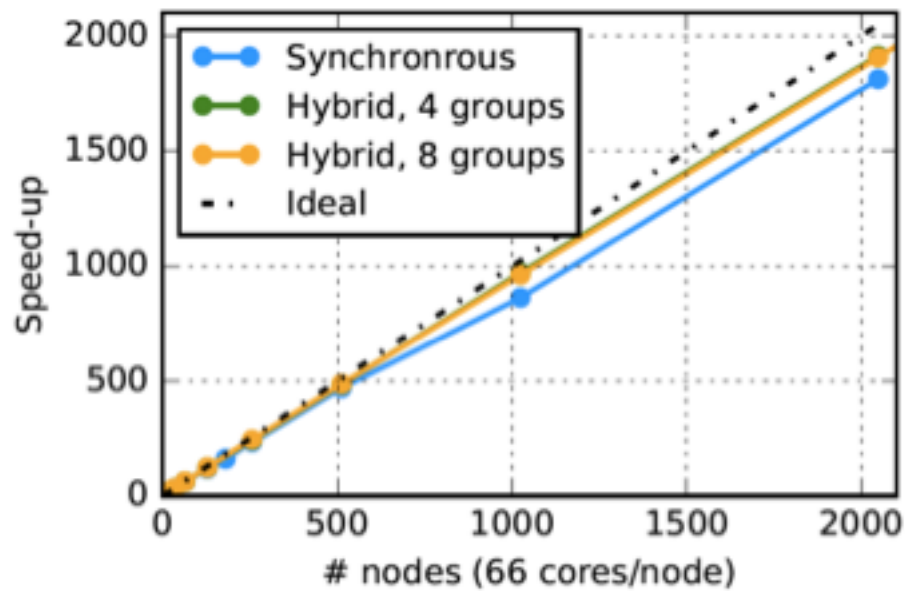


Contributors: Thorsten Kurth, Jian Yang, Ioannis Mitliagkas, Chris Pal, Nadathur Satish, Narayanan Sundaram, Amir Khosrowshahi, Michael Wehner, Bill Collins, *Intel, Stanford, LBL, MILA.*

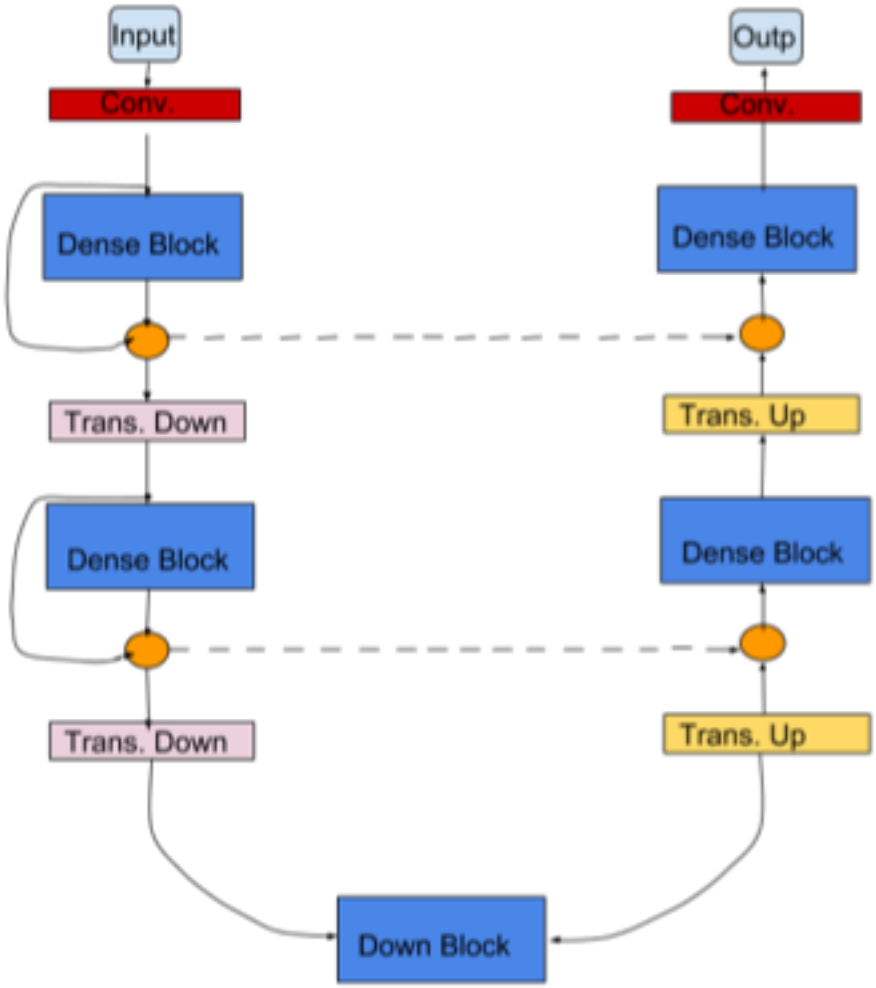
Deep Learning at 15PF (SC'17)





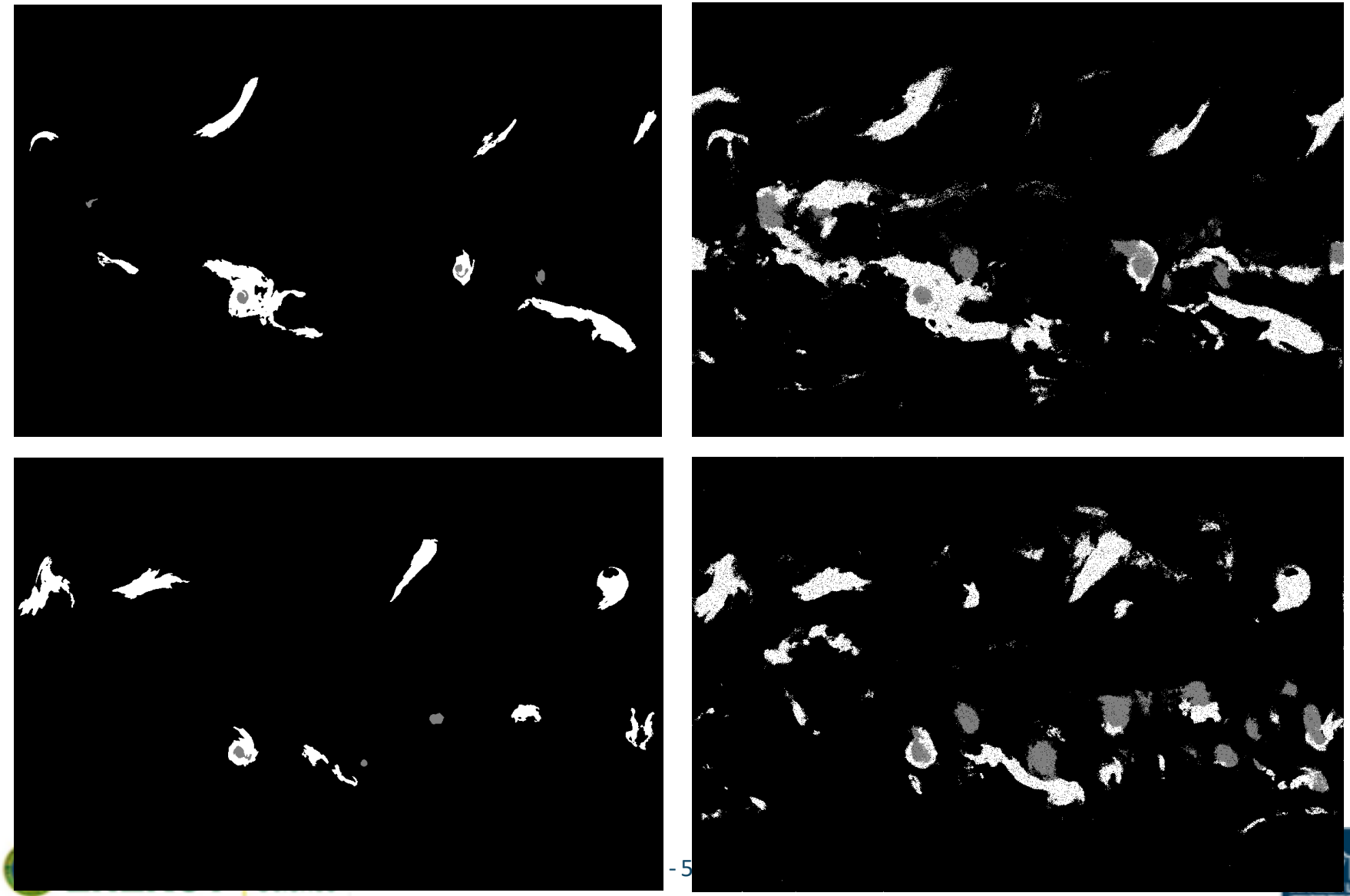


Segmentation



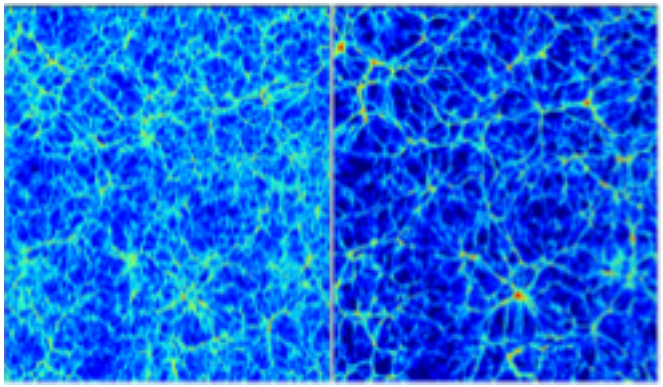
Contributors: Mayur Mudigonda, Thorsten Kurth, Sean Treichler, Josh Romero, Massimiliano Fatica, Mike Houston. *UC Berkeley, LBL, NVIDIA*

Segmentation Results

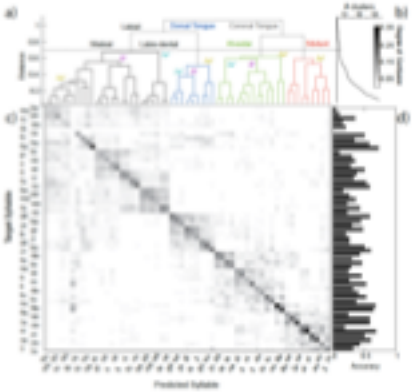


Deep Learning for Science

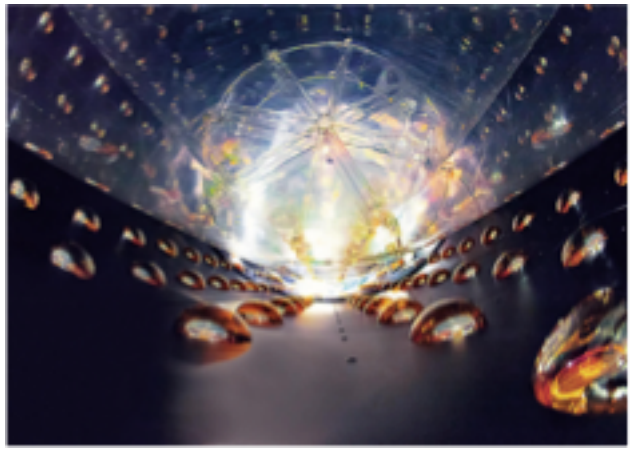
Modeling galaxy shapes



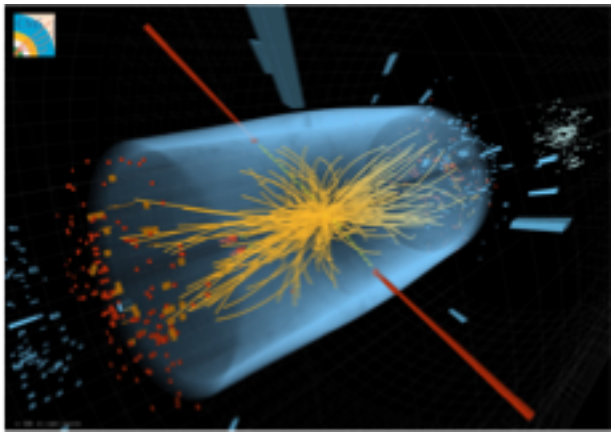
Generating cosmology mass maps



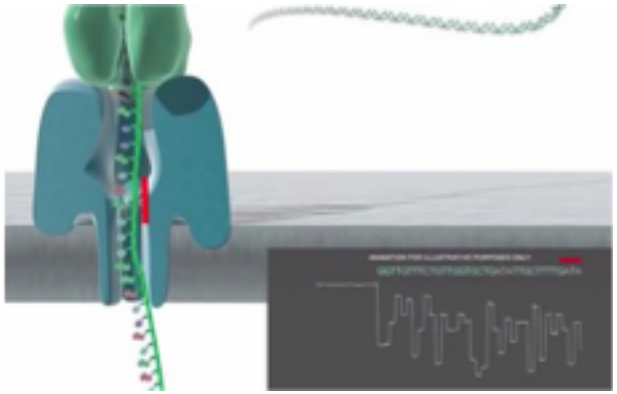
Decoding speech from ECoG



Clustering Daya Bay events



LHC Signal/Background classification

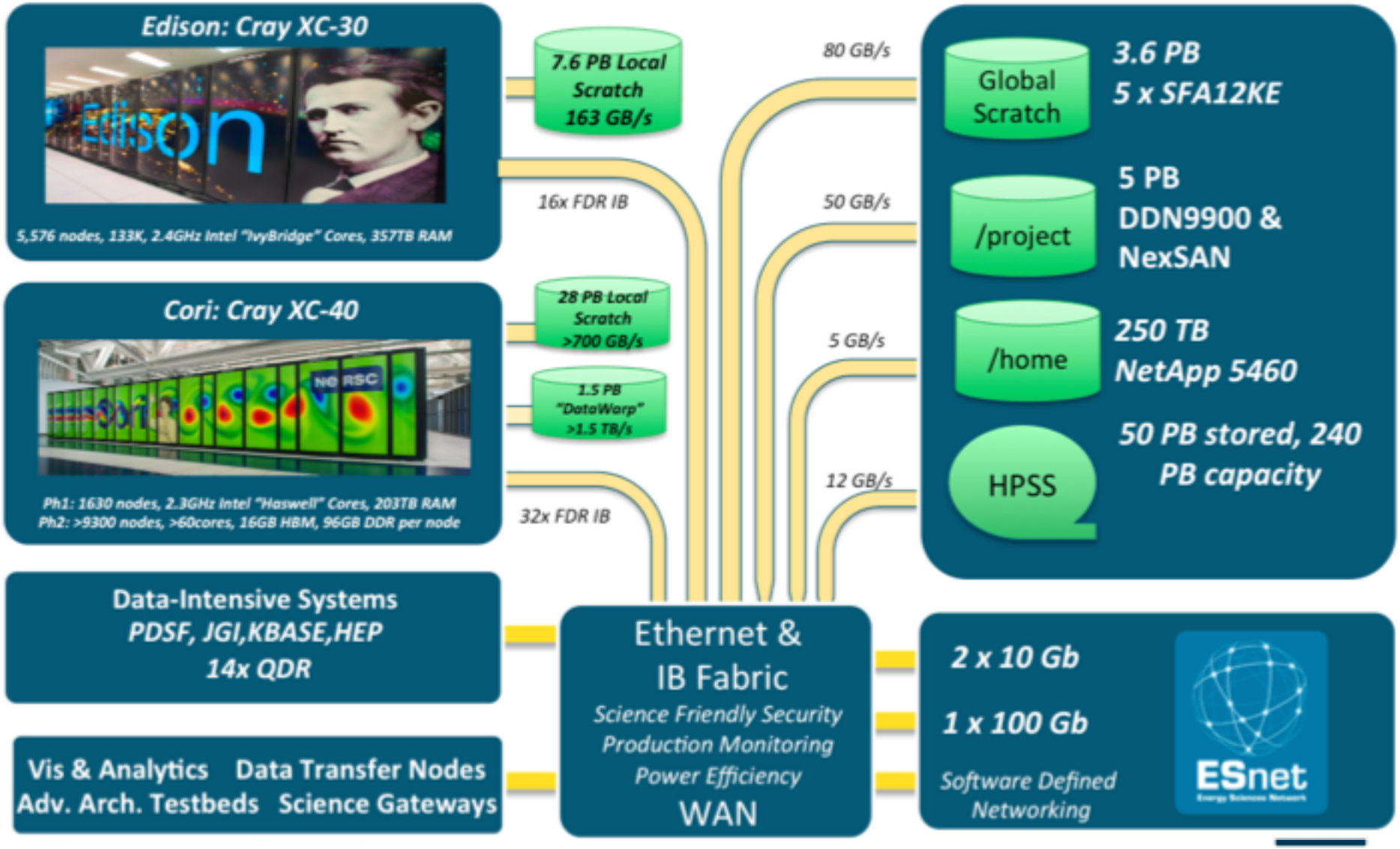


Oxford Nanopore sequencing

U.S. DEPARTMENT OF ENERGY | Office of Science

BERKELEY LAB

Deep Learning Hardware



Deep Learning Software

	Technologies
Deep Learning Frameworks	K, TensorFlow, Caffe, PYTORCH, theano, Neon, CNTK, MXNet, …
Multi Node libraries	MLSL, MPI, Horovod, GRPC
Single Node libraries	MKL-DNN, CuDNN
Hardware	CPUs (KNL), GPUs, FPGAs, Accelerators

Open Challenges

1. Performance and Scaling
2. Complex Data
3. Hyper-Parameter Optimization
4. Scarcity of Labeled Data
5. Interpretability and Visualization
6. Theory

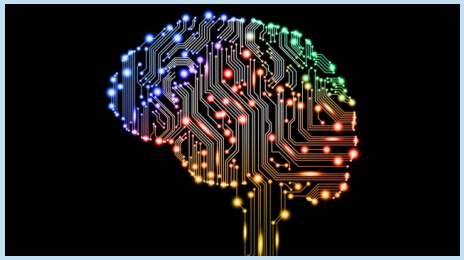
Assumptions…

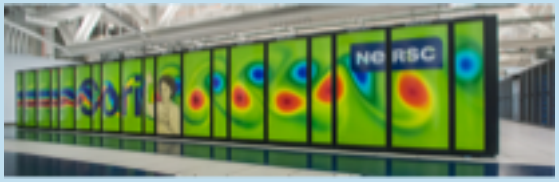
- **Communities will self-organize and conduct labeling campaigns**
  - Active Learning systems can determine optimal strategies for seeking labels
- **Incorporation of domain science principles into learning algorithms**
  - Solution spaces that satisfy physical constraints
- **Pattern Classification, Clustering, Anomaly Detection are solved problems**

What is the role of humans?

Labels

Mechanisms,
Hypothesis





/project

HPSS

Patterns, Clusters,
Anomalies

How close are we to creating a T-800?

- Vision/Perception 👍 😀 🎉
- Speech 😀 🚀 💥
- Motion/Planning 👍 🚀
- Object Manipulation 😐
- Self-Repair ☹️
- Goal-directed Exploration ☹️
- Social Skills 🤐
- Ethics/Morality 😱

How about the T-1000 and T-X?

Time Travel?

Conclusions

- **AI appears to be working**
  - Genuine breakthroughs in vision, speech, control
  - Wide range of commercial applications
- **Tremendous potential for scientific applications**
  - Low-hanging fruit, but hard questions are coming next
- **NERSC is at the forefront of Deep Learning for Science**
  - Applications
  - Hardware and Software
  - R&D on optimizations + scaling, methods

Thanks!

- **Contact: prabhat@lbl.gov**
- **Connect on LinkedIn**
- **Internships, full-time opportunities**