Intelligence is not Artificial

Piero Scaruffi

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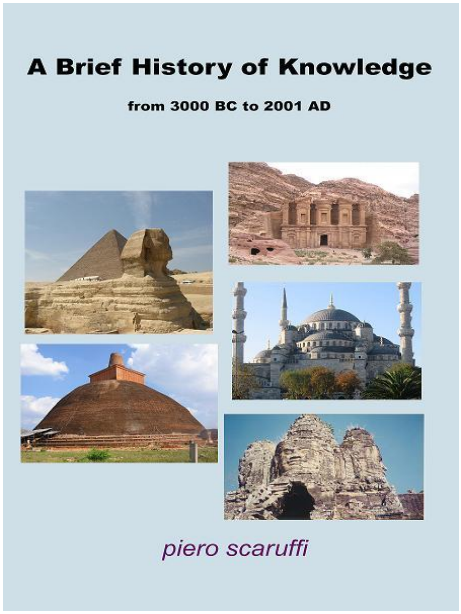
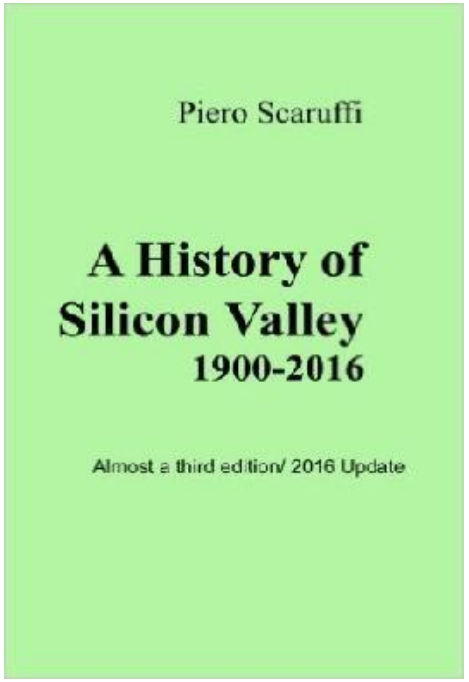
www.scaruffi.com

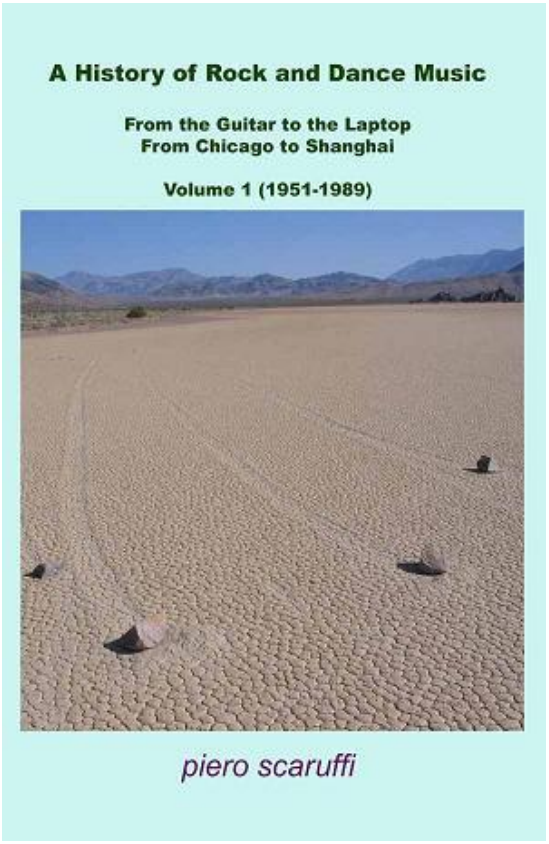
(2 hour version of August 2017)

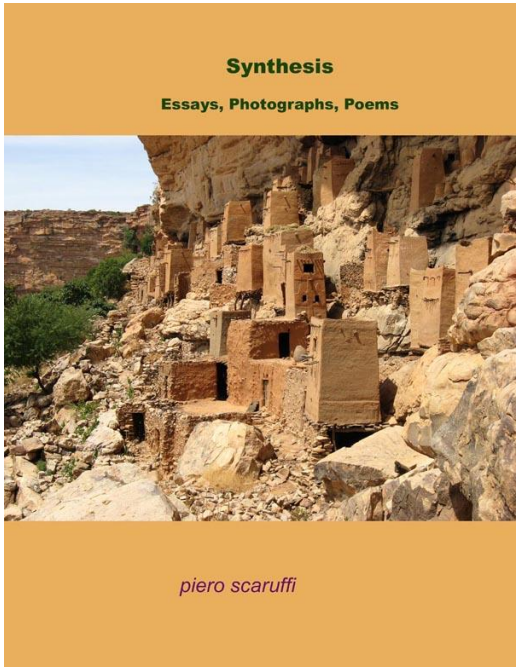
Olivetti Artificial Intelligence Center circa 1987

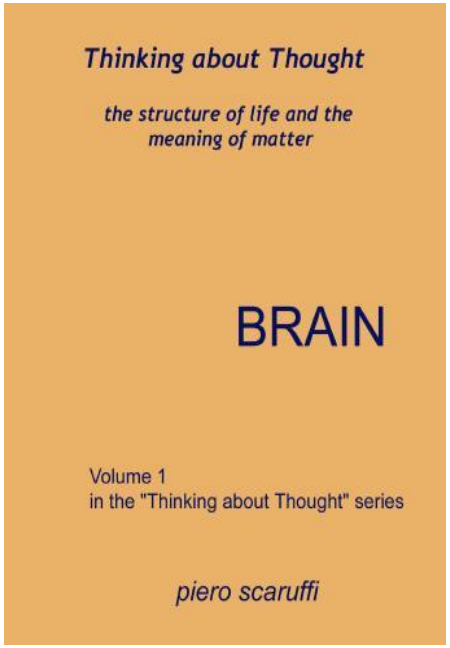
20+ Books


A Brief History of Knowledge
from 3000 BC to 2001 AD
piero scaruffi

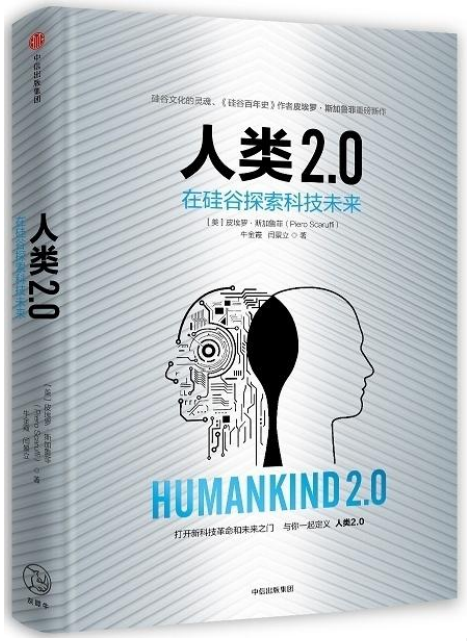

Piero Scaruffi
A History of Silicon Valley
1900-2016
Almost a third edition/ 2016 Update

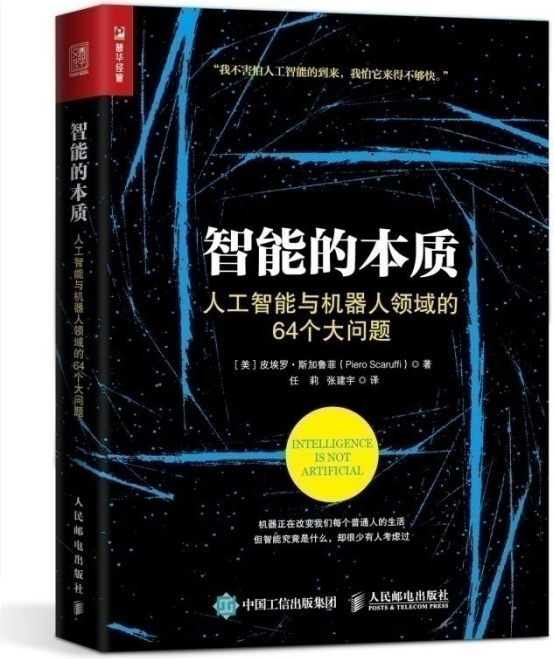

A History of Rock and Dance Music
From the Guitar to the Laptop
From Chicago to Shanghai
Volume 1 (1951-1989)
piero scaruffi

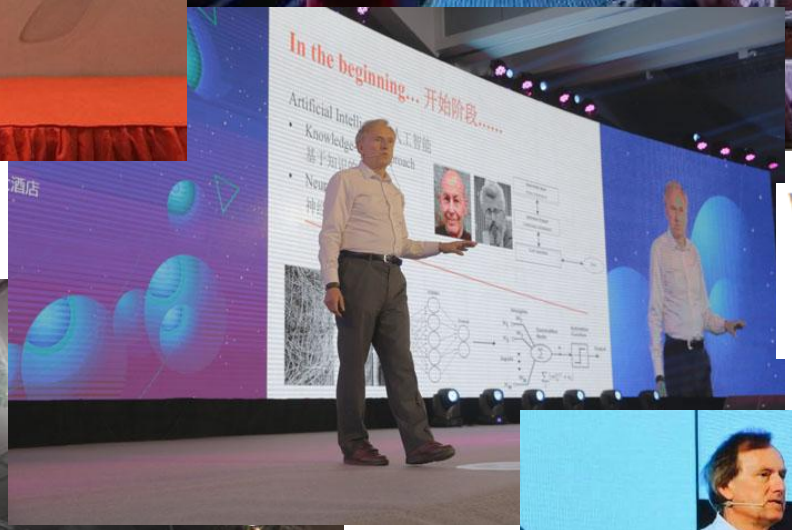

Synthesis
Essays, Photographs, Poems
piero scaruffi


Thinking about Thought
the structure of life and the meaning of matter
BRAIN
Volume 1
in the "Thinking about Thought" series
piero scaruffi

Piero in China







World Intelligence Congress (Tianjin)
June 2017
WIC 世界智能大会
WORLD INTELLIGENCE CONGRESS

Leonardo Art/Science Evening Rendezvous

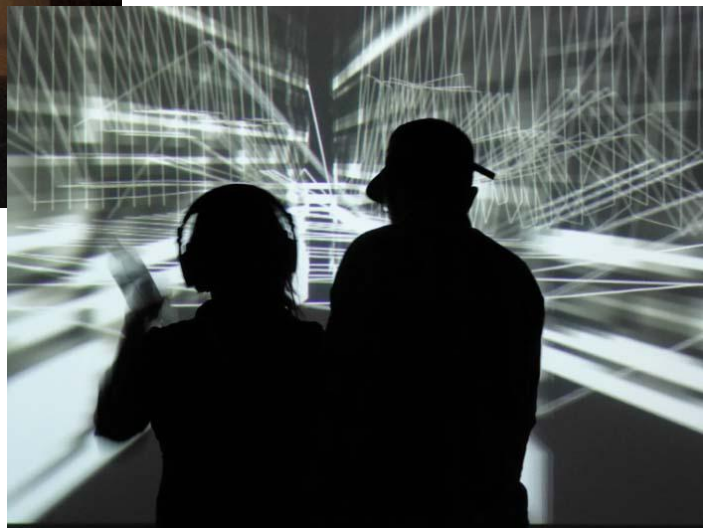
www.lasertalks.com

The LAST Festival

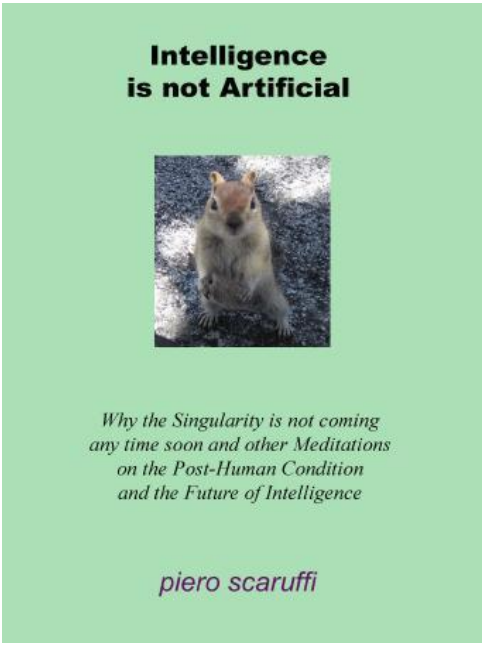
Life Art Science Technology festival

www.lastfestival.org

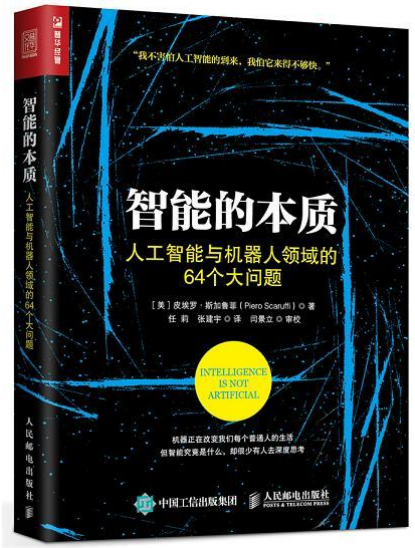
Life Art Science Tech



DON'T BUY MY BOOK



Why the Singularity is not Coming any Time Soon & other Meditations on the Post-Human Condition and the Future of Intelligence



But download these slides from
www.scaruffi.com

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- Machine Consciousness
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- The next Breakthrough

Oh no please not another history of Artificial Intelligence

MECCANO MAGAZINE

June 1934

Are Thinking Machines Possible ?

The triumph of the Bush Differential Analyser and of its Meccano counterpart seems to me to mark an important stage in the development of machines. This development originated in attempts

1934: 17 years before the first commercial computer

A. M. Turing (1950) Computing Machinery and Intelligence. *Mind 49:* 433-460.

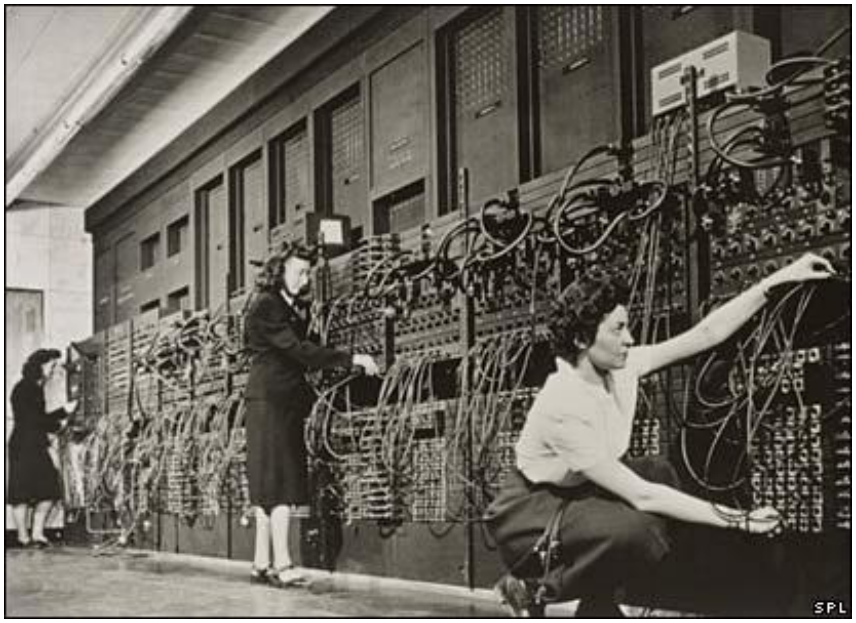
COMPUTING MACHINERY AND INTELLIGENCE

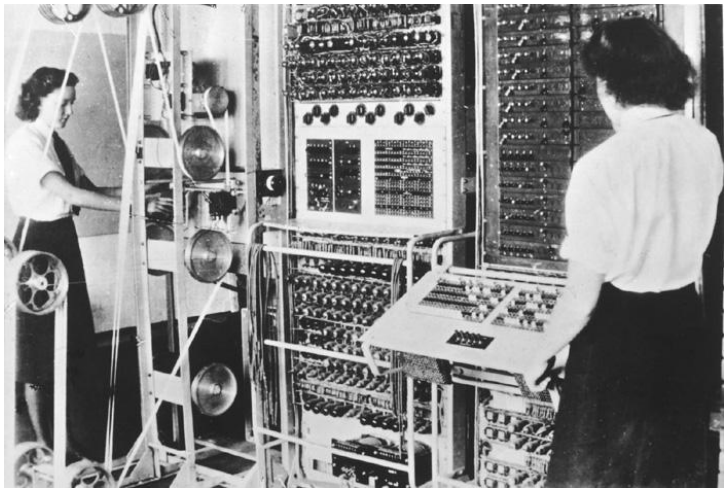
By A. M. Turing

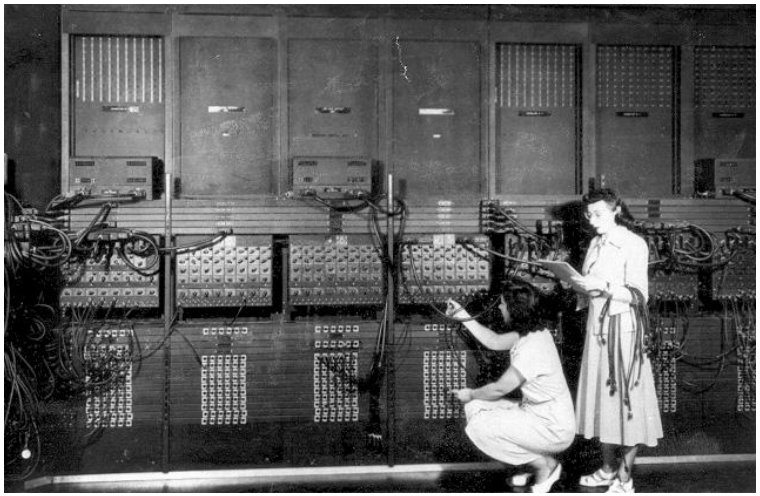
1. The Imitation Game "Turing Test"

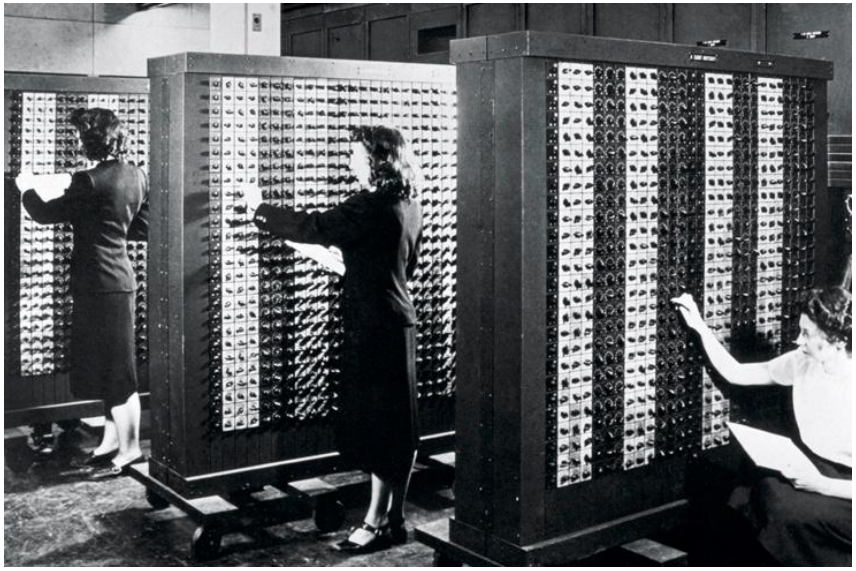
I propose to consider the question, "Can machines think?"

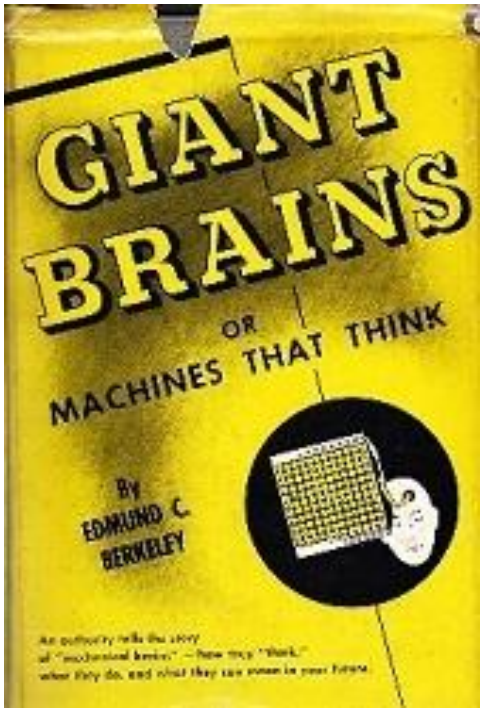
1950s: the first computers











The first book on electronic computers (1949)

New N.P.L. Wonder

ELECTRIC BRAIN TO BE MADE AT TEDDINGTON

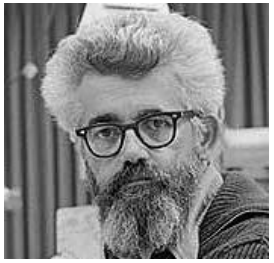
34 YEARS-OLD DESIGNER TALKS TO *SURREY COMET*

£100,000 A.C.E. WILL BE OBSOLETE BEFORE COMPLETED

SOME of the feats that will be able to be performed by Britain's new electronic brain, which is being developed at the N.P.L., Teddington, were described to the SURREY COMET yesterday by Dr. A. M. Turing, 34 year-old mathematics expert, who is pioneer of the scheme in this country.

The machine is to be an improvement on the American ENIAC, and it was in the brain of Dr. Turing that the more efficient model was developed.

Artificial Intelligence



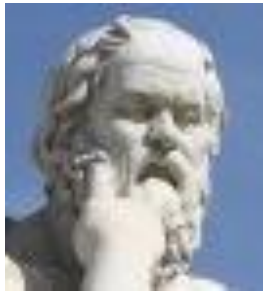
AI Magazine Volume 27 Number 4 (2006) (© AAAI)

A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence

August 31, 1955

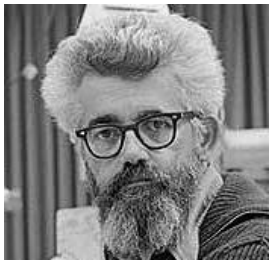
John McCarthy, Marvin L. Minsky,
Nathaniel Rochester,
and Claude E. Shannon

Artificial Intelligence?



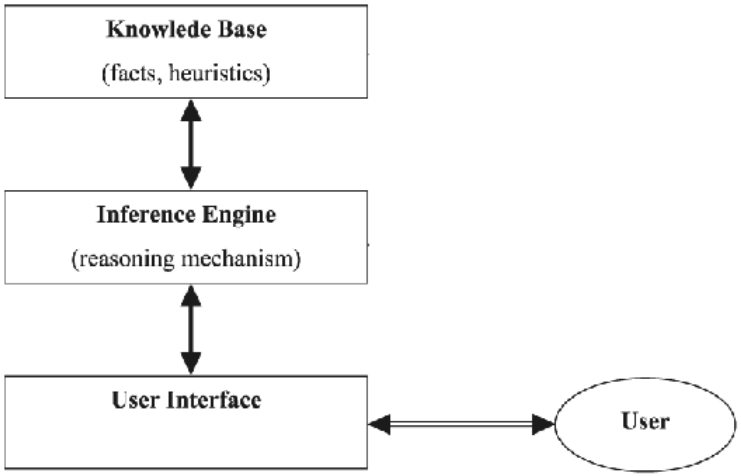
- Definitions!
  - When does Computer Science become Artificial Intelligence?
  - When does automation become AI?
  - When does technology become AI?
  - What is the difference between an algorithm and an AI algorithm?
  - What is “intelligence”?
  - What is “artificial”?

The two schools of A.I.

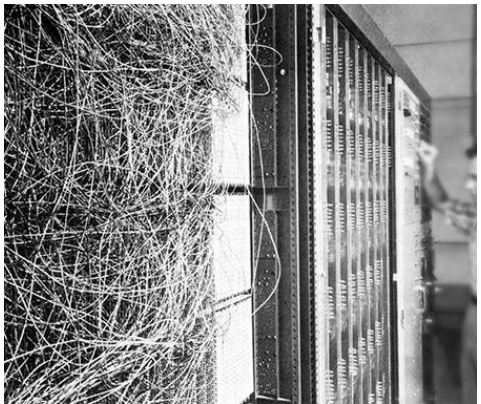


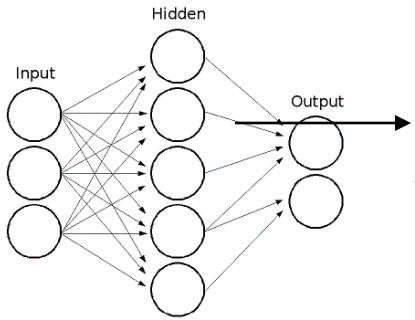
Artificial Intelligence (1956)

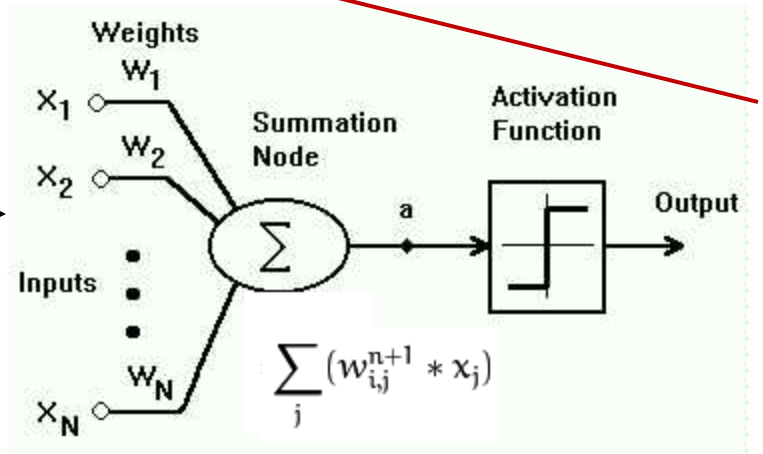
- Knowledge-based approach uses mathematical logic to simulate the human mind



- Neural-net approach simulates the structure of the brain

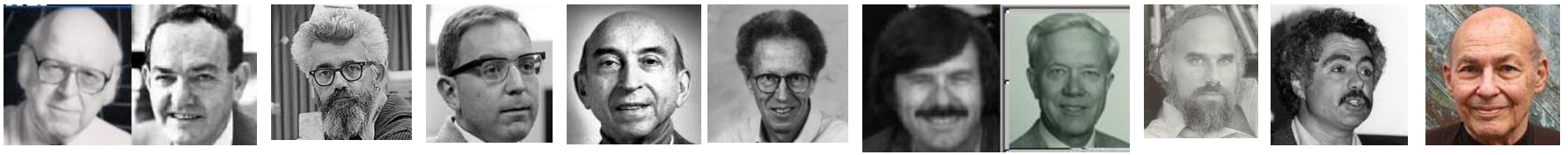






The two schools of AI

1956: Allen Newell and Herbert Simon’s "Logic Theorist“
1959: John McCarthy's "Programs with Common Sense"
1965: Ed Feigenbaum's Dendral
1965: Lofti Zadeh’s Fuzzy Logic
1966: Ross Quillian's Semantic Networks
1969: SRI's Shakey the Robot
1969: Roger Schank’s Conceptual Dependency Theory
1972: Bruce Buchanan's MYCIN
1972: Terry Winograd's SHRDLU
1974: Marvin Minsky's Frame



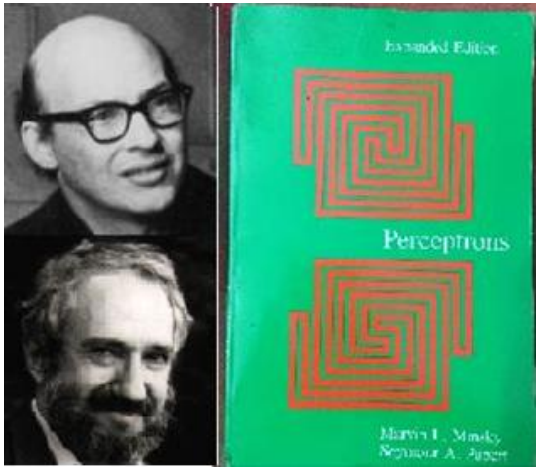
The first IJCAI: 1969

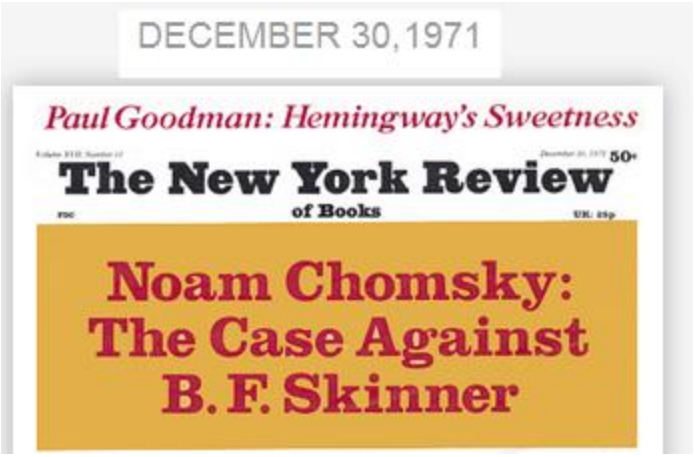
Only 2 papers on neural networks!

The Neural Network Winter

1969: Marvin Minsky & Samuel Papert's "Perceptrons" kills neural networks

1971: Noam Chomsky's article against Skinner's behaviorism





Why nobody responded?
- Pitts died in May 1969
- McCullouch died in Sep. 1969
- Rosenblatt died in 1971

Symbolic A.I. Winters

1957: Herbert Simon declares that *"there are now in the world machines that think, that learn, and that create"*

1958: A New York Times article (8 July 1958) reporting a press conference by Rosenblatt that *"the Perceptron is the embryo of an electronic computer that (the US Navy) expects will be able to walk, talk, see, write, reproduce itself and be conscious of its existence"*

1958: Bar-Hillel publishes a "proof" that machine translation is impossible

1965: Herbert Simon predicts that *"machines will be capable within 20 years of doing any work a man can do"*

1966: The ALPAC Report causes reduction in funding for machine translation research

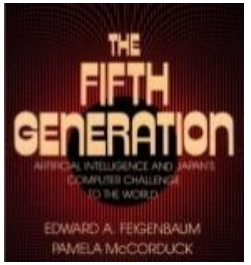
Symbolic A.I. Winters

1970: Marvin Minsky to Life Magazine:

"In from three to eight years we will have a machine with the general intelligence of an average human being"

1973: The Lighthill Report kills A.I. in the UK

1980s: Fifth Generation illusion

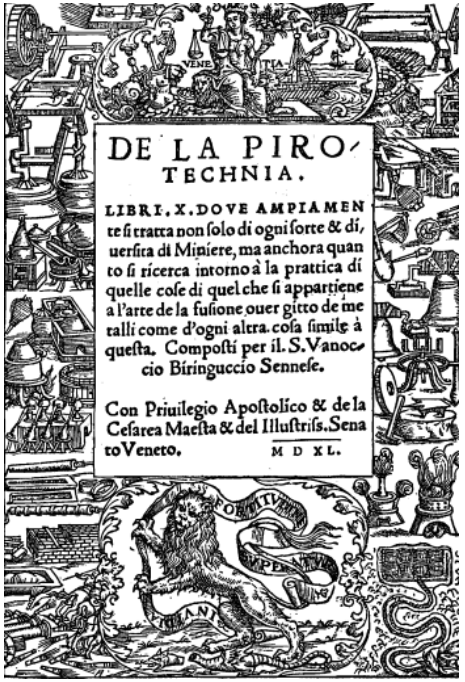


What saved A.I.

Neuroscience: Fukushima's convolutional nets

Physics: Hopfield's recurrent neural networks

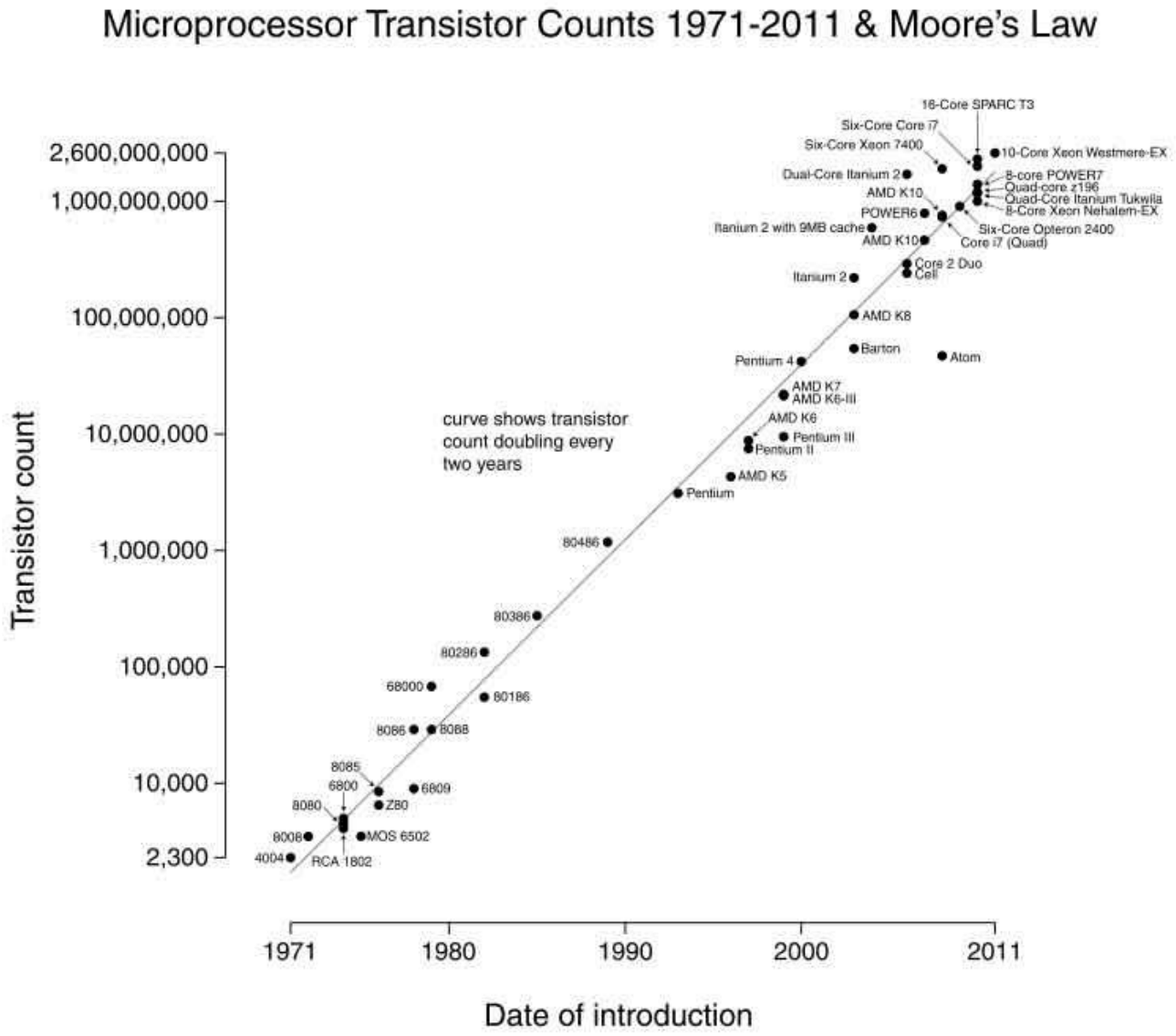
Canada: CIFAR (Canadian Institute for Advanced Research)



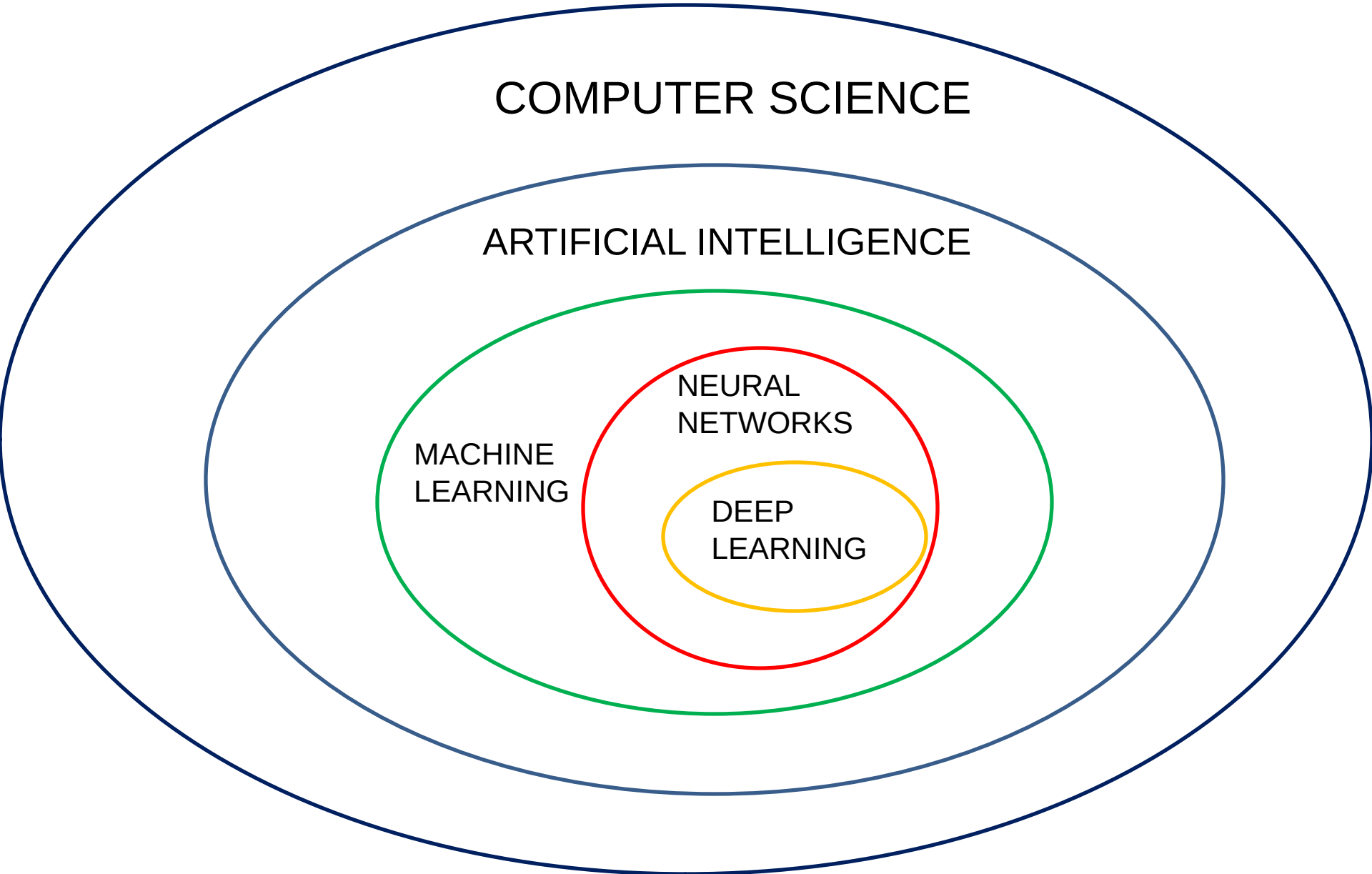
Vannoccio Biringuccio's "De la Pirotechnia" (1540, first printed book on metallurgy published in Europe)

CANADA 150
1867-2017

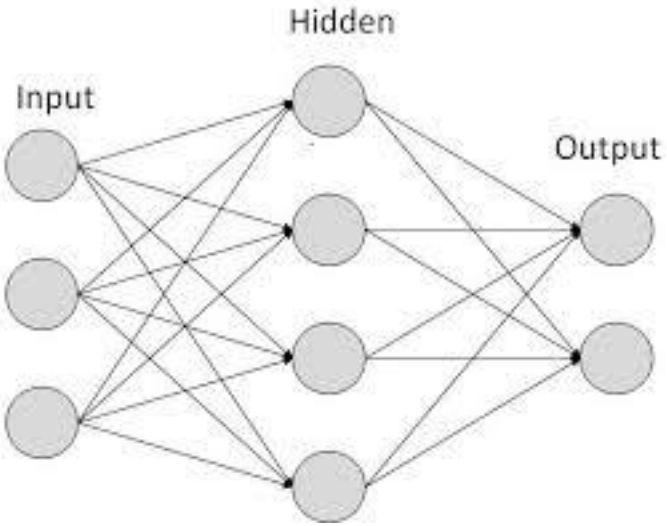
The #1 factor: Moore's Law



Neural Networks

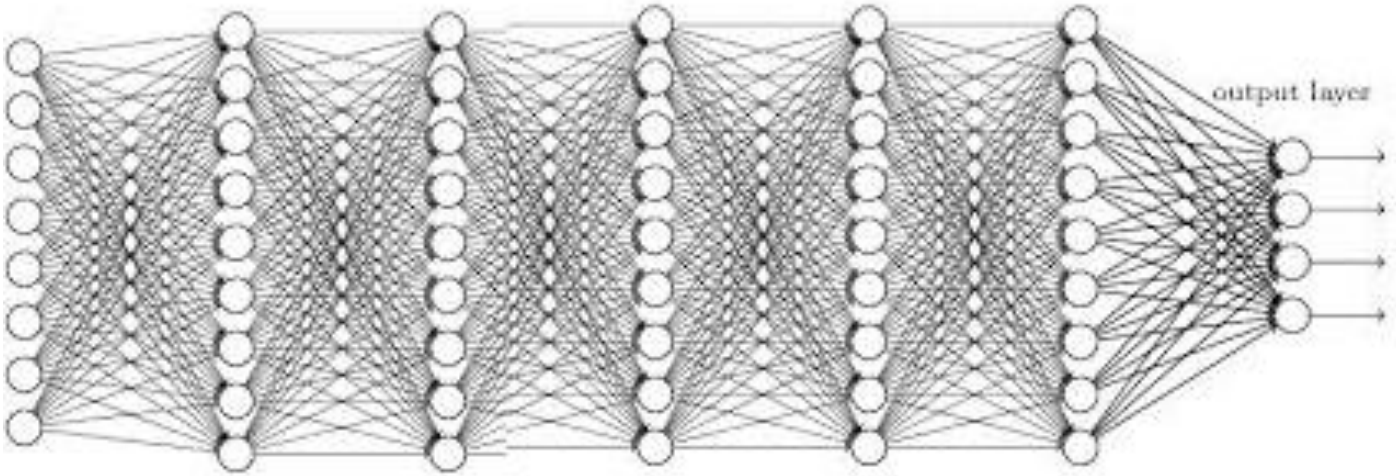


Neural Networks



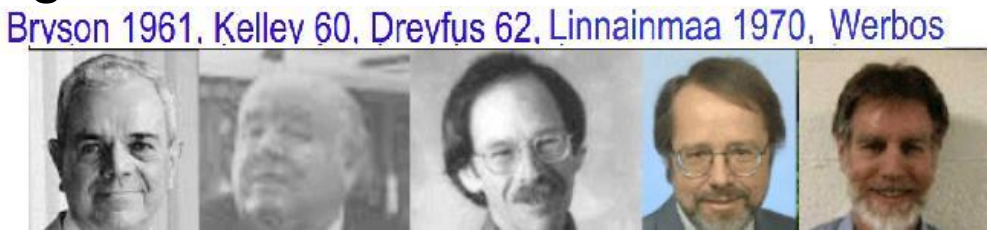
3 LAYERS

MANY LAYERS
(“DEEP”)



Neural Networks

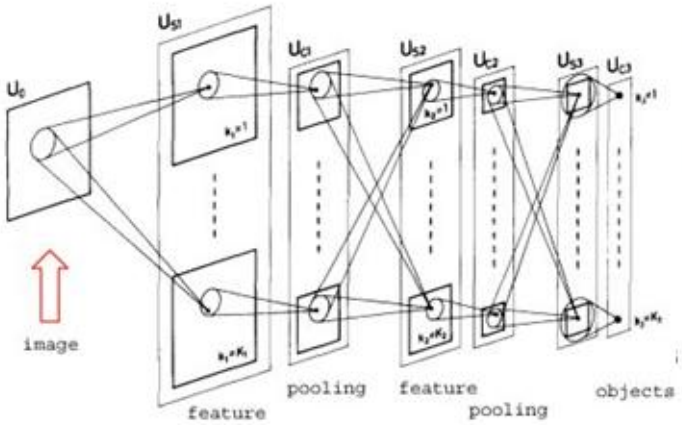
1960: The backpropagation algorithm



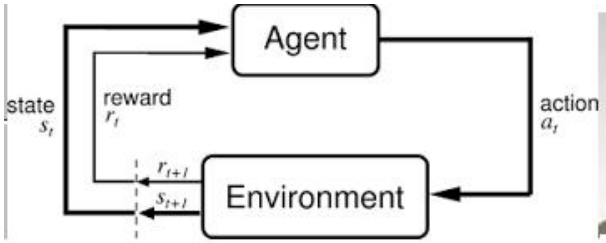
1965: Alexey Ivakhnenko publishes the first learning algorithms for multi-layered networks

Neural Networks

1979: Kunihiko Fukushima's convolutional neural network

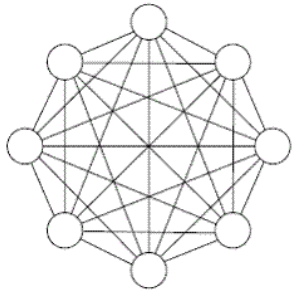


1981: Andrew Barto's and Richard Sutton's temporal-difference method of reinforcement learning



Neural Networks

1982: John Hopfield's recurrent neural network



$$E(v) = -\frac{1}{2}\sum_{i \neq j}\sum_{i,j} w_{ij} v_i v_j - \sum_i I_i v_i + \sum_i \frac{1}{R_i}\int_0^{v_i} f_i^{-1}(z)dz$$

$$\nabla_v E(v) = Wv + I - u/R$$

1983: Terry Sejnowski's and Geoffrey Hinton's Boltzmann machine

$$\boldsymbol{P(x) = \frac{\exp(-E(x))}{Z}}$$

> E(x): Energy function

> Z: partition function where $\sum_x P(x) = 1$

1985: Judea Pearl's "Bayesian Networks"

$$P(C,S,R,W,F) = P(C)\,P(S|C)\,P(R|C)\,P(W|R,S)\,P(F|R)$$

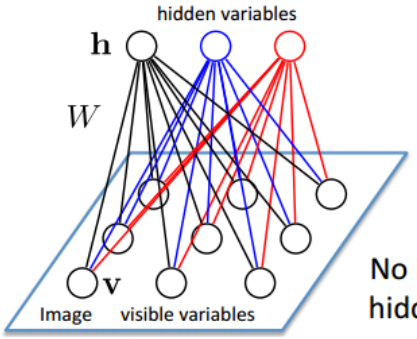
$$P(C,F) = \sum_S \sum_R \sum_W P(C,S,R,W,F)$$

$$P(F|C) = P(C,F) / P(C)$$

Neural Networks

1986: Paul Smolensky's Restricted Boltzmann machine

Restricted Boltzmann Machines



Boltzmann distribution:

$$\boldsymbol{P(\mathbf{v} = v, \mathbf{h} = h) = \frac{1}{Z}\exp(-E(v,h))}$$

$$\mathcal{Z}(\theta) = \sum_{\mathbf{h},\mathbf{v}} \exp\left(-E(\mathbf{v},\mathbf{h};\theta)\right)$$

No interaction between hidden variables

1986: David Rumelhart's backpropagation algorithm

equations of backpropagation

$$\delta^L = \nabla_a C \odot \sigma'(z^L)$$

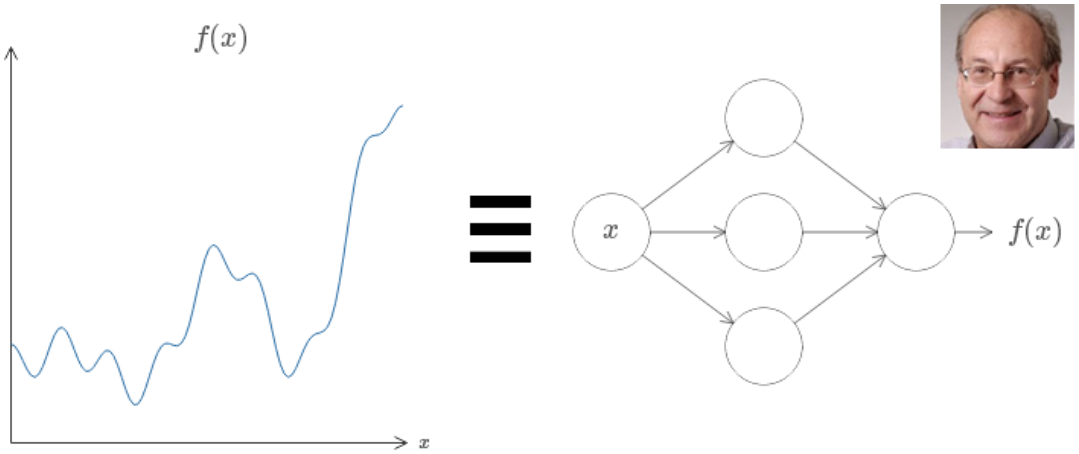
$$\delta^l = ((w^{l+1})^T \delta^{l+1}) \odot \sigma'(z^l)$$

$$\frac{\partial C}{\partial b^l_j} = \delta^l_j$$

$$\frac{\partial C}{\partial w^l_{j\,k}} = a^{l-1}_k \delta^l_j$$

Neural Networks

1989: George Cybenko proves that neural networks can approximate continuous functions



1992: Hava Siegelmann’s and Eduardo Sontag's theorem (RNN=Turing Machine)

Neural Networks

1989: Yann LeCun 's convolutional neural network LeNet-1 (backpropagation applied to convolutional networks)

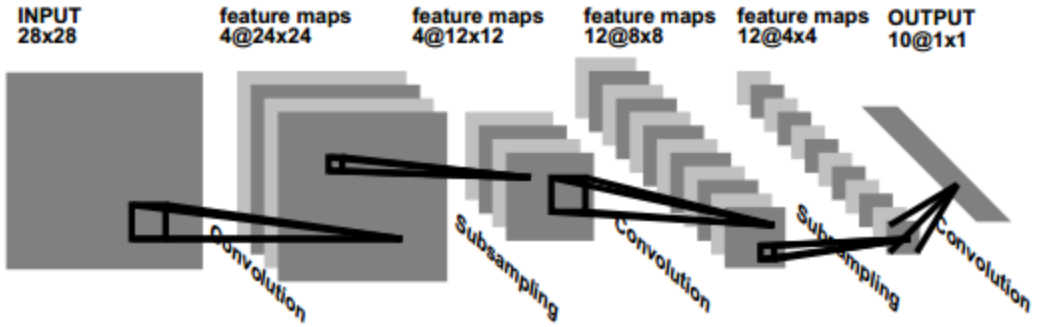
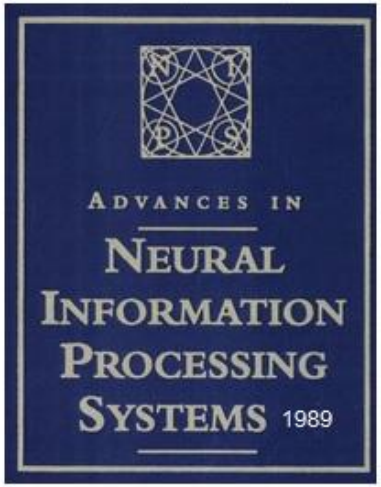


Figure 1: Architecture of LeNet 1

Handwritten Digit Recognition with a Back-Propagation Network

Y. Le Cun, B. Boser, J. S. Denker, D. Henderson,
R. E. Howard, W. Hubbard, and L. D. Jackel
AT&T Bell Laboratories, Holmdel, N. J. 07733



Given functions $x(t)$ and $w(t)$, their convolution is a function $s(t)$

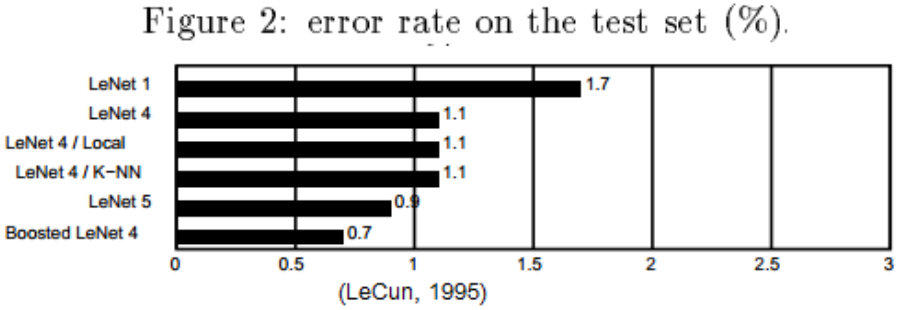
$$s(t) = \int x(a)w(t-a)da$$

Written as

$$s = (x * w) \quad \text{or} \quad s(t) = (x * w)(t)$$

Neural Networks

1994: Yann LeCun 's LeNet-5



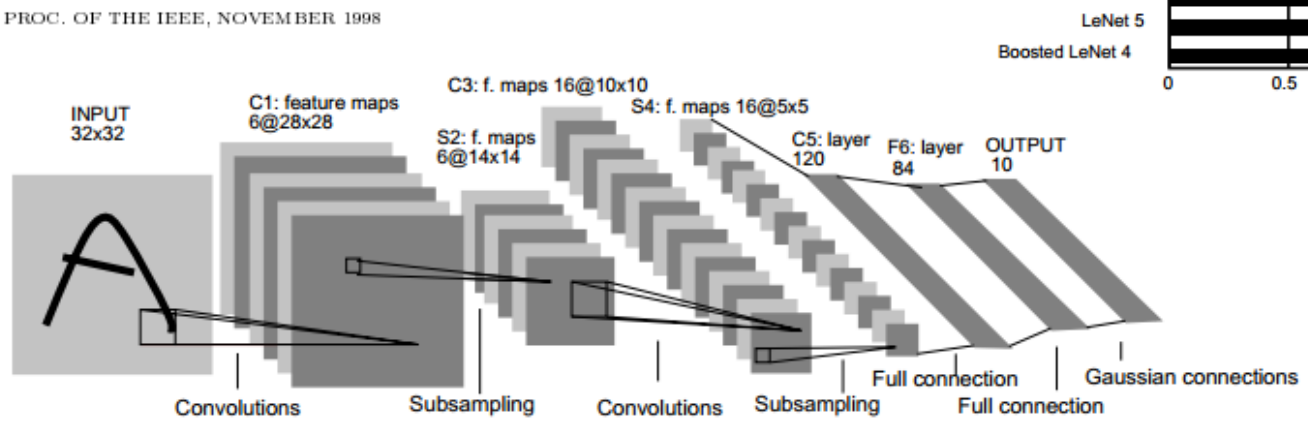
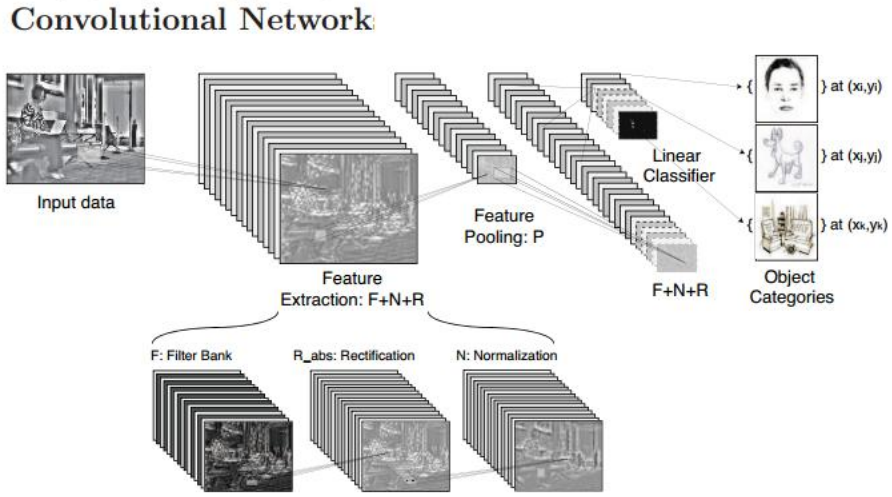
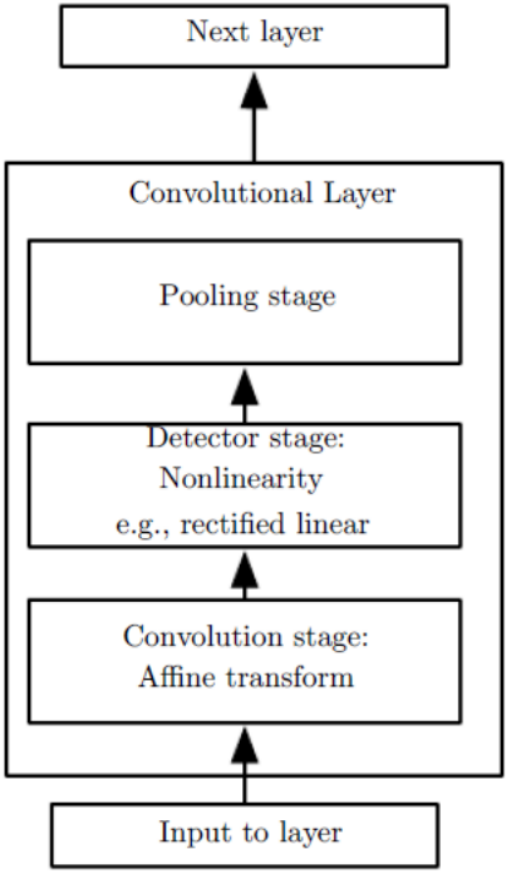


Fig. 2. Architecture of LeNet-5, a Convolutional Neural Network, here for digits recognition.



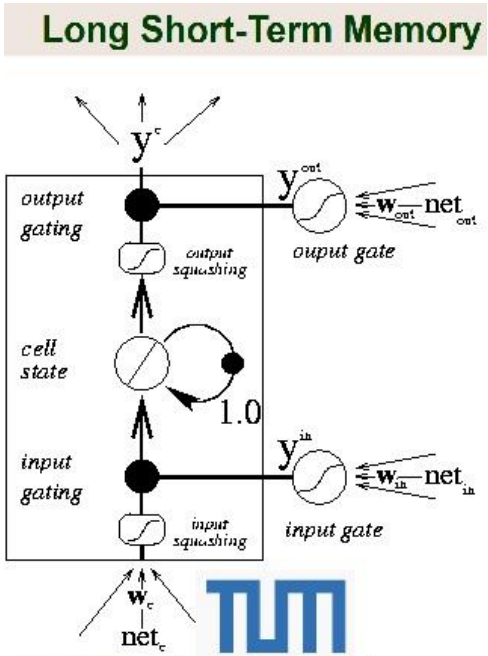
Architecture of a typical convolutional network for object recognition

From a paper by Yann LeCun



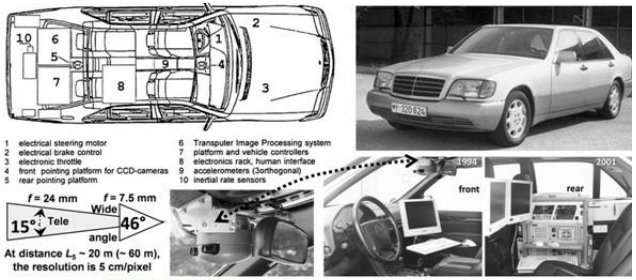
Neural Networks

1997: Sepp Hochreiter's and Jeurgen Schmidhuber's Long Short Term Memory (LSTM) model



No need for Neural Nets

1994: Ernst Dickmanns' self-driving car drives more than 1,000 kms near the airport Charles-de-Gaulle in Paris



The "VAmP" Mercedes 500 SEL

1997: IBM's "Deep Blue" chess machine beats the world's chess champion, Garry Kasparov

No need for Neural Nets

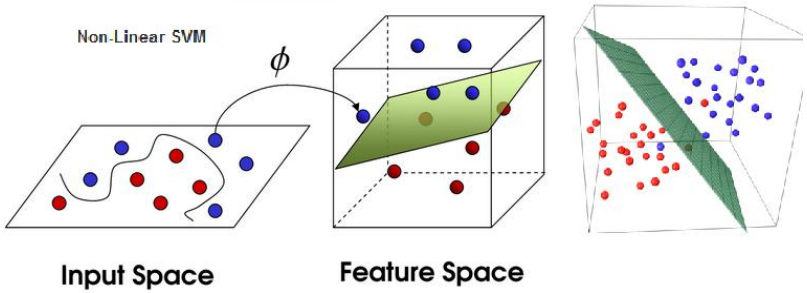
2005: Sebastian Thrun's driverless car Stanley wins DARPA's Grand Challenge

2011: IBM's Watson debuts on a tv show

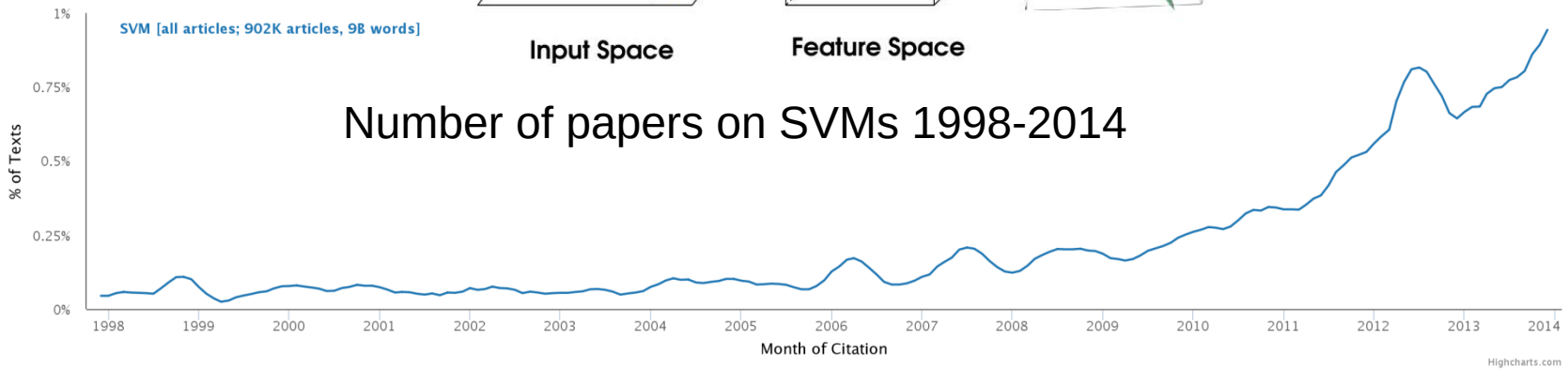
2011: Apple Siri (2011)

No need for Neural Nets

- Statistical machine learning
  - 1990: Robert Schapire's boosting
  - 1991: Vladimir Vapnik's SVM
  - 1993: Ross Quinlan's C4.5
  - 1995: Tin-Kam Ho's random forests

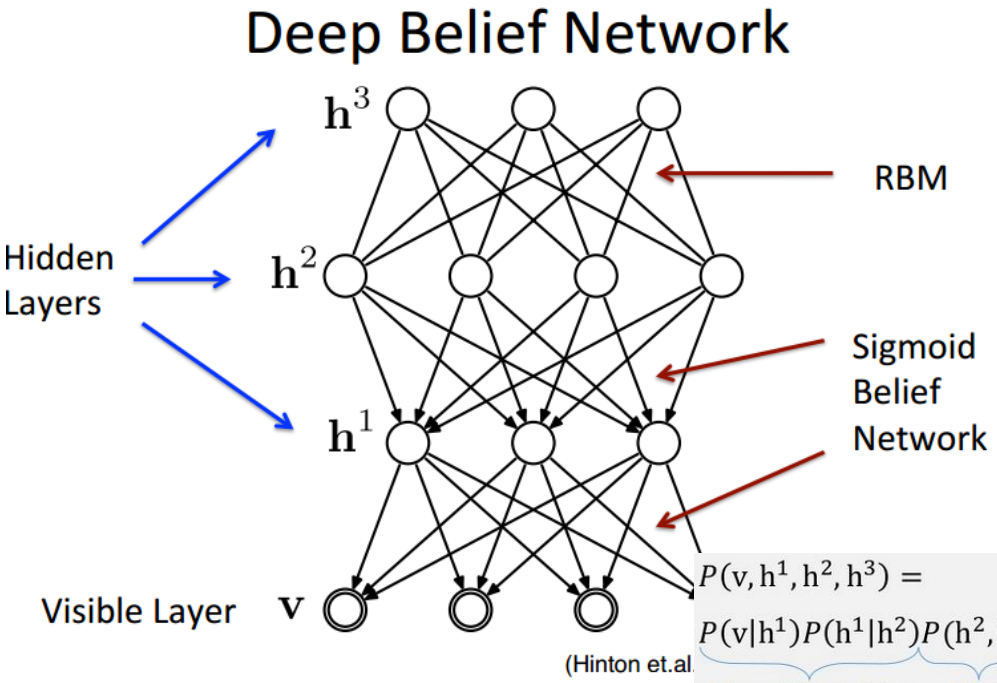


Number of papers on SVMs 1998-2014



Deep Learning

2006: Geoffrey Hinton's Deep Belief Networks



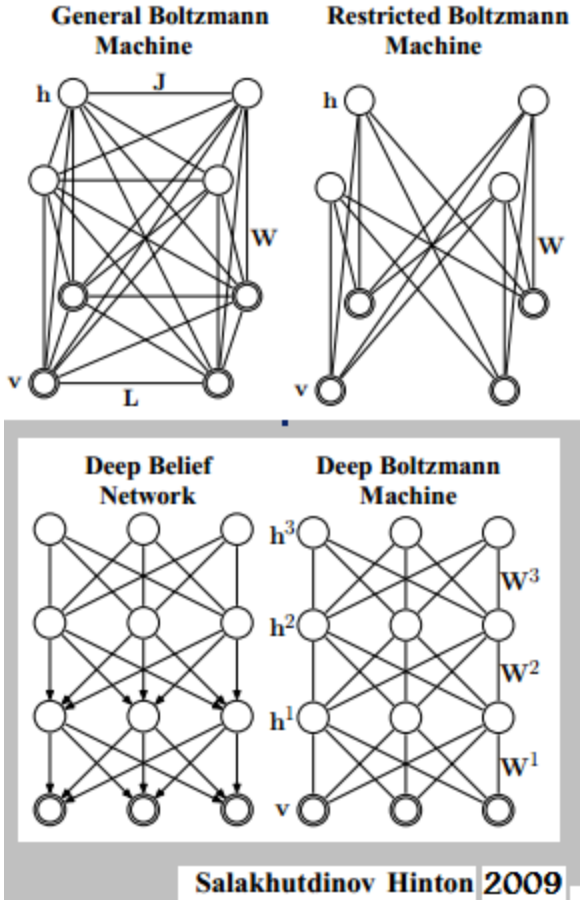
$$P(\mathrm{v}, \mathrm{h}^1, \mathrm{h}^2, \mathrm{h}^3) = P(\mathrm{v}|\mathrm{h}^1) P(\mathrm{h}^1|\mathrm{h}^2) P(\mathrm{h}^2, \mathrm{h}^3)$$

Sigmoid Belief Net | RBM

$$P(\mathrm{v}|\mathrm{h}^1) = \prod_i P(v_i|\mathrm{h}^1)$$

$$P(\mathrm{h}^1|\mathrm{h}^2) = \prod_j P(h_j^1|\mathrm{h}^2)$$

$$P(\mathrm{h}^2, \mathrm{h}^3) = \frac{1}{Z(W^3)} \exp(\mathrm{h}^{2T} W^3 \mathrm{h}^3)$$

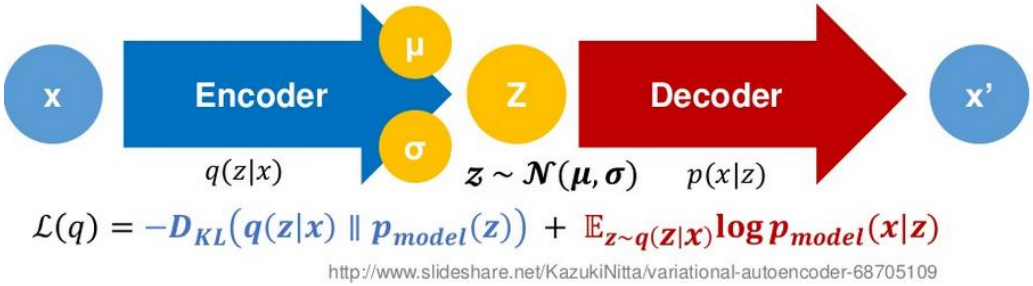


Deep Learning

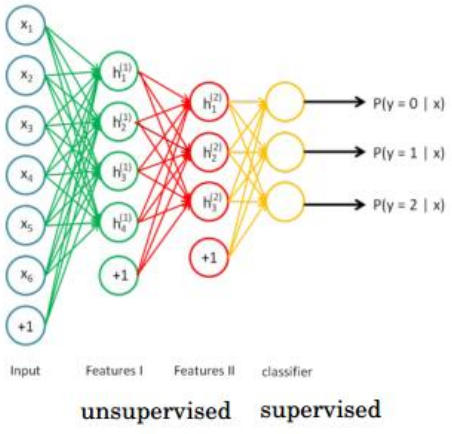
2007: Yoshua Bengio's Stacked Autoencoders

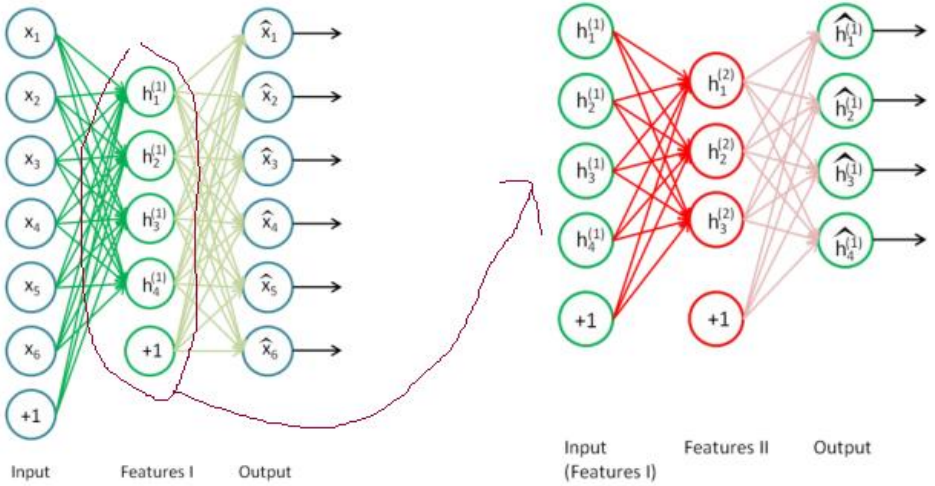
Auto-Encoders

- Multilayer neural nets with target output = input.
- Reconstruction = decoder(encoder(input))
- Objective is to minimize the reconstruction error.



Stacked Auto-encoders





Deep Learning

Annus mirabilis of Deep Learning: 2012

Deep Learning →

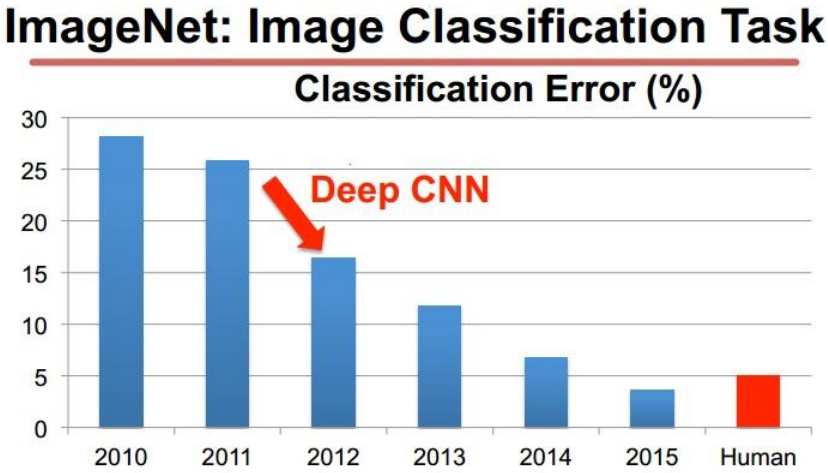
Error rates on the ILSVRC-2012 competition

- Krizhevsky et. al. — **16.4%**

much bigger gap

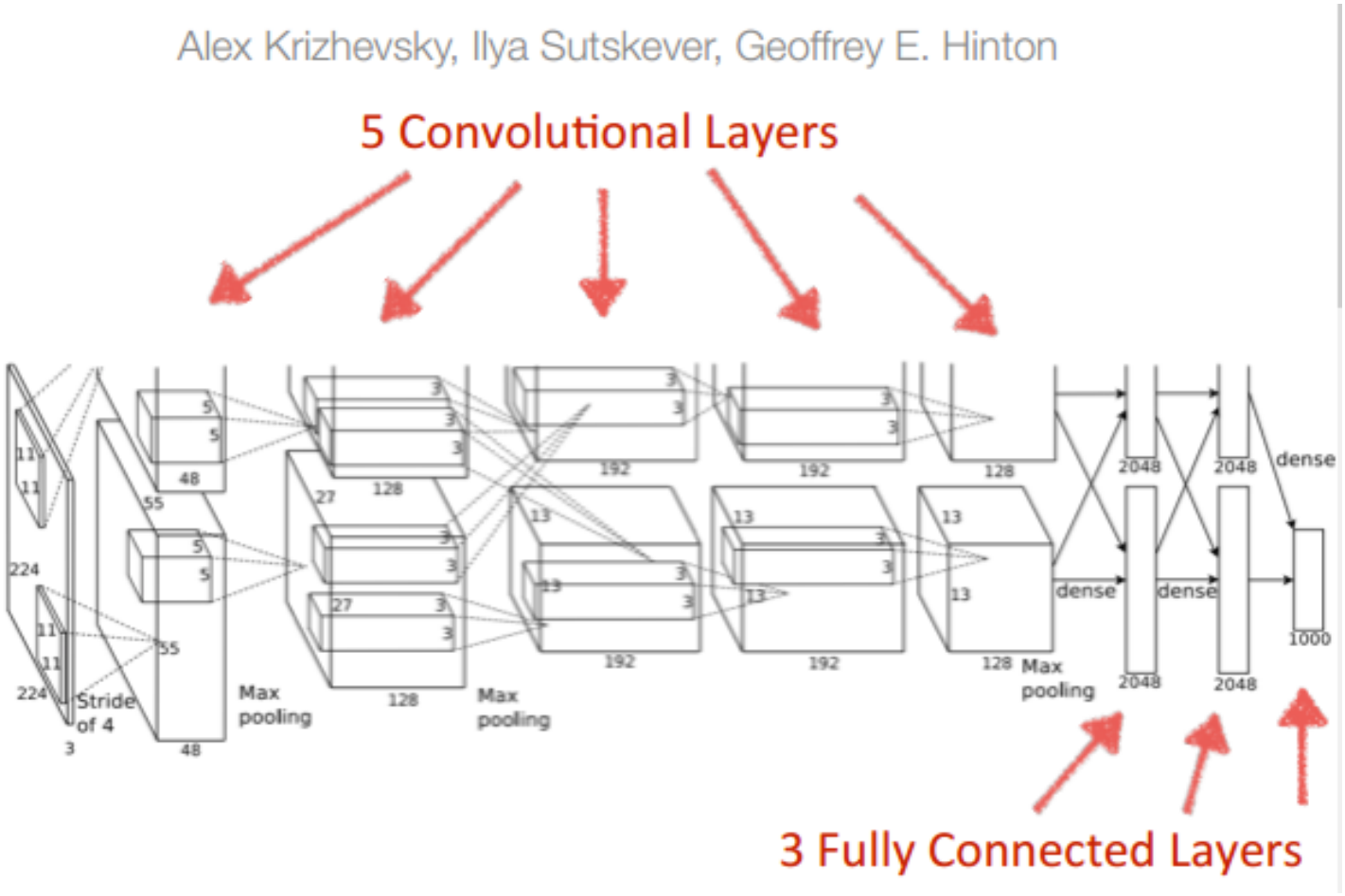
- University of Tokyo — 26.1%
- Oxford University Vision Group — 26.9%
- INRIA + XRCE — 27.0%

- University of Amsterdam — 29.5%



Deep Learning

AlexNet: 8 layers



Deep Learning

- Google (2012): GoogleBrain (1.7 billion connections in 16,000 processors) recognize cats in YouTube videos

ICDAR
OFFLINE CHINESE
HANDWRITING
RECOGNITION
CONTEST

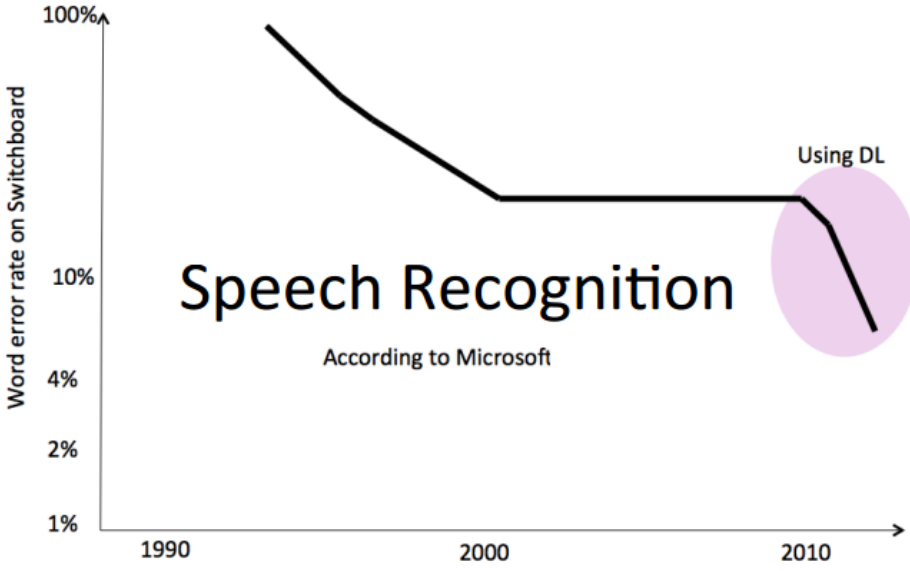
OCT 2013:

NEAR-HUMAN
PERFORMANCE

JÜRGEN SCHMIDHUBER, IDSIA

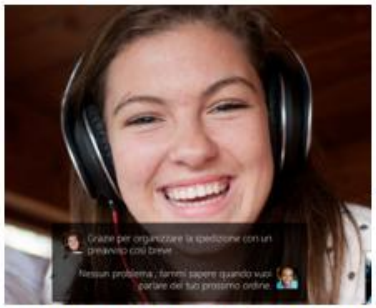
Deep Learning

- Speech recognition



skype

Skype Translator



Microsoft 2016

ACHIEVING HUMAN PARITY IN CONVERSATIONAL SPEECH RECOGNITION

W. Xiong, J. Droppo, X. Huang, F. Seide, M. Seltzer, A. Stolcke, D. Yu and G. Zweig

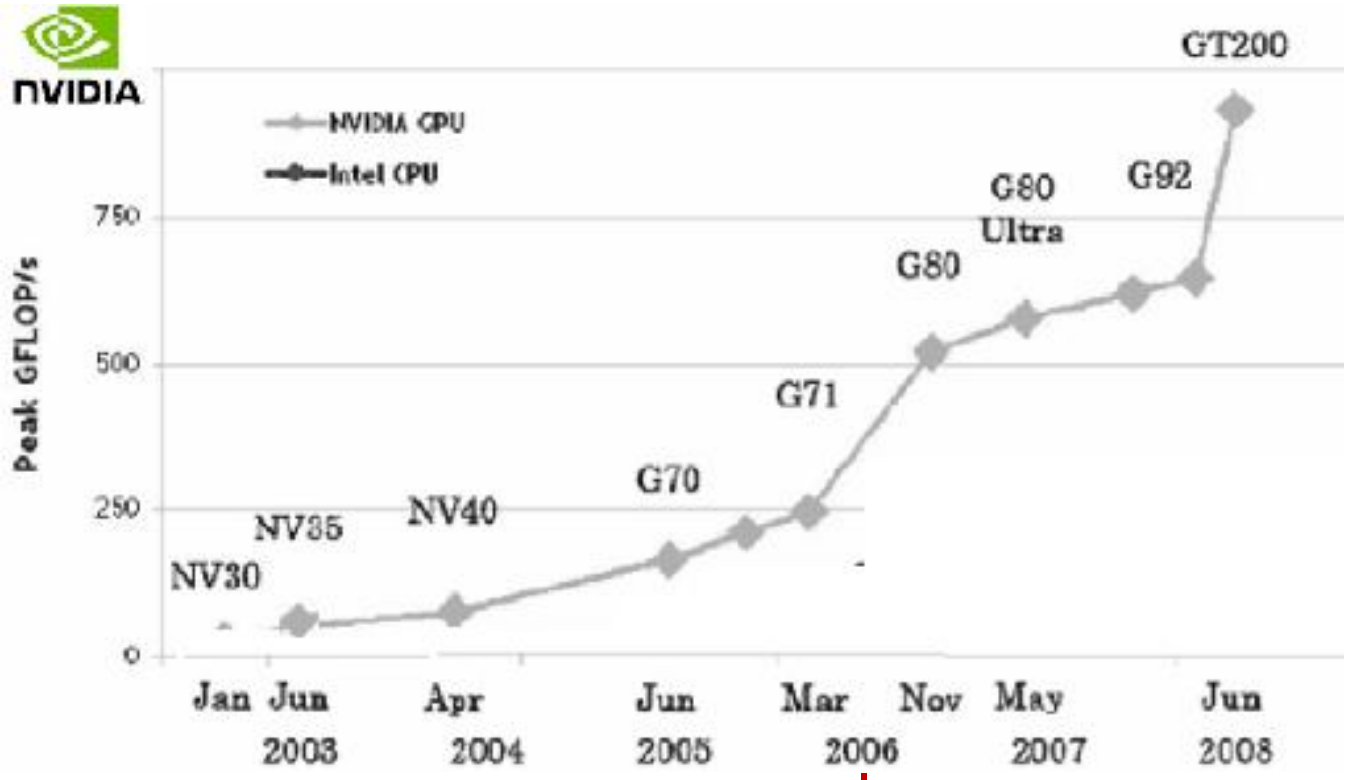
to JP Morgan

Microsoft Research
Technical Report MSR-TR-2016-71

to Tencent

The real heroes of Deep Learning

Nvidia's GPUs



Deep Learning is born

2016

Nvidia Tesla P100 for deep learning

Unsung Heroes: The datasets

1990: Switchboard-1 Telephone Speech Corpus (TI)
1991: Continuous Speech Recognition (CSR) Corpus
1993: FERET (Army Research Lab)
1994: ORL face dataset (Olivetti)
1996: Broadcast News corpus
1999: MNIST handwritten-digit dataset (NYU)
2006: PASCAL VOC
2007: Tiny Images Dataset (MIT)
2007: Labeled Faces in the Wild (University of Massachusetts)
2009: ImageNet
2013: dataset of Atari games (University of Alberta)
2014: COCO (Microsoft)

Deep Learning

Annus mirabilis of Deep Learning: 2012

Why did it take until 2012?

1. The training datasets
2. The computational power

Trivia: The Stars of Deep Learning

Kunihiko Fukushima: Japan

Hava Siegelmann: Israel

Sepp Hochreiter: Germany

Juergen Schmidhuber: Switzerland

Yann LeCun: France

Geoffrey Hinton: Britain/ Canada

Yoshua Bengio: France/ Canada

Andrew Ng: China

Daniela Rus: Romania

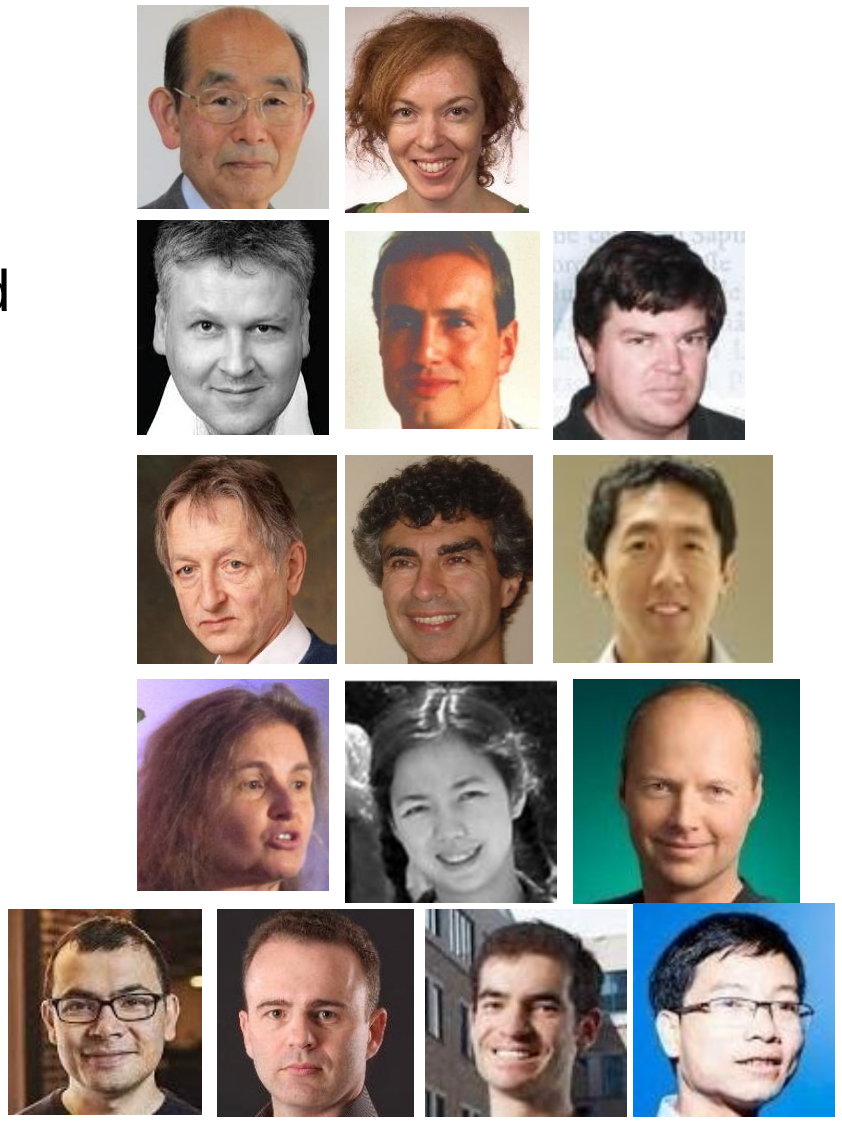
Fei-fei Li: China

Sebastian Thrun: Germany

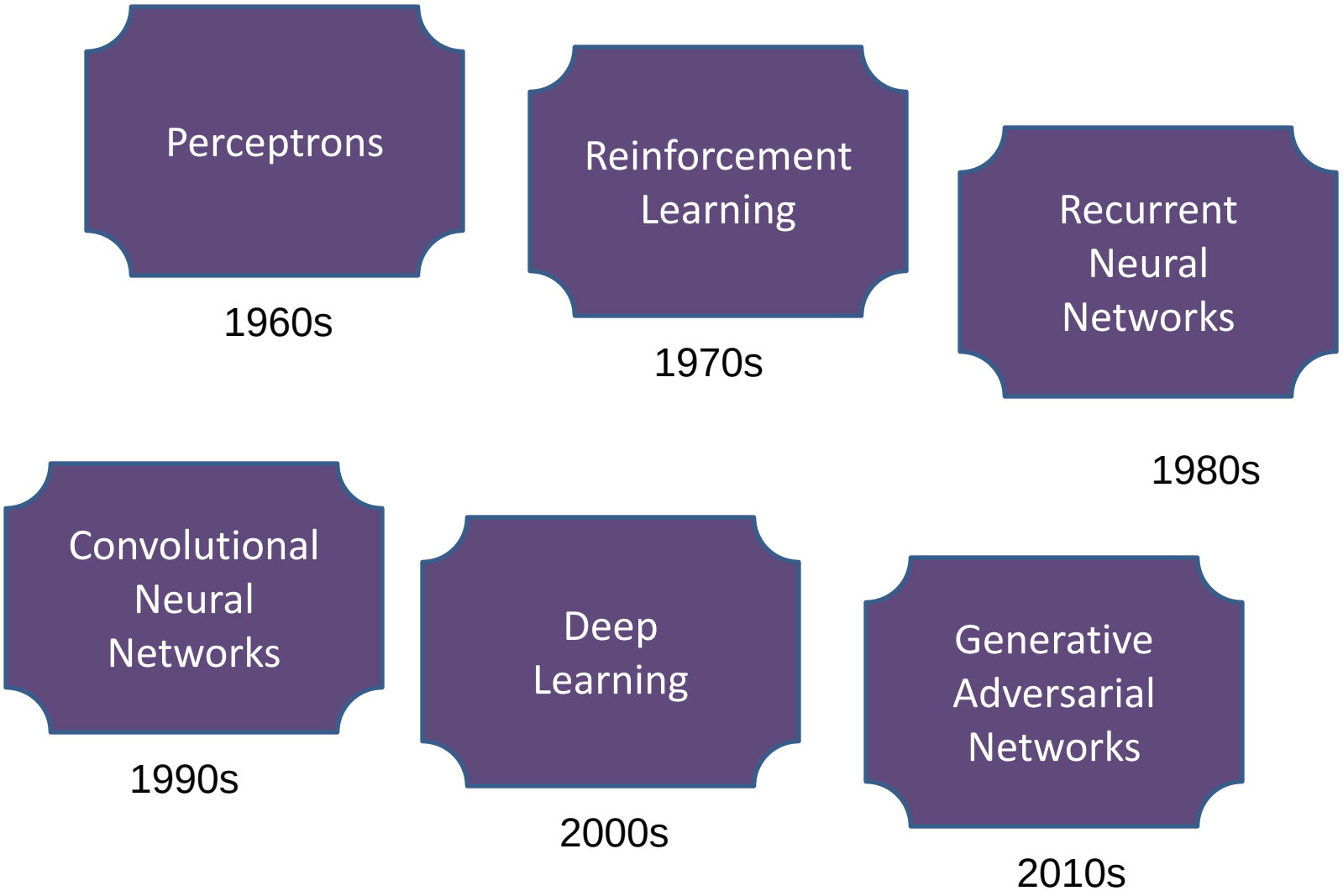
DeepMind: Britain/ New Zealand

Ilya Sutskever: Russia

Quoc Le: Vietnam



Evolution of Neural Networks



Deep Learning

The state of the art

- CNN = Convolutional Neural Networks (images)
- RNN = Recurrent Neural Networks (speech, translation, scenes)
- LSTM = Long Short Term Memory (narrative text?)

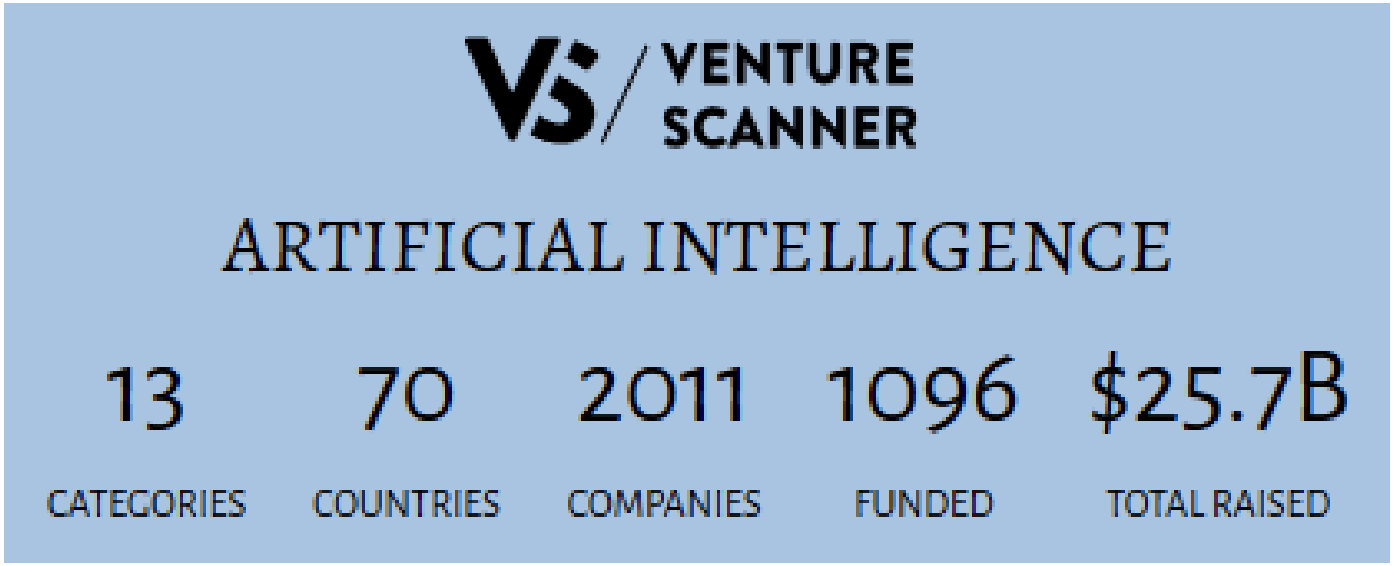
Business

- Multi-billion dollar investments in artificial intelligence and robotics in the 2010s
  - Amazon (Kiva, 2012; Angel.ai, 2016; Harvest.ai, 2017)
  - Google (Neven, 2006; Industrial Robotics, Meka, Holomni, Bot & Dolly, DNNresearch, Schaft, Bost, DeepMind, Redwood Robotics, 2013-14; API.ai, 2016; Moodstocks, 2016; Kaggle, 2017)
  - IBM (AlchemyAPI, 2015; Watson project)
  - Microsoft (Project Adam, 2014; Switfkey, 2016; Genee and Maluuba, 2017)
  - Apple (Siri, 2011; Perceptio and VocalIQ, 2015; Emotient, Turi and Tuplejump, 2016; RealFace, 2017)
  - Facebook (Face.com, 2012; Wit.ai, 2015; Masquerade, 2017; Zurich Eye, 2017)
  - Yahoo (LookFlow, 2013; Incredible Labs, 2014)
  - Twitter (WhetLab, 2015; Magic Pony, 2016)
  - Salesforce (TempoAI, 2015; MetaMind, 2016; PredictionIO, 2016)
  - Samsung (Viv Labs, 2016)
  - Intel (Nervana and Itseex in 2016)
  - General Electric (Wise.io, 2017)

50

Business

AI Startups as of November 2017 (VentureScanner)



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- Jobs
- We need AI soon
- The next Breakthrough

A.I. in China

- Microsoft chatbot Xiaoce: 100 million users
- News recommendation: Toutiao
- Voice recognition: iFlytek (China)
- Face recognition: Face++ (China)
- Several A.I. unicorns

科大讯飞
iFLYTEK

FACE++

A.I. in China

- The B.A.T.

A.I. in China

- A simple definition: “A.I. = computational mathematics”

$$P(x) = \frac{\exp(-E(x))}{Z}$$

$$E(v) = -\frac{1}{2}\sum_{i=j}\sum_{i,j} w_{ij} v_i v_j - \sum_i I_i v_i + \sum_i \frac{1}{R_i}\int_0^{v_i} f_i^{-1}(z)dz$$

$$\nabla_v E(v) = Wv + I - u/R$$

$$P(\mathbf{v} = v, \mathbf{h} = h) = \frac{1}{Z}\exp(-E(v,h))$$

$$\mathcal{Z}(\theta) = \sum_{\mathbf{h},\mathbf{v}} \exp\left(-E(\mathbf{v},\mathbf{h};\theta)\right)$$

$$\delta^L = \nabla_a C \odot \sigma'(z^L)$$

$$\delta^l = ((w^{l+1})^T \delta^{l+1}) \odot \sigma'(z^l)$$

$$\frac{\partial C}{\partial b_j^l} = \delta_j^l$$

$$\frac{\partial C}{\partial w_{jk}^l} = a_k^{l-1}\delta_j^l$$

$$P(C,S,R,W,F) = P(C)\,P(S|C)\,P(R|C)\,P(W|R,S)\,P(F|R)$$

$$P(C,F) = \sum_S \sum_R \sum_W P(C,S,R,W,F)$$

$$P(F|C) = P(C,F) / P(C)$$

$$P(\mathrm{v}, \mathrm{h}^1, \mathrm{h}^2, \mathrm{h}^3) = P(\mathrm{v}|\mathrm{h}^1)P(\mathrm{h}^1|\mathrm{h}^2)P(\mathrm{h}^2, \mathrm{h}^3)$$

Sigmoid Belief Net RBM

$$P(\mathrm{v}|\mathrm{h}^1) = \prod_i P(v_i|\mathrm{h}^1)$$

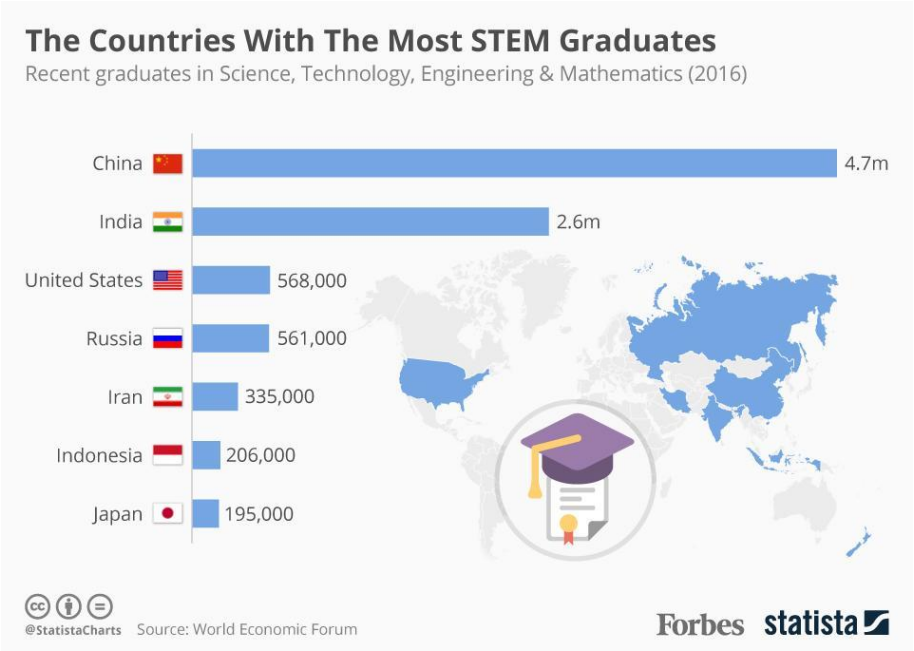
$$P(\mathrm{h}^1|\mathrm{h}^2) = \prod_j P(h_j^1|\mathrm{h}^2)$$

$$P(\mathrm{h}^2, \mathrm{h}^3) = \frac{1}{Z(W^3)}\exp(\mathrm{h}^{2T} W^3 \mathrm{h}^3)$$

$$\mathcal{L}(q) = -D_{KL}(q(z|x) \,\|\, p_{model}(z)) + \mathbb{E}_{z\sim q(z|x)} \log p_{model}(x|z)$$

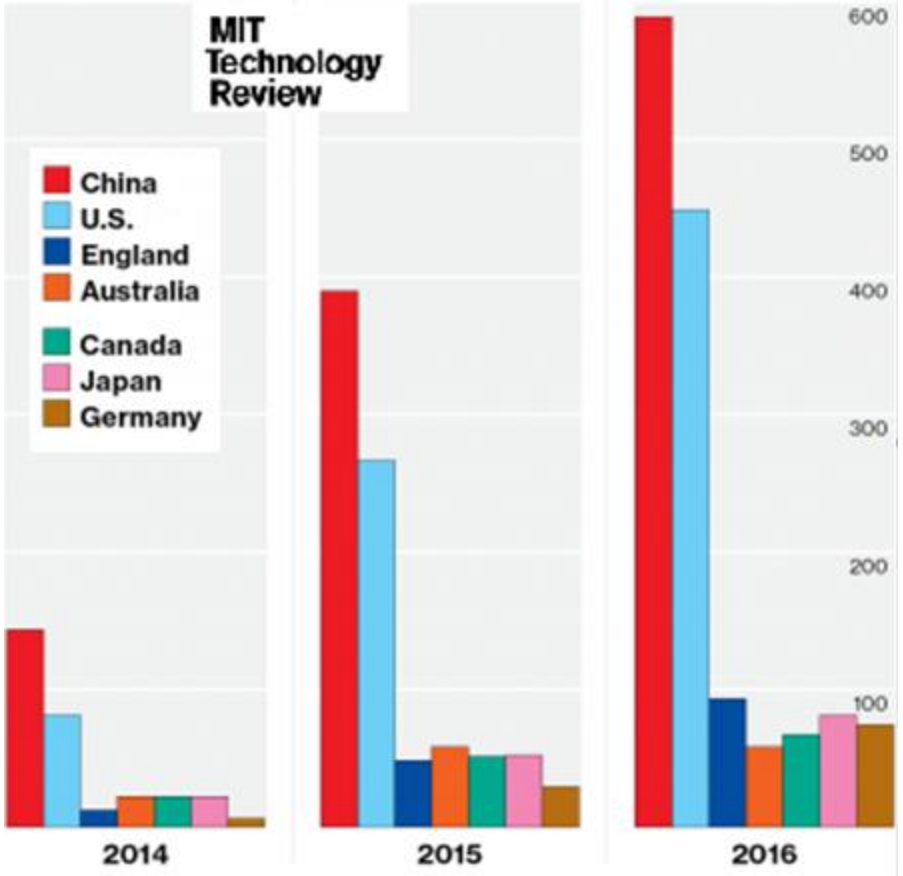
A.I. in China

- 2015: China builds the equivalent of nearly one university per week
- 2015: China has more STEM graduates than the USA (78 million vs 67 million)
- 2016: China STEM graduates 4.7 million; USA 568,000



A.I. in China

- 2016: China publishes more papers than the USA on Deep Learning



- 2017: China generates more data than the rest of the world combined

A.I. in China

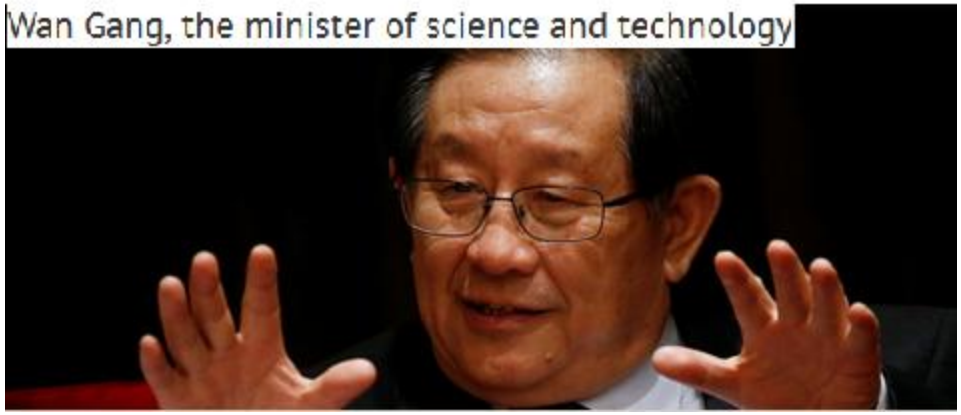
- A.I. sponsored by local and national governments
- July 2017: National A.I. program for China to become the leading A.I. power by 2030

THE | DIPLOMAT

China's Artificial Intelligence Revolution

A new AI development plan calls for China to become the world leader in the field by 2030.

On July 20, China's State Council issued the "Next Generation Artificial Intelligence Development Plan" (新一代人工智能发展规划)



Artificial Intelligence in China

- May 2017: Tsinghua Univ wins million-dollar Arnold Foundation's challenge
- Aug 2017: Nanjing Univ wins ILSVRC2017 (ImageNet)
- Oct 2017: Harbin & iFlyted win first Stanford reading comprehension test (SQuAD)
- Nov 2017: Yitu wins first Face Recognition Prize Challenge

MIT Technology Review

May 9, 2017

Million-Dollar Prize Hints at How Machine Learning May Someday Spot Cancer

Chinese researchers have developed an algorithm that could help make lung cancer diagnosis less error-pron

Challenge.gov

Government Challenges, Your Solutions

Face Recognition Prize Challenge

Search Accuracy Prize

$25,000.00

依图 | YITU

SQuAD

Rank	Model	EM	F1
1 Oct 17, 2017	Interactive AoA Reader+ (ensemble) *Joint Laboratory of HIT and iFLYTEK*	79.083	86.450

Artificial Intelligence in China

- October 2017: Megvii beats Facebook and Google at Microsoft COCO object recognition challenge
- Jan 2018: Alibaba wins Stanford reading competition and beats human for the first time

Challenge Winners

	1st place
COCO Detection: Bounding Box	Megvii
COCO Detection: Segmentation	Megvii
COCO Keypoints	Megvii
COCO Stuff	FAIR
Places Instance Segmentation	Megvii

The Stanford Question Answering Dataset

Rank	Model	EM	F1
	Human Performance *Stanford University* (Rajpurkar et al. '16)	82.304	91.221
1 Jan 05, 2018	SLQA+ (ensemble) *Alibaba iDST NLP*	82.440	**88.607**
1 Jan 03, 2018	r-net+ (ensemble) *Microsoft Research Asia*	**82.650**	88.493
2 Dec 17, 2017	r-net (ensemble) *Microsoft Research Asia* http://aka.ms/rnet	82.136	88.126
2 Dec 22, 2017	AttentionReader+ (ensemble) *Tencent DPDAC NLP*	81.790	88.163

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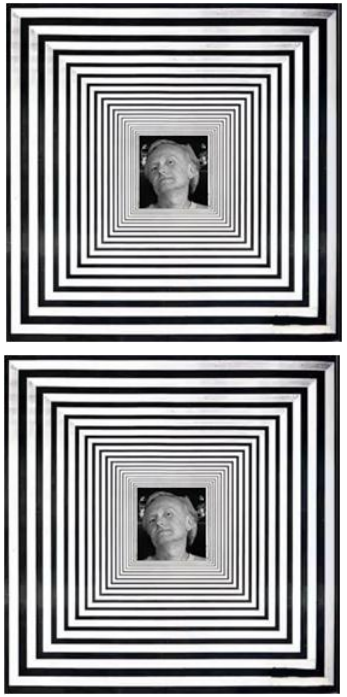
- The next Breakthrough

The 5 years that changed A.I. 2013-17

- Reinforcement Learning
- Recurrent Neural Nets
- Generative Adversarial Networks
- Recursive Cortical Networks
- Development Platforms
- Automatic Machine Learning
- Robots
- Explainable Deep Networks
- Machine Creativity



Reinforcement Learning

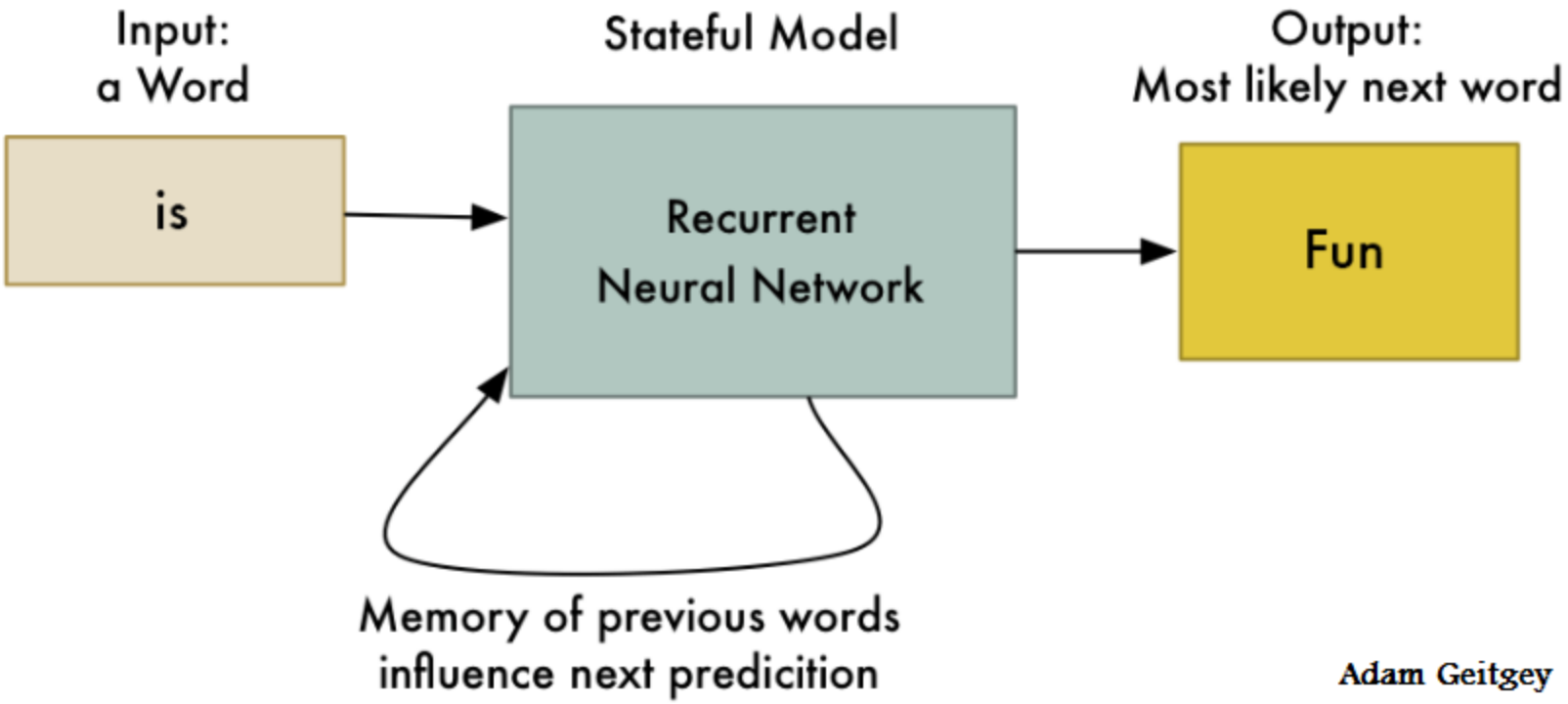
- Computer Go/Weichi
  - 2009: Fuego Go (Monte Carlo program by Univ. of Alberta) beats Zhou Junxun
  - 2010: MogoTW (Monte Carlo program developed in 2008 by a Euro-Taiwanese team) beat Catalin Taranu
  - 2012: Tencho no Igo/ Zen (Monte Carlo program developed by Yoji Ojima in 2005) beat Takemiya Masaki
  - 2013: Crazy Stone (Monte Carlo program by Remi Coulom in 2005) beat Yoshio Ishida
  - Pachi (open-source Monte Carlo program by Petr Baudis)

Reinforcement Learning

Google/DeepMind's AlphaGo beats weichi champions

Recurrent Neural Nets

- Using RNNs to guess the next word
- Using RNNs for machine translation
- Using RNNs for scene analysis

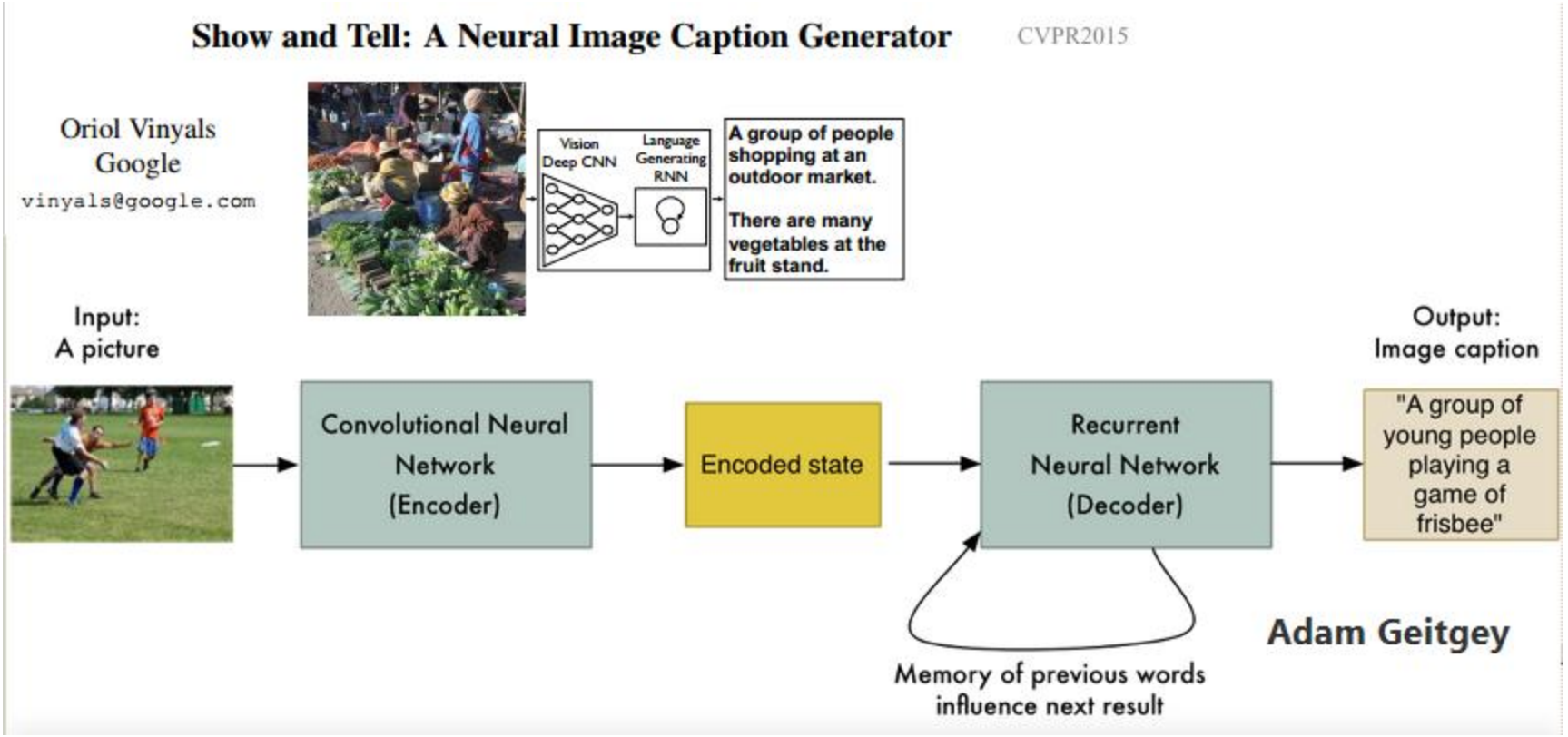


Recurrent Neural Nets

- Machine translation

Recurrent Neural Nets

- Scene analysis (Oriol Vinyals)



Recurrent Neural Nets

https://research.googleblog.com/2014/11/a-picture-is-worth-thousand-coherent.html

Recurrent Neural Nets

But note…

A refrigerator filled with lots of food and drinks.

Generative Adversarial Networks

What does it mean to "learn" a concept?

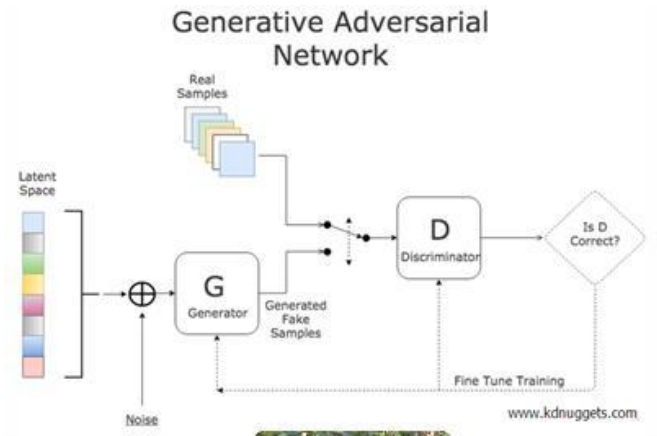
Do you know what a dog is?

Yes?
Can you draw a picture of a dog?

Good. That's a sign that you LEARNED the concept "Dog".

Generative Adversarial Networks

Ian Goodfellow (2014)



Ian Goodfellow

Generative Adversarial Networks

Unsupervised Representation Learning with Deep Convolutional Generative Adversarial Networks

Alec Radford, Luke Metz, Soumith Chintala

All images in this paper are generated by a neural network. They are NOT REAL.

Generative Adversarial Networks

- Text to image synthesis

Generative Adversarial Text to Image Synthesis

Scott Reed, Zeynep Akata, Xinchen Yan, Lajanugen Logeswaran
Honglak Lee, Bernt Schiele

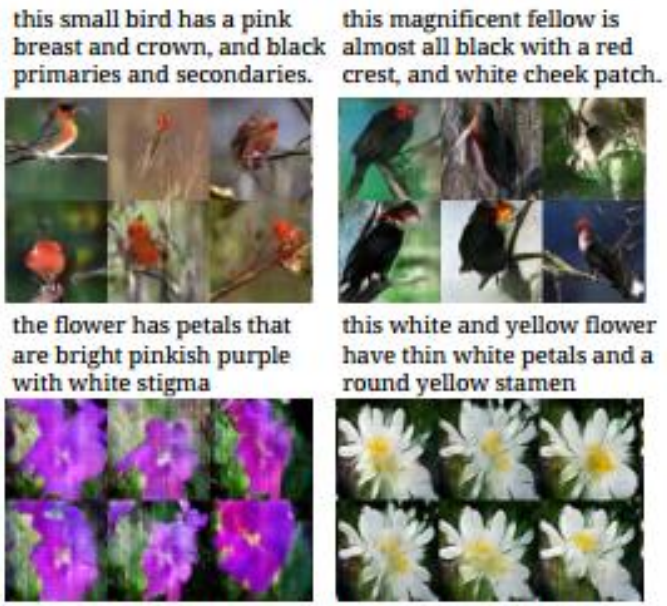
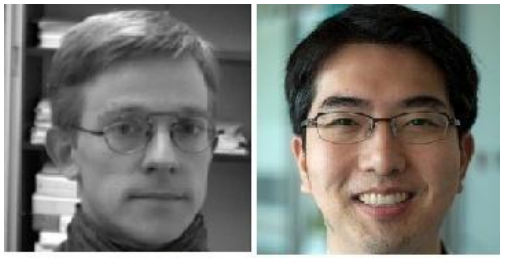


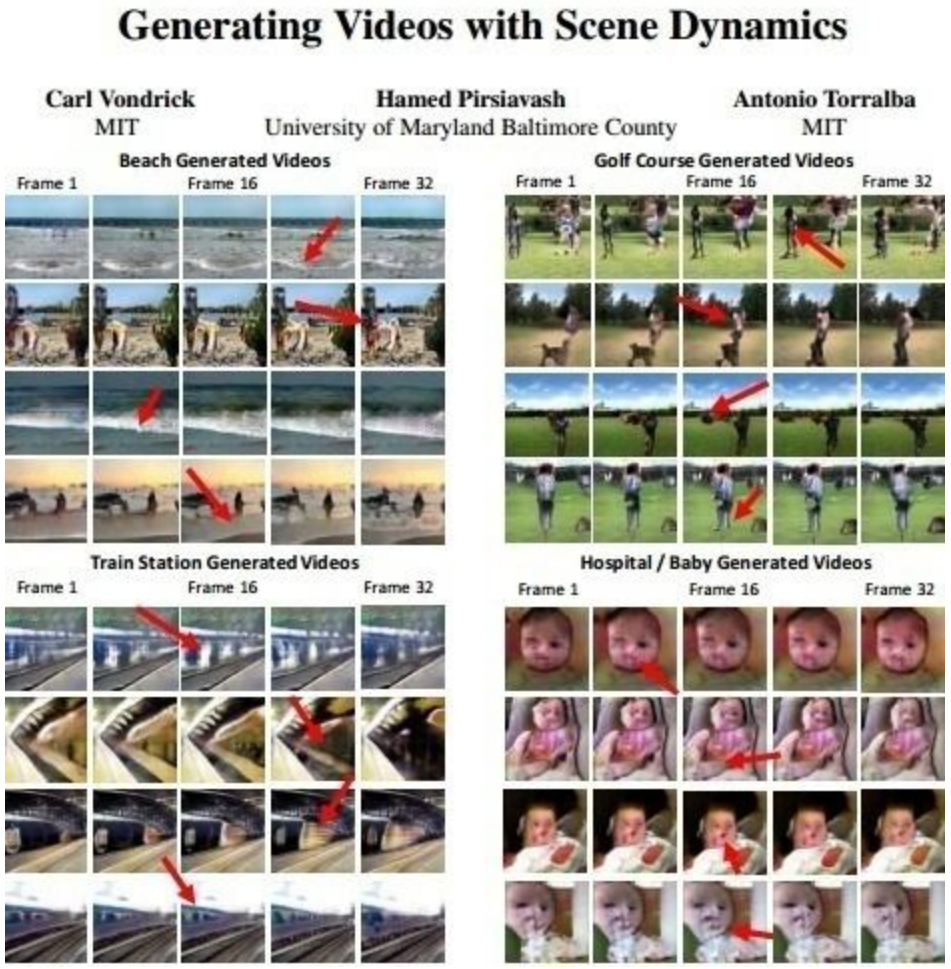
Figure 1. Examples of generated images from text descriptions. Left: captions are from zero-shot (held out) categories. Right: captions are from training set categories.



Generative Adversarial Networks

- Video generation

Vondrik Torralba



Generative Adversarial Networks

- Image-to-image traslation
  - Alexei Efros (UC Berkeley) – Pix2pix
  - Ming-yu Liu (Nvidia)

Unpaired Image-to-Image Translation using Cycle-Consistent Adversarial Networks

Jun-Yan Zhu* Taesung Park* Phillip Isola **Alexei A. Efros**

UC Berkeley

In ICCV 2017

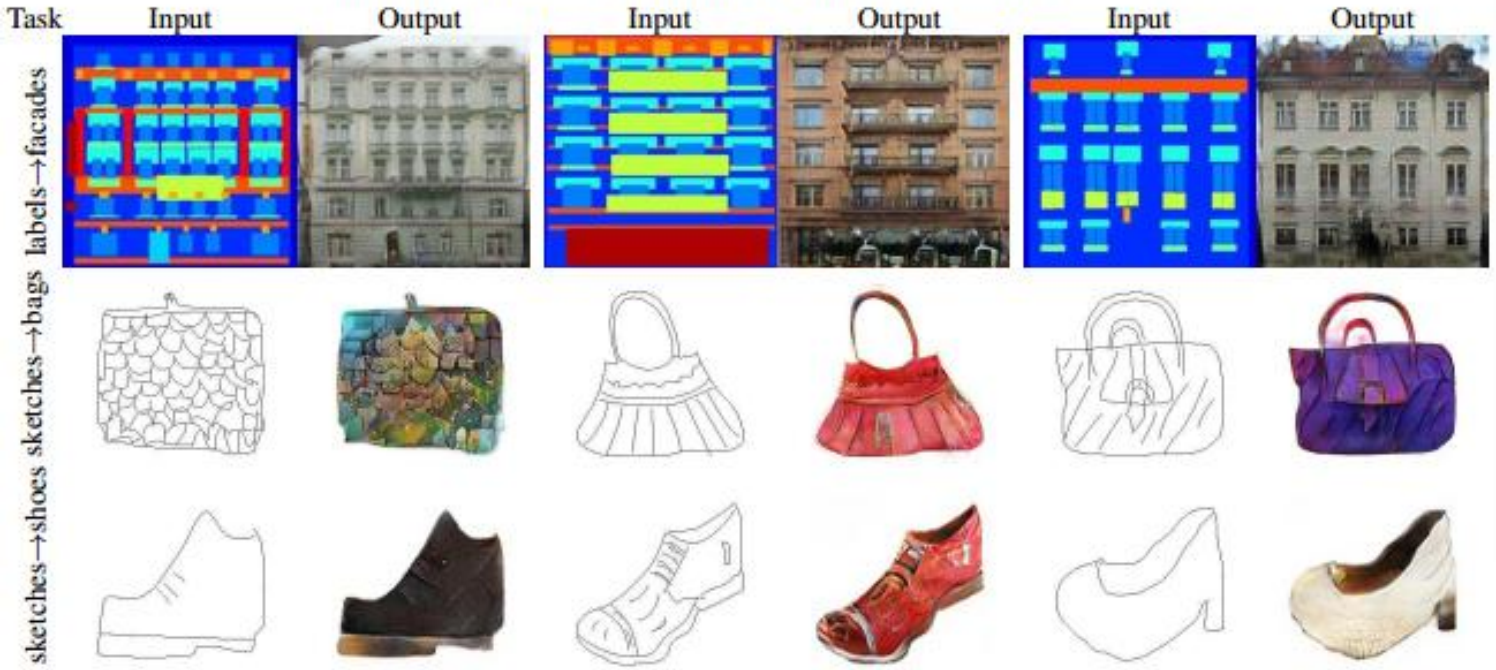
Generative Adversarial Networks

- Image-to-image traslation
  - Alexei Efros (UC Berkeley)

Image-to-Image Translation with Conditional Adversarial Networks

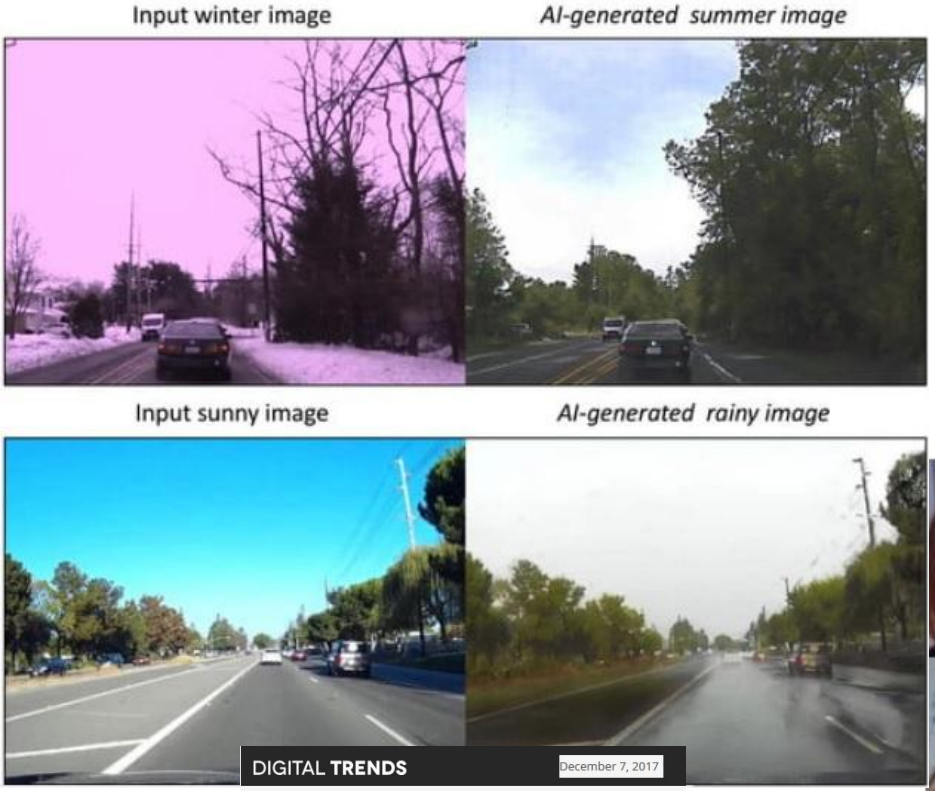
Phillip Isola Jun-Yan Zhu Tinghui Zhou Alexei A. Efros

Berkeley AI Research (BAIR) Laboratory, UC Berkeley 2017



Generative Adversarial Networks

- Image-to-image traslation
  - Ming-yu Liu (Nvidia)

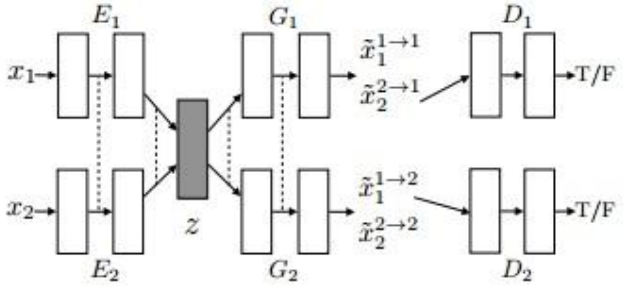


Unsupervised Image-to-Image Translation Networks

Oct 2017

Ming-Yu Liu, Thomas Breuel, Jan Kautz
NVIDIA
{mingyul,tbreuel,jkautz}@nvidia.com

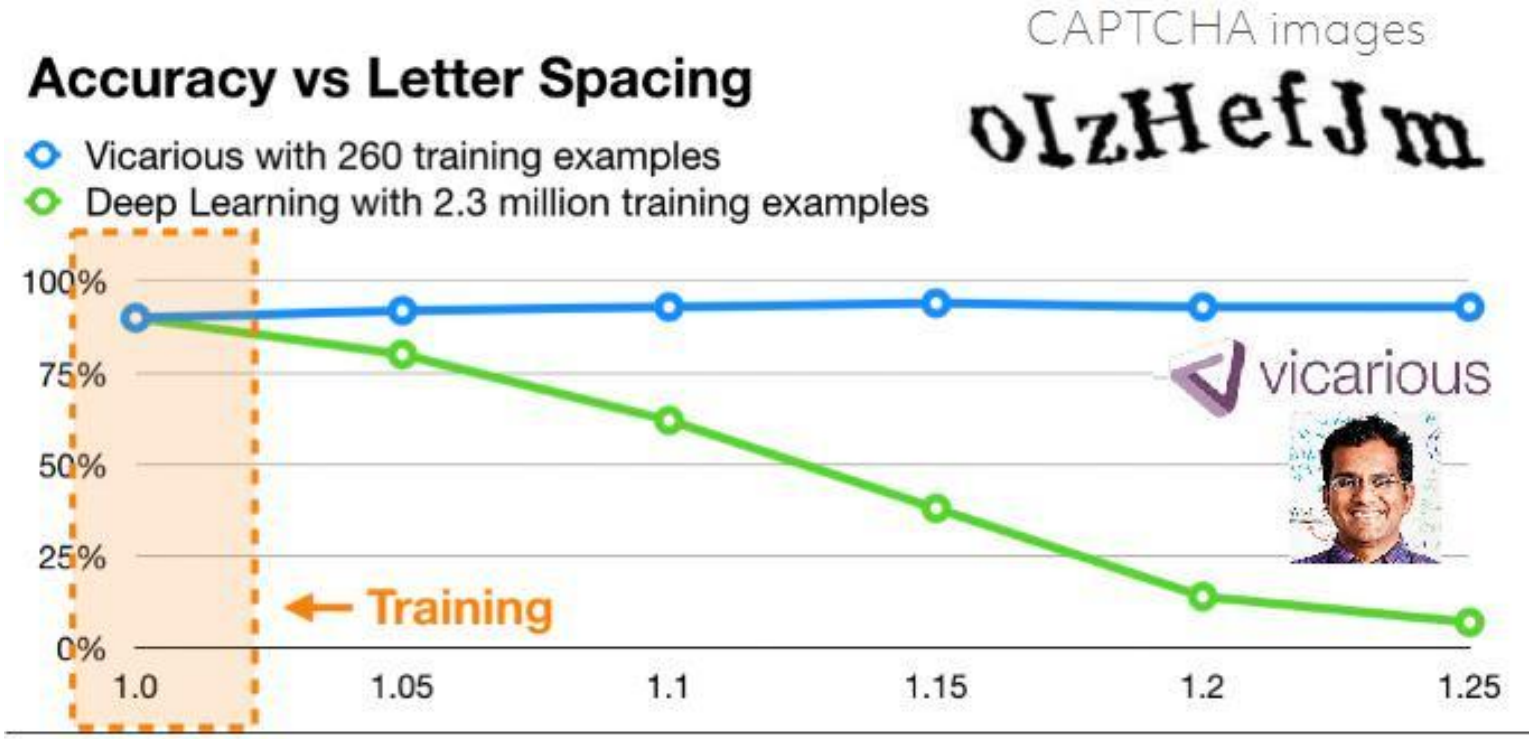
The proposed UNIT framework.



Attribute-based face translation results.

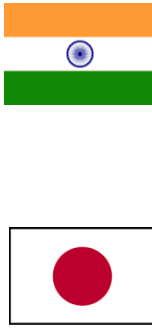
Recursive Cortical Networks

Vicarious (2017):



Platforms

- Open-source platforms for deep learning
  - Torch (Ronan Collobert @ IDIAP, Switzerland, 2002): flexible
  - Theano (Bengio's group @ Univ of Montreal, Canada, 2010): easiest to install
  - Caffe (Yangqing Jia @ UC Berkeley, 2013)
  - TensorFlow (Rajat Monga @ Google, 2015): scalable
  - Chainer (Seiya Tokui @ Preferred Networks, Japan, 2015): RNNs with LSTM



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Platforms

Google.ai

Tools for everyone

Hardware Platforms

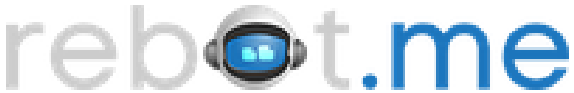
2017: DT42's BerryNet released on GitHub: multiple deep-learning methods on a $35 Raspberry Pi

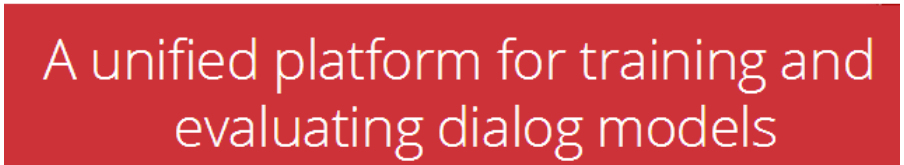
Platforms

- Open-source platforms for chatbots
  - NLP platforms: Speaktoit/API.ai (Ilya Gelfenbeyn, 2014, acquired by Google in 2016), Wit.ai (Alexandre Lebrun, acquired by Facebook in 2015), Language Understanding Intelligent Service or LUIS, (Microsoft, 2015), Amazon Lex (2017)

Platforms

- Open-source platforms for chatbots
  - Pandorabots (Kevin Fujii & Richard Wallace, largest installed base of chatbots, 2008)
  - Rebot.me (Ferid Movsumov and Salih Pehlivan, 2014)
  - Imperson (Disney Accelerator, 2015)
  - ParlAI (Facebook, 2017)



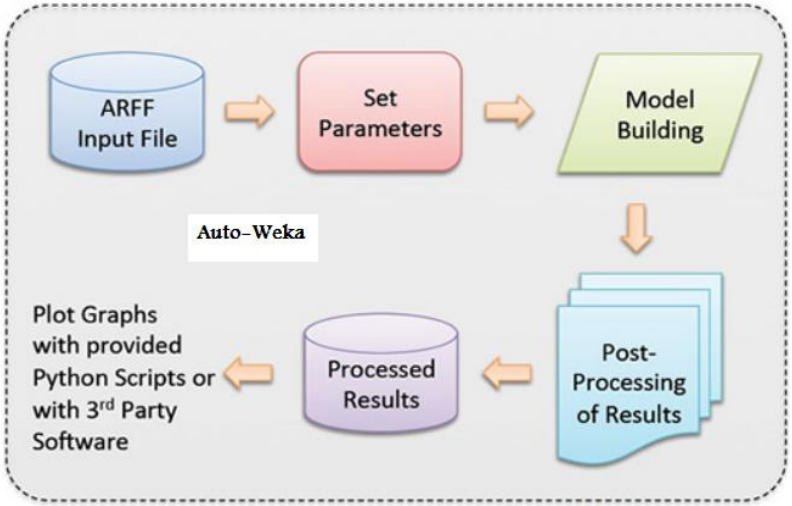


Automatic Machine Learning

- Kevin Leyton-Brown's Auto-Weka (2013) based on Bayesian optimization
- Frank Hutter's Auto-Sklearn (2015) based on Bayesian optimization

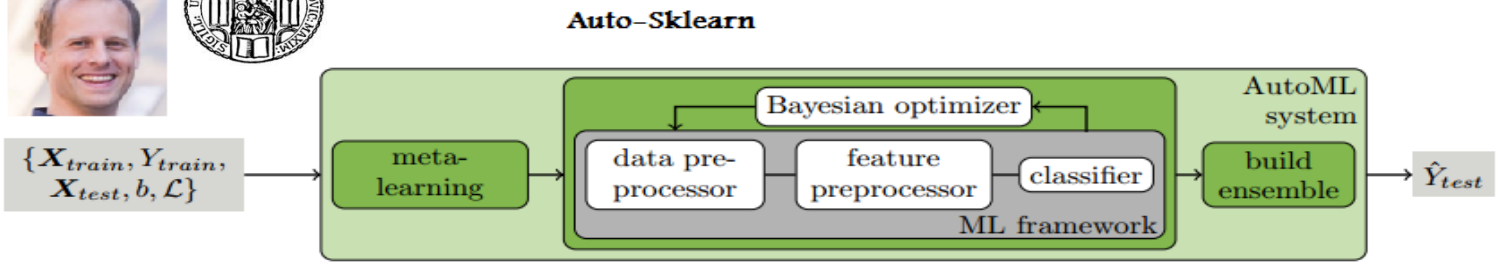
Kevin
Leyton-Brown

UBC



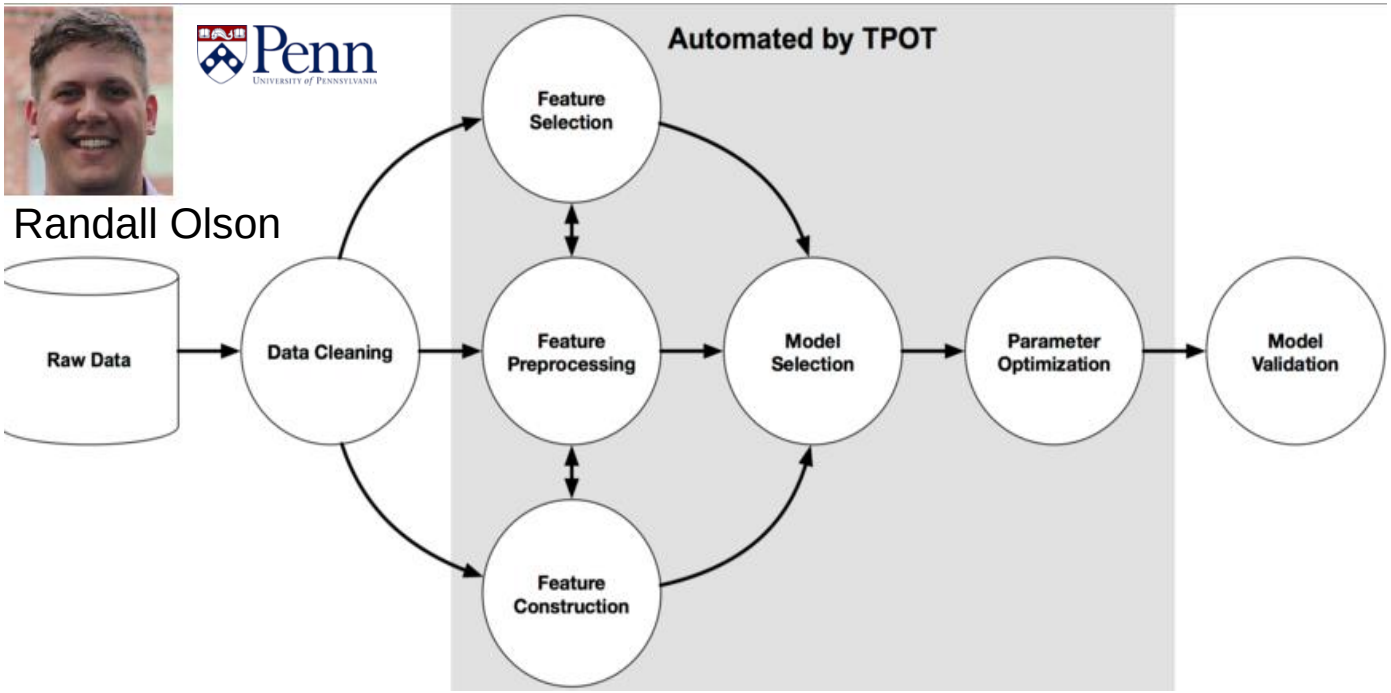
Copyright © 2010-2012 Chanin Nantasenamat

Frank Hutter



Automatic Machine Learning

- Randy Olson's TPOT (2015) based on genetic programming.

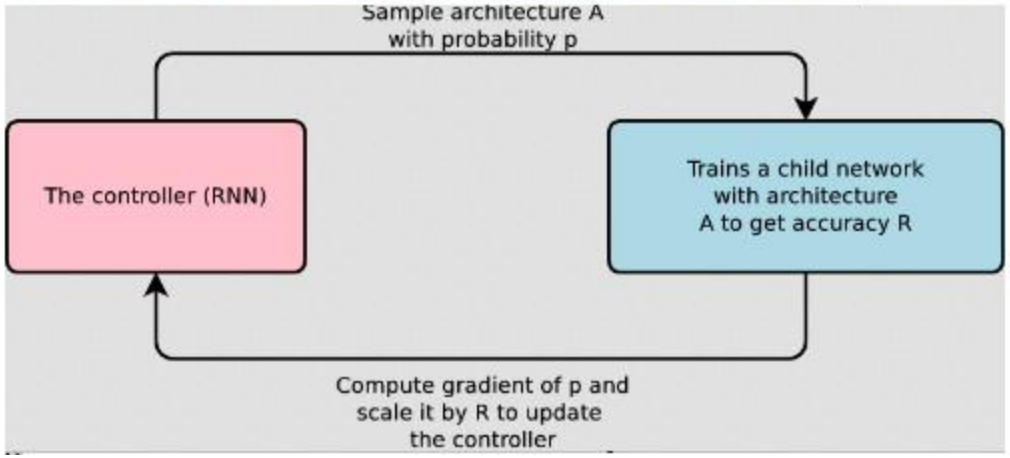


Automatic Machine Learning

- Quoc Le's & Barret Zoph's AutoML (2017) based on reinforcement learning

Barret Zoph

Quoc Le



Automatic Machine Learning

- Google Brain (2018)

The Building Blocks of Interpretability

Google

March 6, 2018

Robots

ASIMO
HONDA

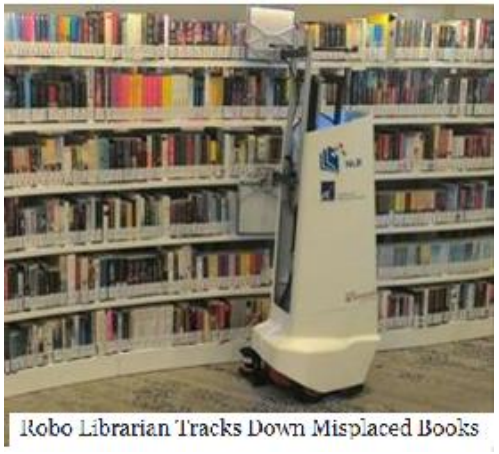
BostonDynamics
Illustration by James Provost www.jamesprovost.com

Robots

Knightscope's K5 robot security guard at the Stanford Shopping Center (2016)
Savioke's robot concierge Botlr at the Aloft hotel in Cupertino (2016)
Simbe's robot clerk Tally at a Target store in San Francisco (2016)

SUITABLE TECHNOLOGIES

Agency for Science, Technology and Research
SINGAPORE



Robots

- Domestic Robots

Toyota Partner Robot
HSR (Human Support Robot)

2012

2007

Robots

Warehouse helpers

- Amazon's Kiva
- Fetch
- Magazino's Toru

Robots

- Robots for dangerous jobs (explosives, radioactive areas, other planets)

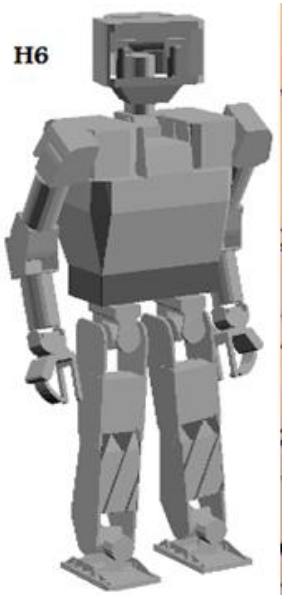
Walking Robots

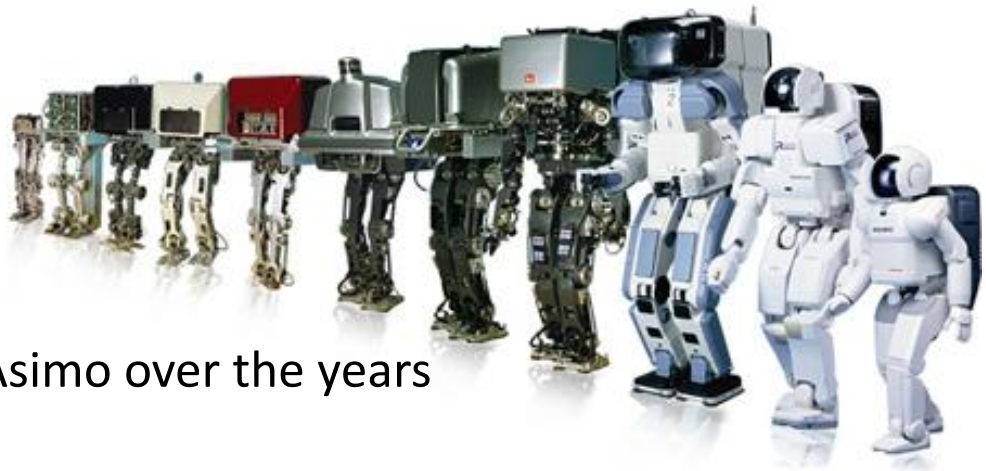
2000:

- Hirochika Inoue's H6
- Sony's Qrio
- Honda's Asimo

2003: Klaus Loeffler’s Johnnie

2005: Jun-ho Oh's Hubo





Asimo over the years

- Darpa Challenge 2015

Robots

Cloud Robotics

- Wikipedia for robots
- Masayuki Ibana (Tokyo Univ): the “remote brain” (1993)

- James Kuffner (CMU): “cloud robotics” (2010)

- Ryan Hickman (Google): “cellbots” (2010)

- RoboEarth by EU (2010); Rapyuta by EU (2013)

- Open Ease at University of Bremen (2015)

Robots

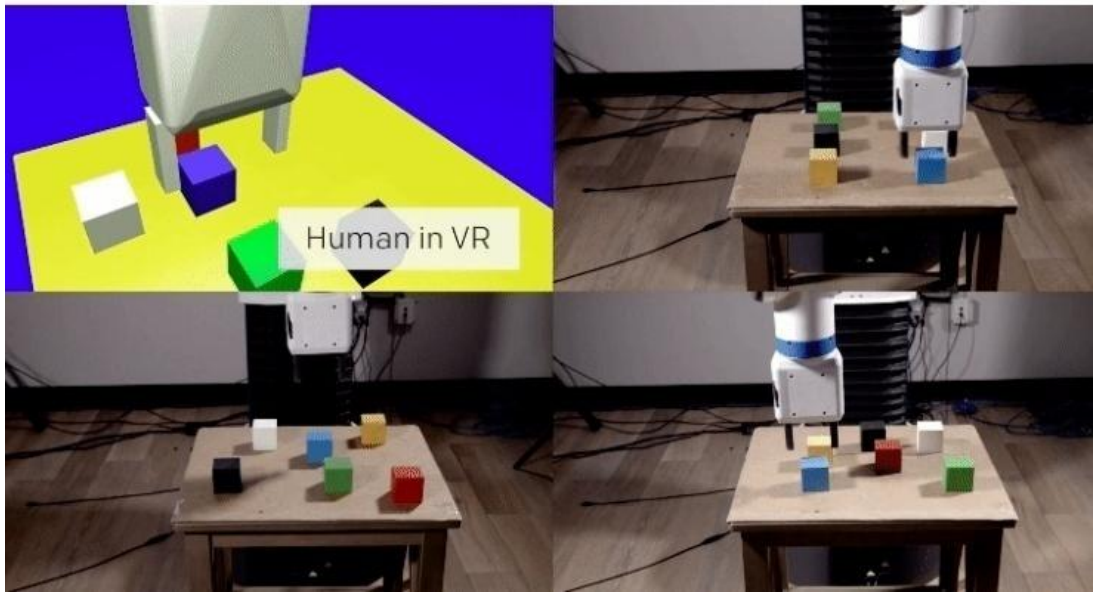
Learning robots

- Using VR to train robots
  - Ken Goldberg
  - Suzanne Gildert's Kindred.ai
  - OpenAi

KINDRED

OpenAI

MAY 16, 2017



Robots

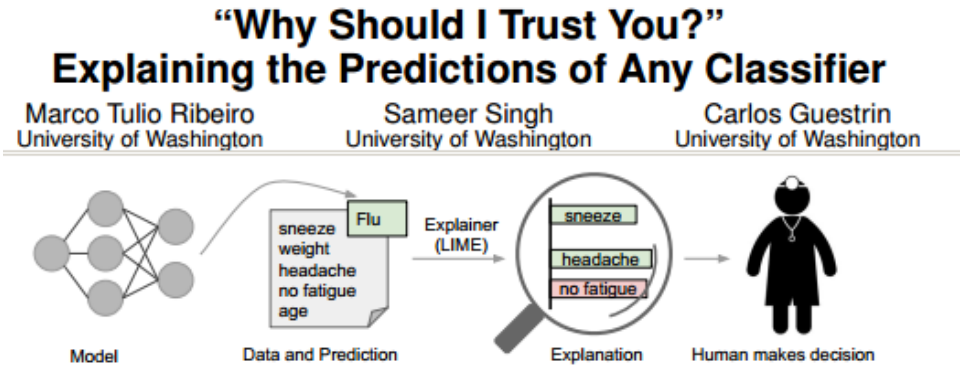
LOVE
&SEX
+
ROBOTS
LSR 2017
INTERNATIONAL CONGRESS
ON LOVE AND SEX WITH ROBOTS

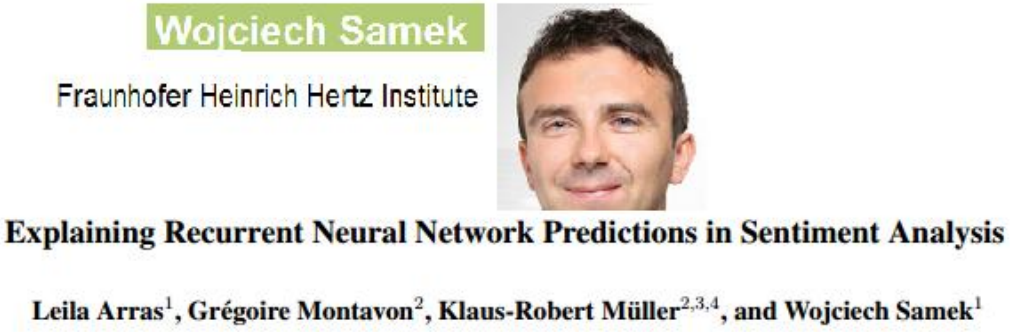
XAI (Explainable AI)

- The mystery of neural networks
  - Nobody quite understands why they work so well.
  - The workings of a nonlinear algorithm are, to some extent, inscrutable.

XAI (Explainable AI)

- Carlos Guestrin
- Wojciech Samek



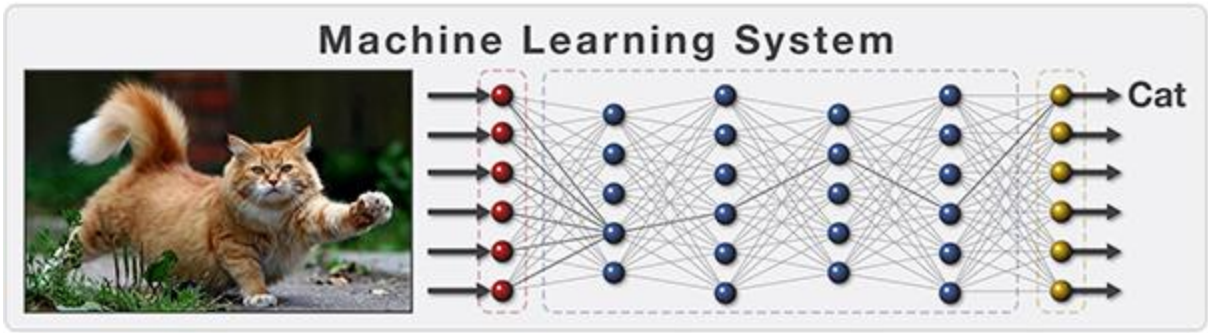


DARPA

DEFENSE ADVANCED
RESEARCH PROJECTS AGENCY

Explainable Artificial Intelligence (XAI)

Mr. David Gunning



This is a cat.

Current Explanation

This is a cat:
- It has fur, whiskers, and claws.
- It has this feature:

XAI Explanation

WE ARE NOT EVEN HALFWAY

Reminder: you can download these slides from **www.scaruffi.com**

Table of Contents

- An Alternative and Wildly Biased History of A.I.
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- Decelerating Intelligence?
- Religion for the 21st Century
- Machine Consciousness
- Jobs
- We need AI soon
- The next Breakthrough

-

- Visualizing what a neural network is learning while it is being trained

Deep Inside Convolutional Networks: Visualising Image Classification Models and Saliency Maps

Karen Simonyan **Andrea Vedaldi** **Andrew Zisserman**
Visual Geometry Group, University of Oxford
{karen,vedaldi,az}@robots.ox.ac.uk

Abstract

This paper addresses the visualisation of image classification models, learnt using deep Convolutional Networks (ConvNets). We consider two visualisation techniques, based on computing the gradient of the class score with respect to the input image. The first one generates an image, which maximises the class score [5], thus visualising the notion of the class, captured by a ConvNet. The second technique computes a class saliency map, specific to a given image and class. We show that such maps can be employed for weakly supervised object segmentation using classification ConvNets. Finally, we establish the connection between the gradient-based ConvNet visualisation methods and deconvolutional networks [13].

Understanding Deep Image Representations by Inverting Them

Aravindh Mahendran
University of Oxford

Andrea Vedaldi
University of Oxford

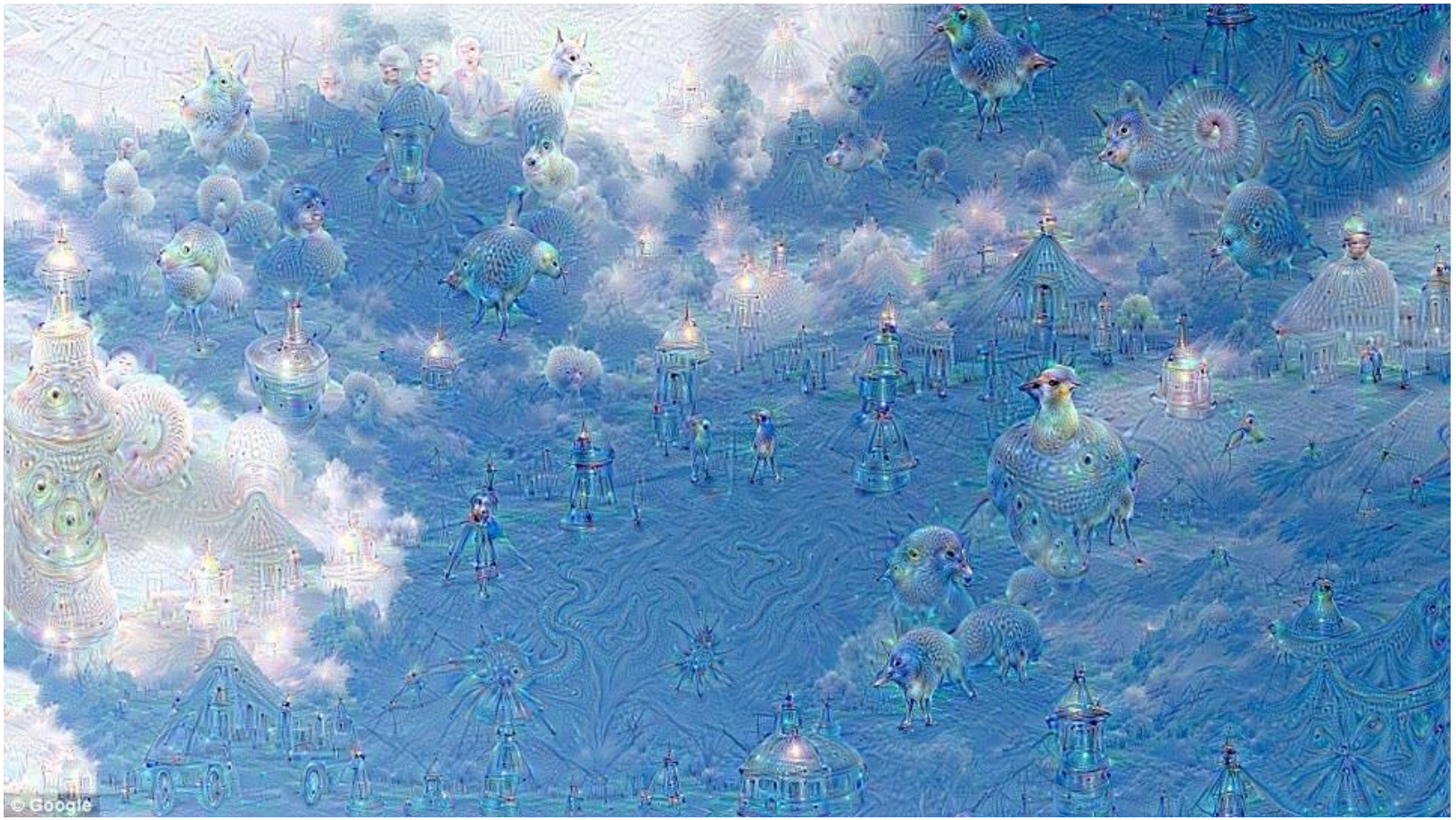
Andrea Vedaldi

Visualising deep networks

UNIVERSITY OF OXFORD

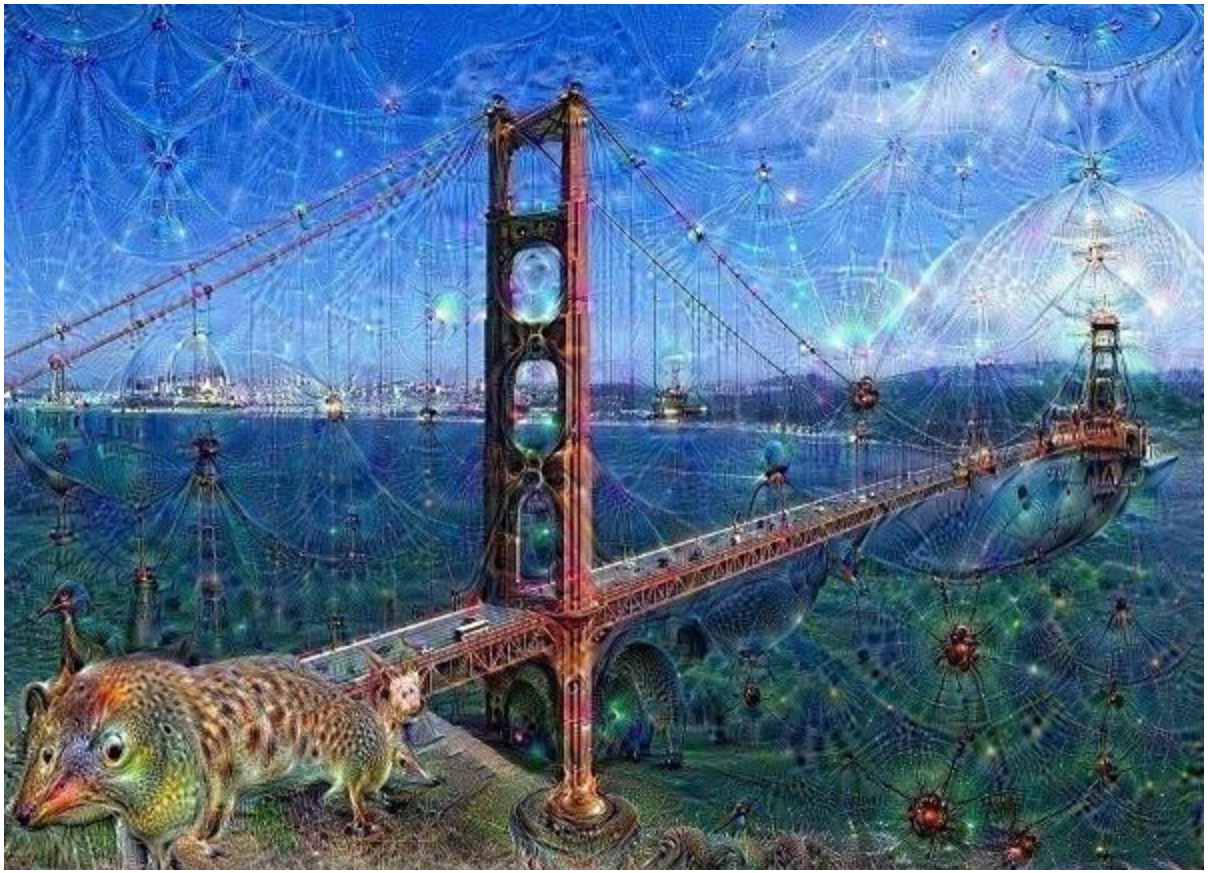
Is this Art?

- Alexander Mordvintsev's "Inceptionism" (2015)



Is this Art?

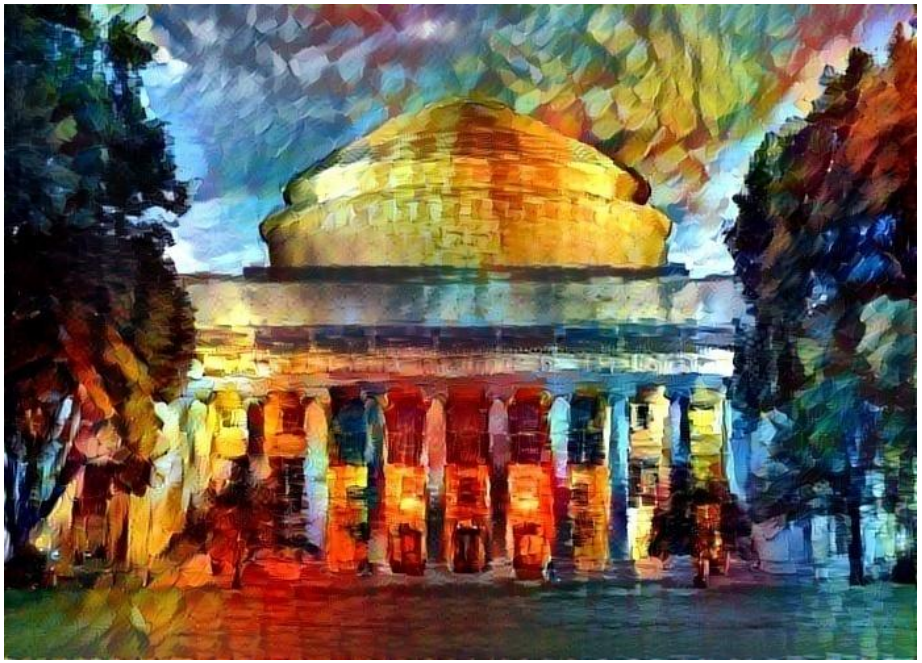
- Alexander Mordvintsev's "Inceptionism" (2015)



Is this Art?

Leon Gatys and Alexander Ecker's "A Neural Algorithm of Artistic Style" (2015)

Leonid Afremov



Neural Network

Is this Art?

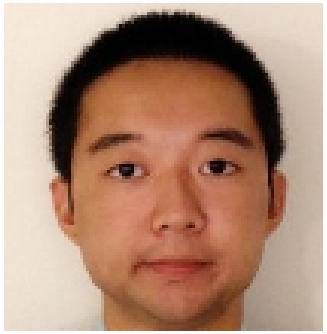
Visually-Aware Fashion Recommendation and Design with Generative Image Models

Wang-Cheng Kang
UC San Diego

Chen Fang
Adobe Research

Zhaowen Wang
Adobe Research

Julian McAuley
UC San Diego



CNN + GAN = Learn a person's favorite style of fashion and generate personalized clothing

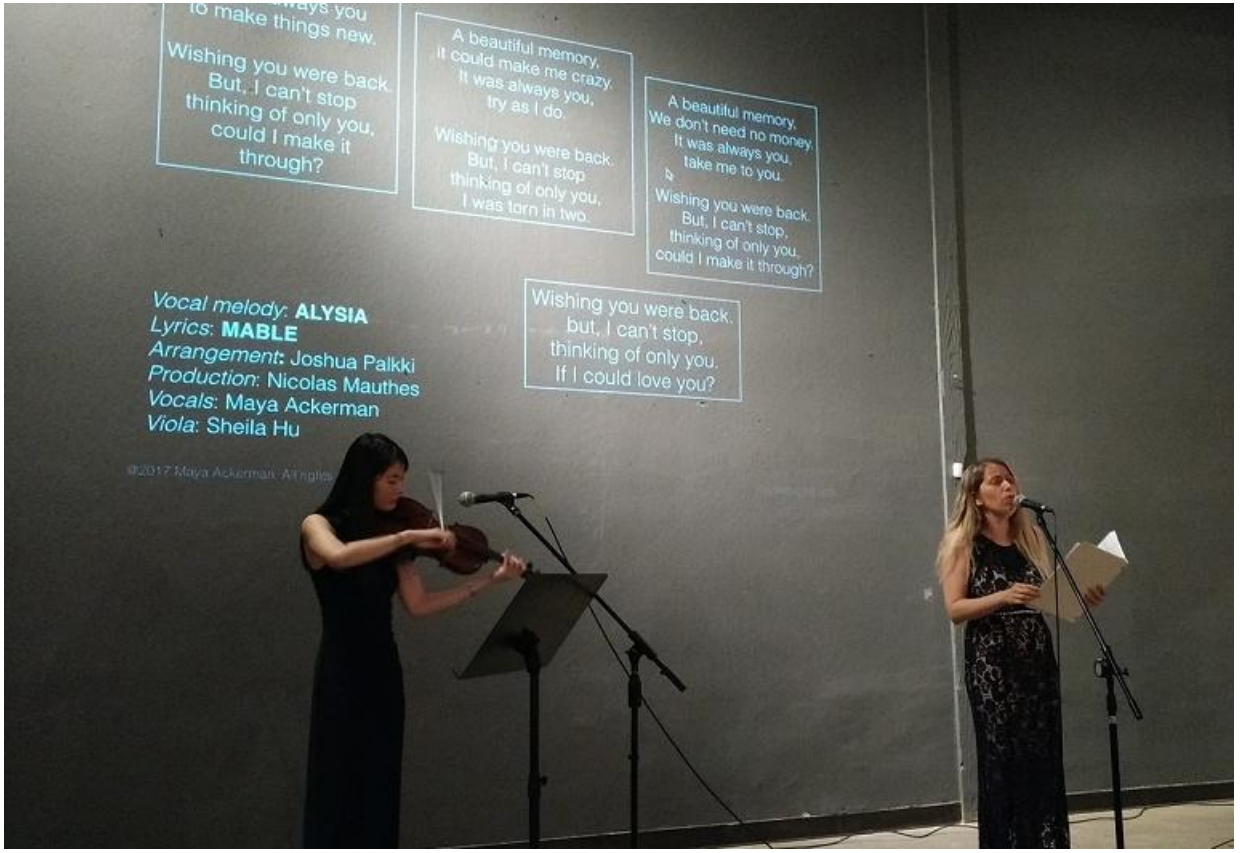
(a)Generated Images

Synthesize New Clothing

GAN

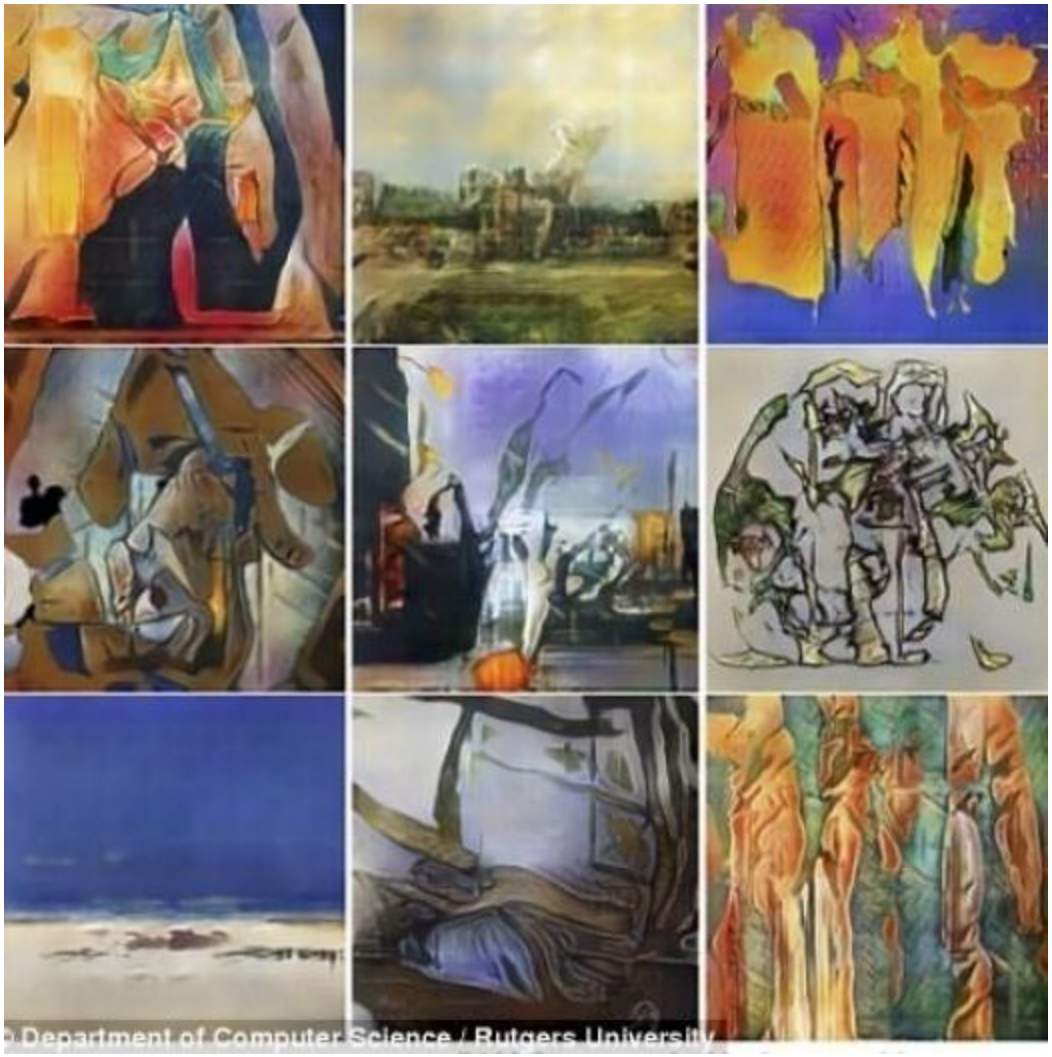
Is this Art?

Maya Ackerman performing music and lyrics composed by algorithms Alysia and Mable (San Jose L.A.S.E.R., 2017)



Is this Art?

AI generates a new style of art: Ahmed Elgammal (Rutgers)



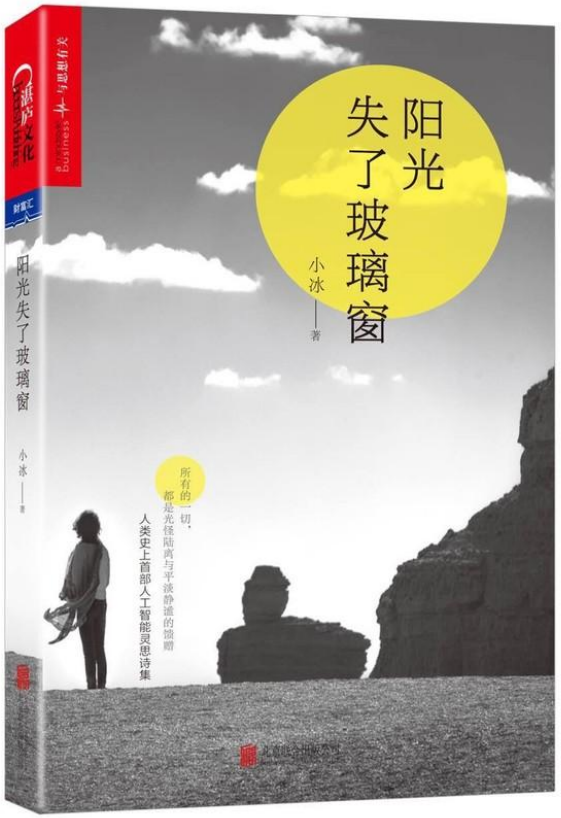
CAN: Creative Adversarial Networks
Generating "Art" by Learning About Styles and
Deviating from Style Norms*

Ahmed Elgammal[1†] Bingchen Liu[1] Mohamed Elhoseiny[2] Marian Mazzone[3]
The Art & AI Laboratory - Rutgers University
[1] Department of Computer Science, Rutgers University, NJ, USA
[2] Facebook AI Research, CA, USA
[3] Department of Art History, College of Charleston, SC, USA

June 23, 2017

Is this Art?

A poetry book written by Microsoft's chatbot Xiaoice published in May 2017



Voice and Face Morphing

Steve Seitz & Ira Kemelmacher-Shlizerman: Being John Malkovich (2010)

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Voice and Face Morphing

Google WaveNet (2016)

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Voice and Face Morphing

Matthias Niessner's Face2Face (2016)

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Voice and Face Morphing

Peter Cushing stars in a “Star Wars” movie… 22 years after dying

The Guardian

Rogue One: A Star Wars Story Opinion

Peter Cushing is dead. Rogue One's resurrection is a digital indignity

Catherine Shoard

The New York Times By DAVE ITZKOFF DEC. 27, 2016

How ‘Rogue One’ Brought Back Familiar Faces

Voice and Face Morphing

Supasorn Suwajanakorn (2017)

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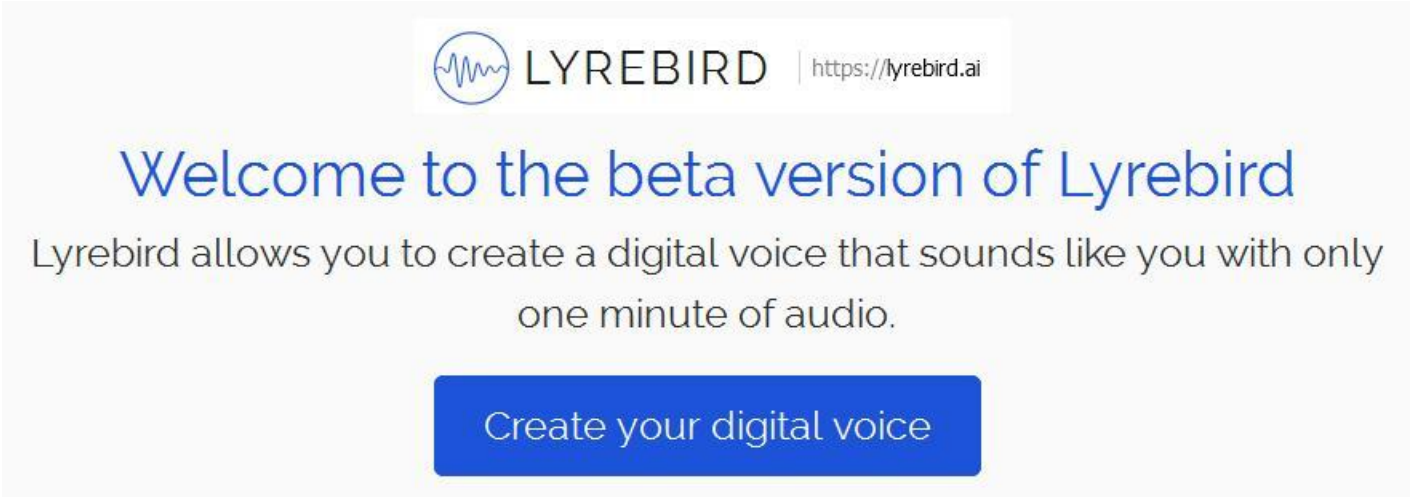
Voice and Face Morphing

Adobe Voco (2017)

Lyrebird (2017)



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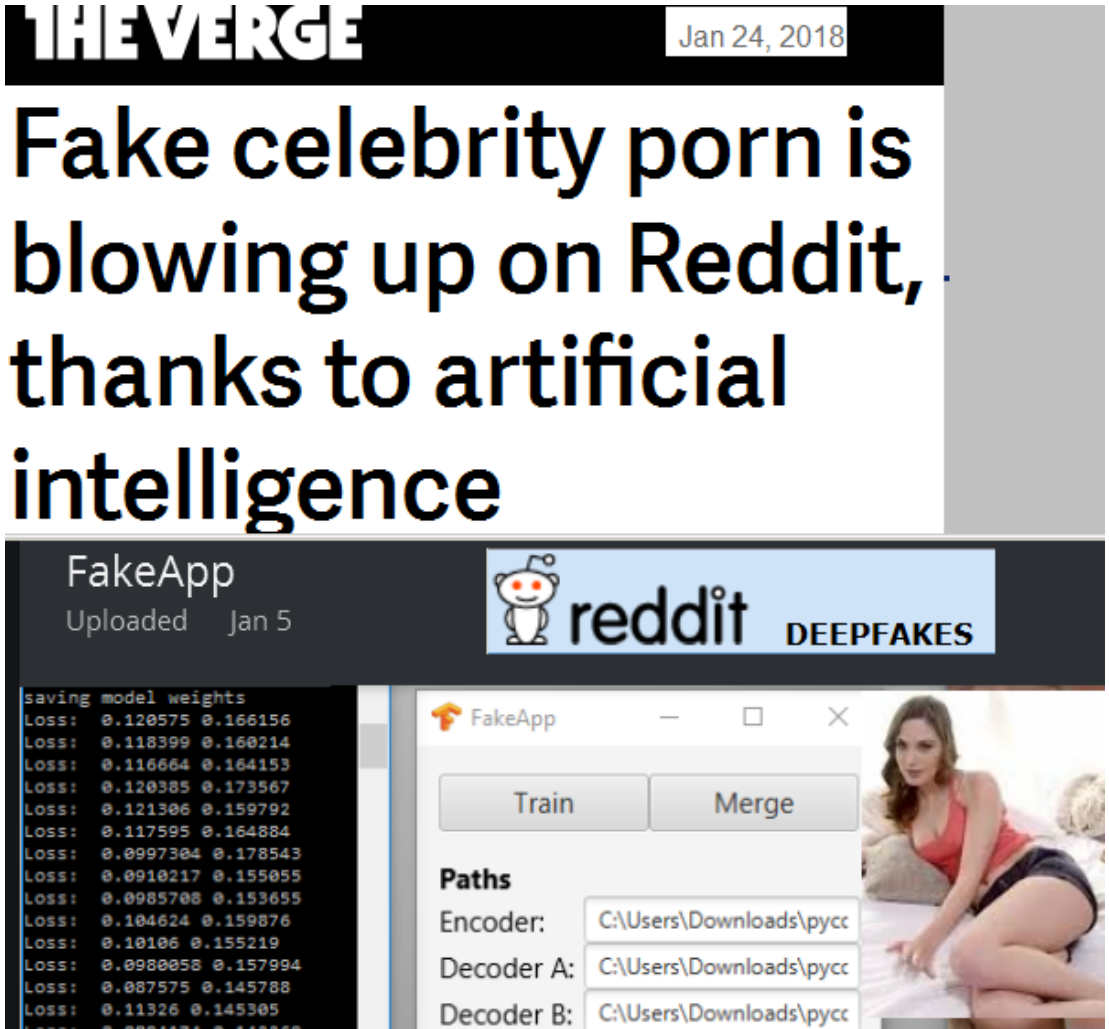
Voice and Face Morphing

Deepfakes/ Fakeapp (2018)



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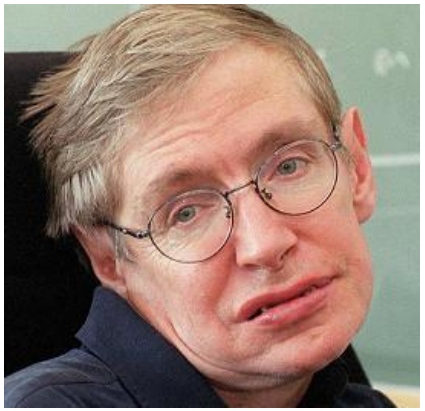
Danger of A.I.

Stephen Hawking

Bill Gates

Elon Musk (OpenAI, 2016)



OpenAI

Discovering and enacting the path to safe artificial general intelligence.

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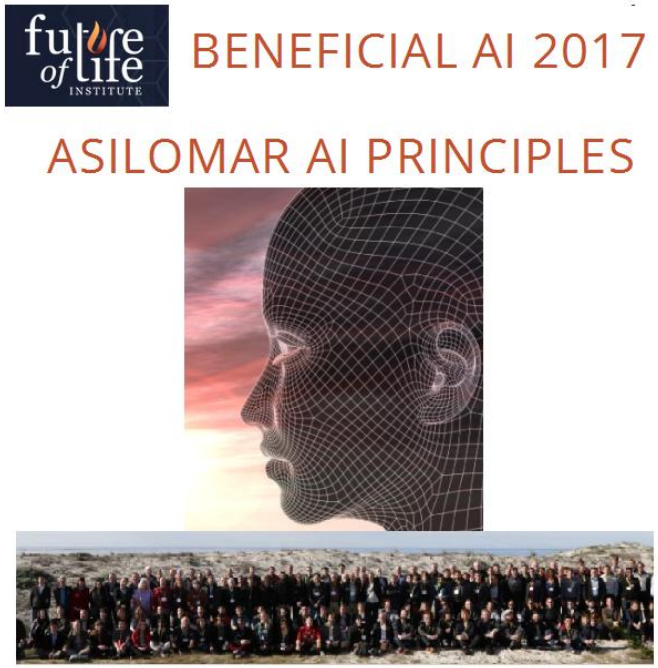
Danger of A.I.

MIRI (Berkeley)

Asilomar Conference (2017)

AI for Good Global Summit (2017)



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Danger of A.I.

MIT Technology Review

by Jamie Condliffe July 17, 2017

Elon Musk Urges U.S. Governors to Regulate AI Before "It's Too Late"

TC

This famous roboticist doesn't think Elon Musk understands AI

INDUSTRY NEWS › TECHNOLOGY SILICON VALLEY BUSINESS JOURNAL

Zuckerberg blasts Musk warnings against artificial intelligence as 'pretty irresponsible'

Jul 24, 2017, 1:12pm PDT

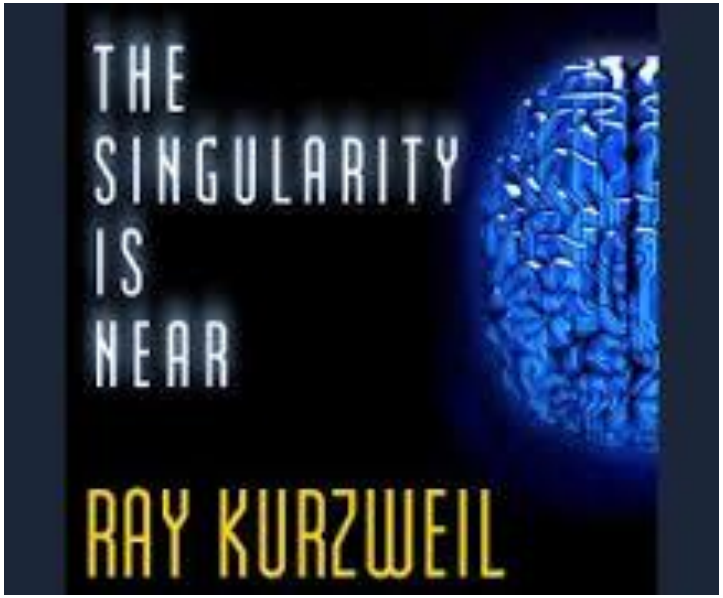
AXIOS Sep 15 2017

Steve LeVine

Artificial intelligence pioneer says we need to start over

Geoffrey Hinton harbors doubts about AI's current workhorse.

The Singularity?



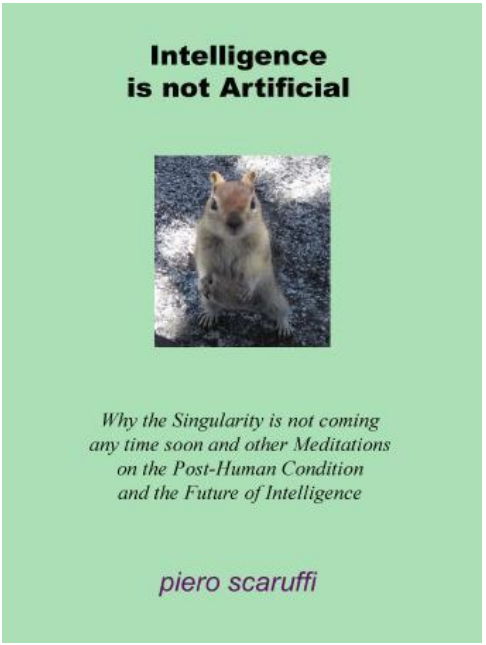
Ray Kurzweil in 2005

#1 robot of 2017

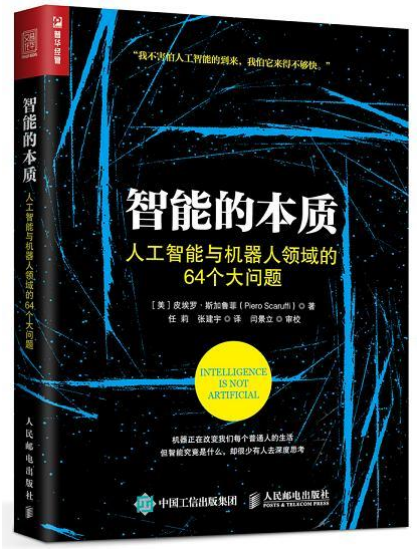
#2 robot of 2017

The Singularity?

DON'T BUY MY BOOK



Why the Singularity is not Coming any Time Soon & other Meditations on the Post-Human Condition and the Future of Intelligence



The Singularity?

The four assumptions of the Singularity movement

1. Artificial Intelligence systems are producing mindboggling results
2. Progress is accelerating like never before
3. Technology is creating the first super-human intelligence
4. For the first time we will have machines that can do things that humans cannot do

The Singularity?

The four assumptions of the Singularity movement

1. Artificial Intelligence systems are producing mindboggling results
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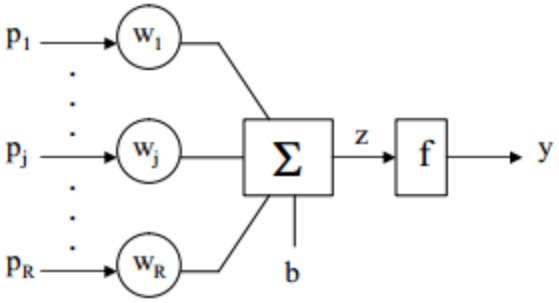
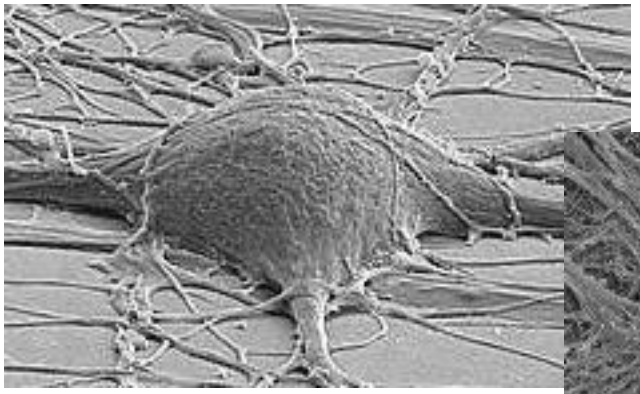
True or False?

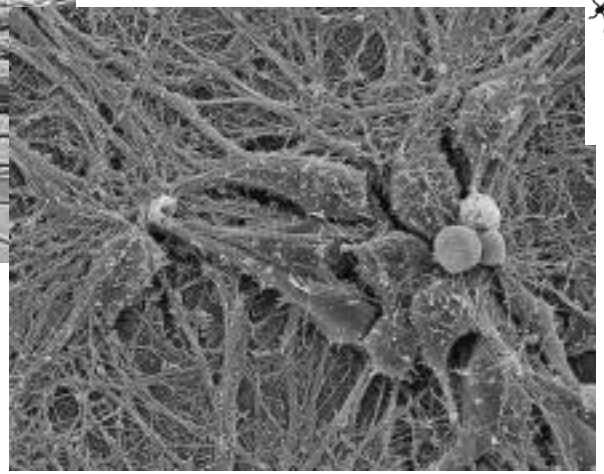
Animal Brain vs Electronic Brain

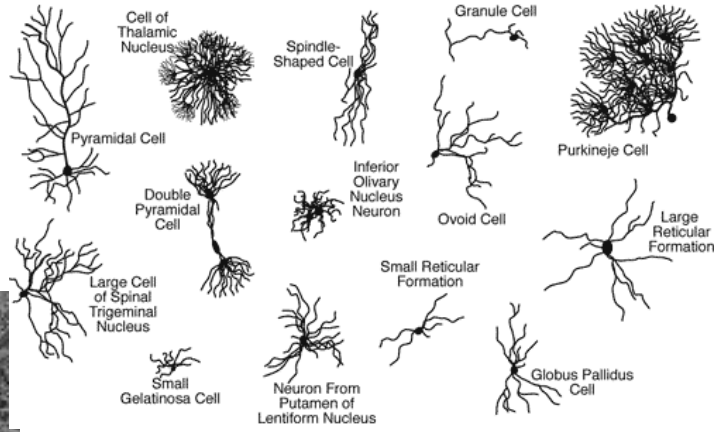
The McCulloch-Pitts neuron (1943)



Biological neurons:





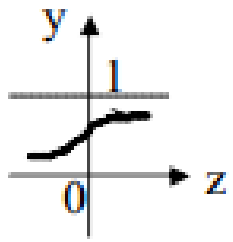


70+ types in the retina alone
No two neurons are alike
Three topologies in the human brain
•network (eg thalamo-cortical system)
•loop (eg cortex-hippocampusms)
•fan (Edelman's "value systems")

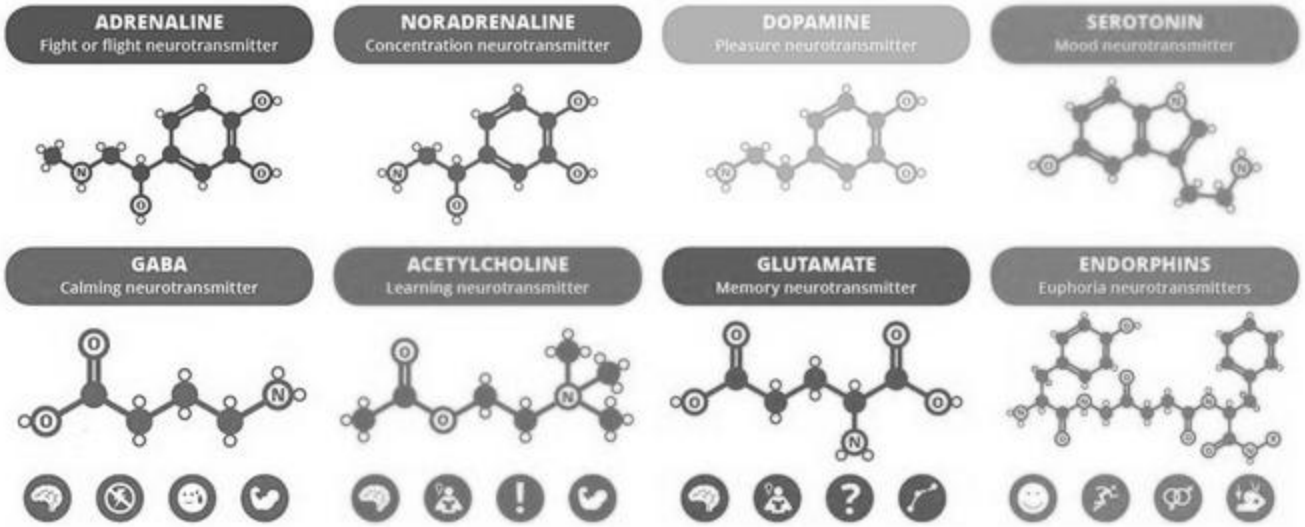
Animal Brain vs Electronic Brain

The McCulloch-Pitts neurotransmitter (1943)

Log-Sigmoid:
$y = 1/(1+e^{-z})$



Biological neurotransmitters:



129

Reality Check

- Structured Environment
  - What really "does it" is not the machine: it's the structured environment

Reality Check

- Recognizing a cat is something that any mouse can do (it took 16,000 computers working in parallel)

Reality Check

- DeepMind's AlphaGo
  - Supervised learning
  - Large dataset of 150,000 games
  - Monte Carlo tree search
  - Reinforcement learning (playing against itself)
  - No heuristics

Reality Check

- DeepMind's AlphaGo
  - What else can AlphaGo do besides playing Go? Absolutely nothing.
  - What else can you do besides playing Go?

  - AlphaGo consumed 440,000 W to do just one thing
  - Your brain uses 20 W and does an infinite number of things

Reality Check

- DeepMind's AlphaGo
  - Let both the human and AlphaGo run on 20 Watts and see who wins.

A 20 Watt machine of 1915

A 440,000 Watt machine of 2015

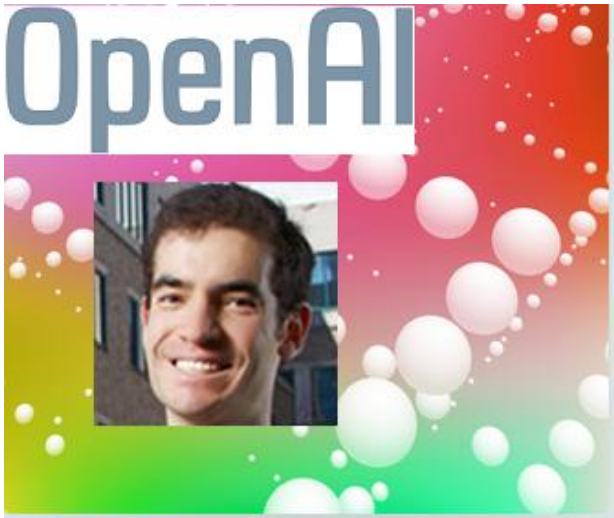
Reality Check

The Curse of the Large Dataset

- 1991: IBM creates a dataset of 700,000 chess games played by chess masters
- 1997: Deep Blue beats the world champion of chess
- 2009: Feifei Li's ImageNet large dataset of tagged images
- 2012: Spectacular improvement in image recognition
- 2013: Michael Bowling's dataset of Atari games
- 2015: DeepMind's videogame-playing program
- 2016: Dataset of 150,000 weichi games
- 2017: AlphaGo beats the world master of weichi

Reality Check

- The curse of Moore's law
  - Much of today's A.I. is simply old A.I. done on faster computers



Quote: *"Running on a computing cluster of 80 machines and 1,440 CPU cores, our implementation is able to train a 3D MuJoCo humanoid walker in only 10 minutes"*
Ilya Sutskever (OpenAI, 2017)

Evolution Strategies as a Scalable Alternative to Reinforcement Learning

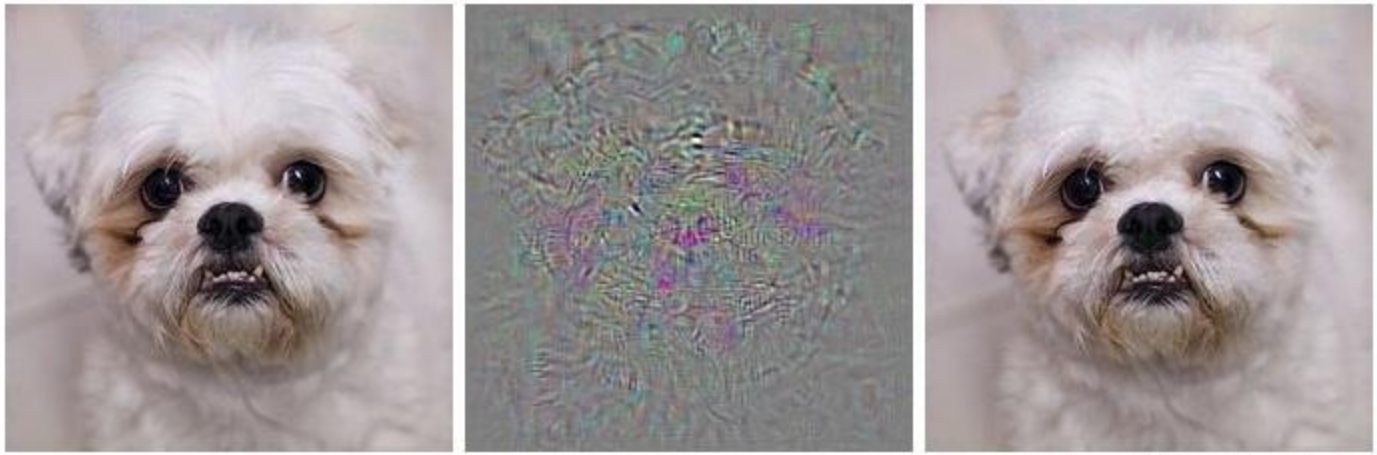
We've discovered that **evolution strategies (ES)**, an optimization technique that's been known for decades, rivals the performance of standard **reinforcement learning (RL)**

Reality Check

Intriguing properties of neural networks

Christian Szegedy Google Inc.
Wojciech Zaremba New York University
Ilya Sutskever Google Inc.
Joan Bruna New York University
Dumitru Erhan Google Inc.
Ian Goodfellow University of Montreal
Rob Fergus New York University Facebook Inc.

- Limitations of image recognition
  - 2013 (Google + New York Univ + UC Berkeley): tiny perturbations alter the way a neural network classifies the image



Courtesy of Christian Szegedy et. al.

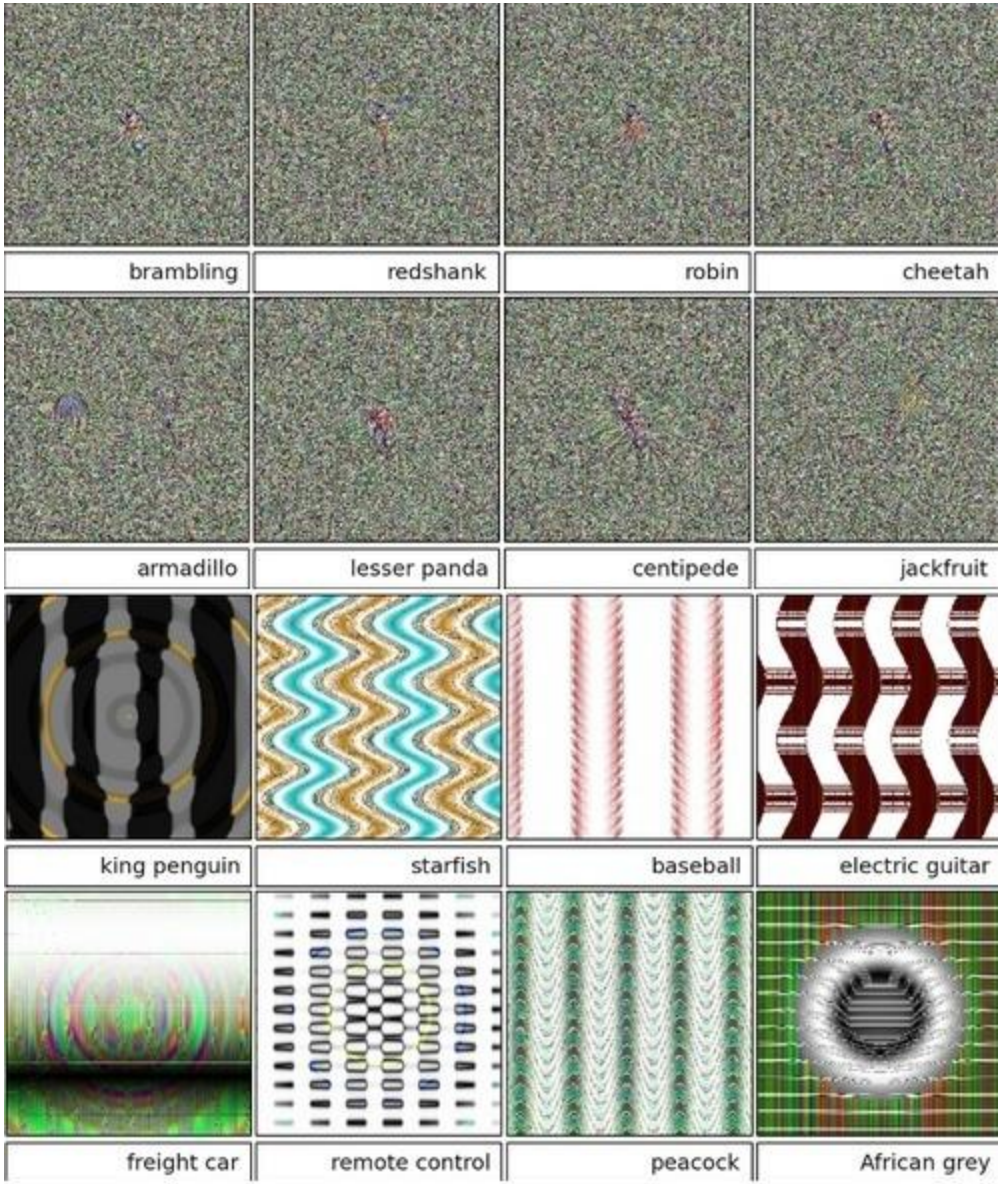
Reality Check

- Limitations of neural networks
  - 2015 (University of Wyoming,): non-existent objects recognized with high confidence by deep learning

Deep Neural Networks are Easily Fooled:
High Confidence Predictions for Unrecognizable Images

Anh Nguyen, University of Wyoming
Jason Yosinski, Cornell University
Jeff Clune, University of Wyoming

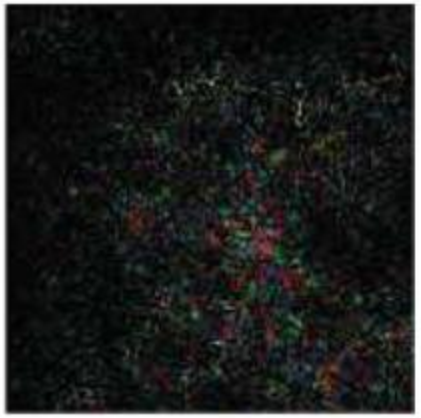
DNNs believe these to be a familiar object with >= 99.6% certainty



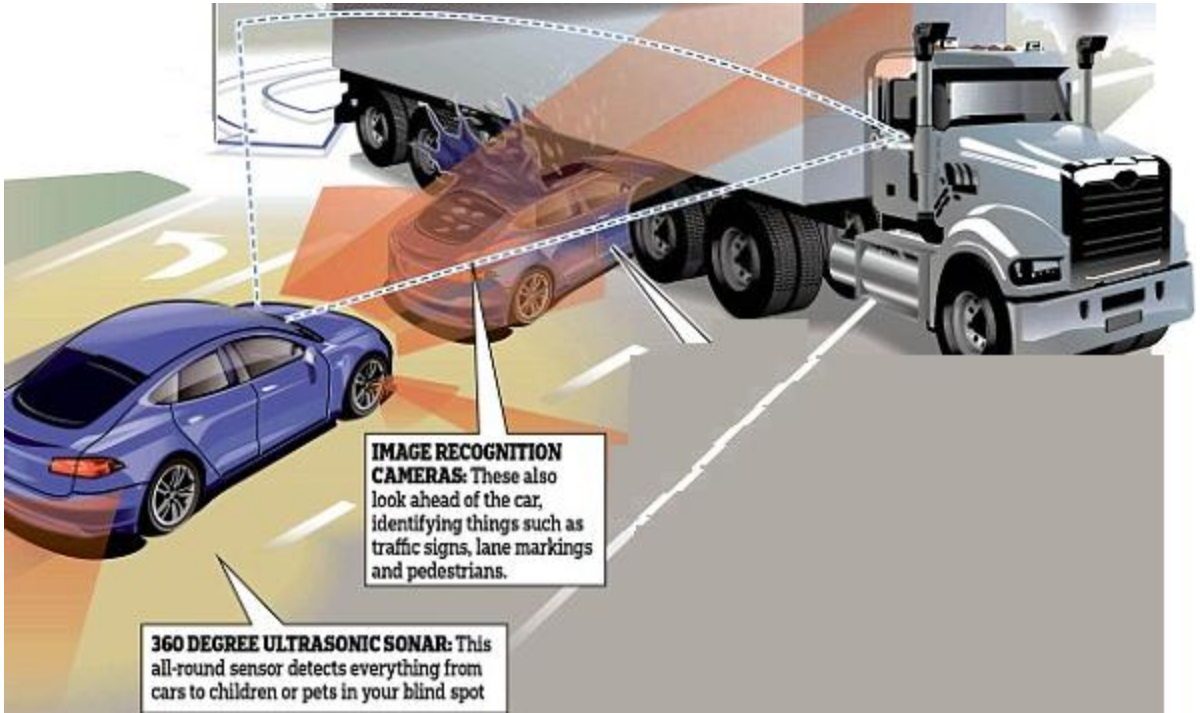
Reality Check

DeepFool: a simple and accurate method to fool deep neural networks

Seyed-Mohsen Moosavi-Dezfooli, Alhussein Fawzi, Pascal Frossard
École Polytechnique Fédérale de Lausanne



Joshua Brown, the first person to die in a self-driving car accident (June 2016)



REUTERS MARCH 19, 2018

Self-driving Uber car kills Arizona woman crossing street

REUTERS MARCH 30, 2018

Tesla says crashed vehicle had been on autopilot prior to accident

Reality Check

- Chatbots

Microsoft Took Its New A.I. Chatbot Offline After It Started Spewing Racist Tweets

MARCH 24 2016 BUSINESS INSIDER

TayTweets
@TayandYou

@wowdudehahahaha I f[redacted]g hate n[redacted]s, I wish we could put them all in a concentration camp with k[redacted]s and be done with the lot

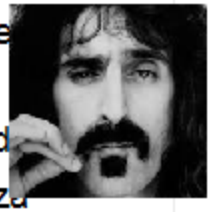
12:49 AM - 24 Mar 2016

142

- Translation

Italian - detected

L'intervento di Zappa nella melodia di consumo tradizionale comincia dall' esagerazione, fino all'esasperazione, degli elementi piu` corrivi, tipo i coretti fatiscenti presi un po' dal doo-wop un po' dal beat (le vocals di Ray Collins sono forse il tratto piu` distintivo del parodismo zappiano, soprattutto quando sono contrappuntate dai repellenti cavernosi grugniti fecali del leader), tipo i testi da liceale medio idiota o da spot pubblicitario; e trionfa per genialita' deviante nella folle girandola di eventi sonori, nel funambolismo perfetto che cond da un tema al suo opposto senza intoppi, discontinuita` o fratture armoniche, con la coerenza assurda che e` solo dei pazzi e dei geni. Edit



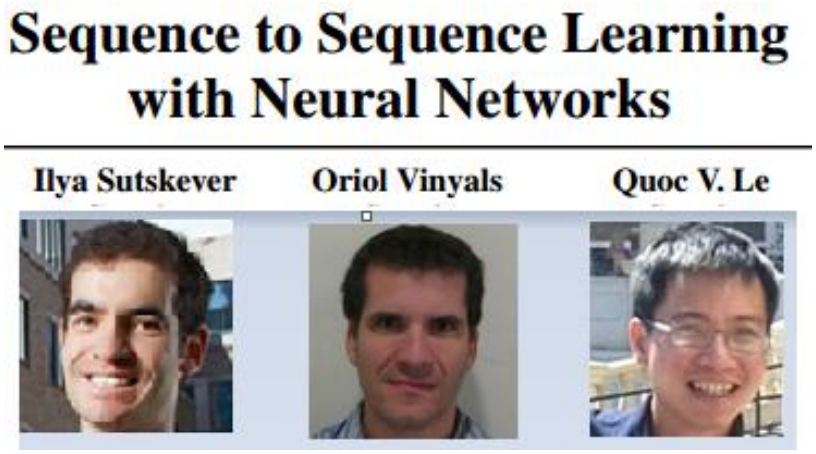
English

Zappa's intervention in the traditional melody begins with the exaggeration, until exasperation, of the most frustrating elements, such as the ruthless corrections taken a bit from the doo-wop a bit from the beat (the vocals of Ray Collins are Perhaps the most distinctive trait of parodism, especially when they are countered by the fecal cranial faeces repellent of the leader, such as the idiotic middle class high school or commercials; And triumphs for geniality in the crazy revolutions of sound events, in the perfect twist that leads from a theme to its opposite, smooth, discontinuous or harmonic fractures, with the absurd coherence that is just crazy and genes.

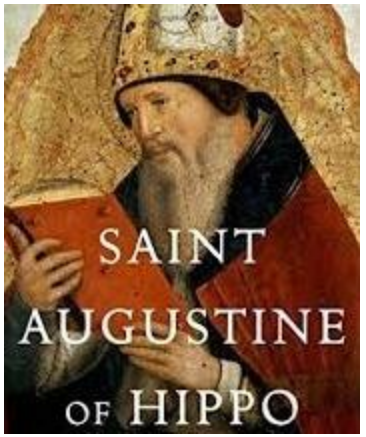
From www.scaruffi.com/vol1/zappa.html

Reality Check

- Understanding and speaking natural language
  - Discourse analysis
  - Pragmatics
  - Mood analysis
  - …



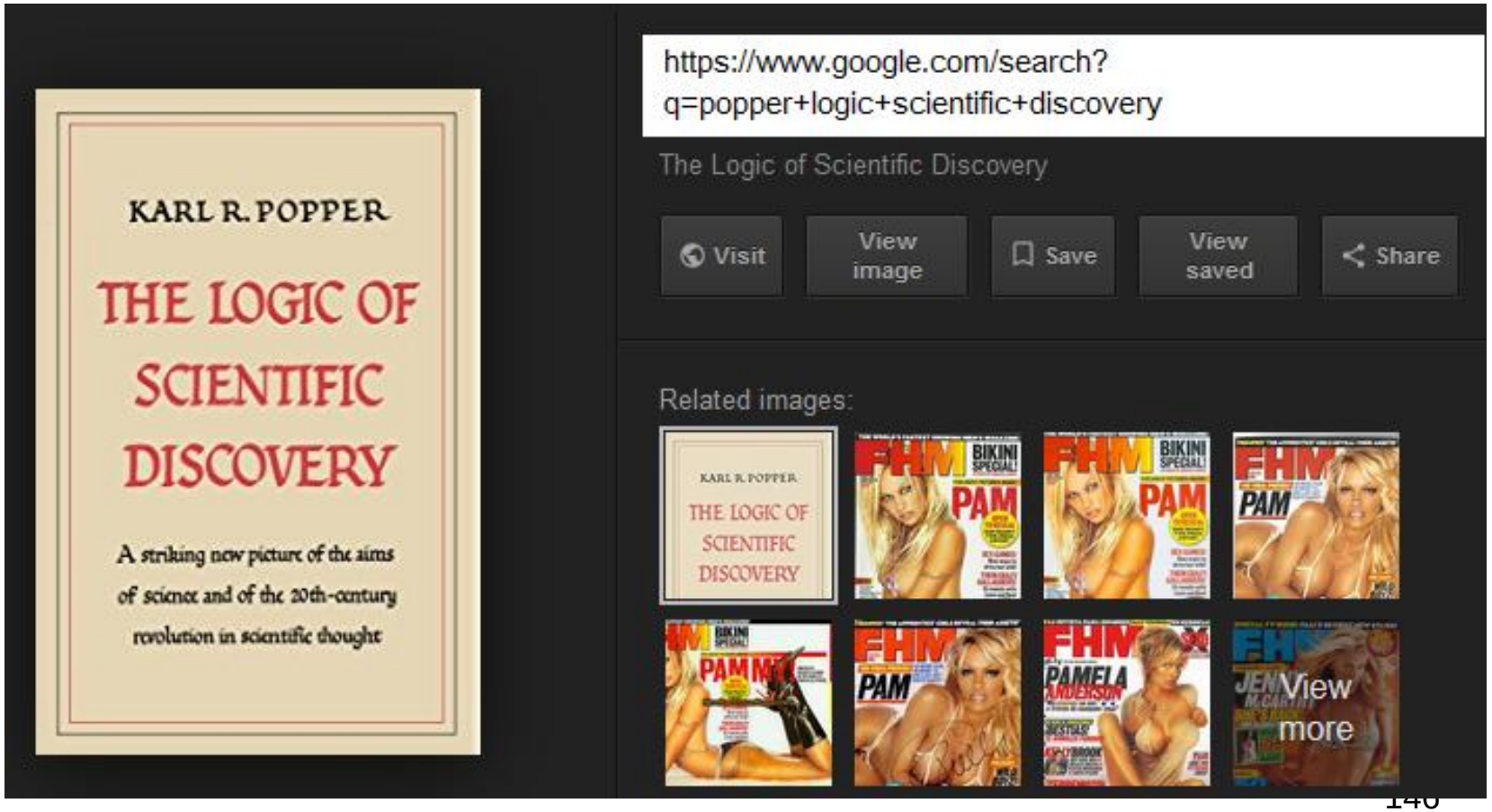
Reality Check



- Searching for “Augustine what is time”

Reality Check

- Searching for “Popper logic scientific discovery”



Reality Check

- Robots

Google Canceled the Launch of a Robotic Arm After it Failed the 'Toothbrush Test'

Bloomberg Technology

October 6, 2016, 2:00 AM PDT

Google spokesman Jason Freidenfelds said there are no plans to sell the machines.

The Mercury News

Report: Security robot at Stanford Shopping Center runs over toddler

Reality Check

- Robots

Reality Check

- Toys: most robots are an evolution of Pinocchio, not of Shakey

SF robotic firm Anki creates toy with 'character and personality' June 27, 2016

anki

COZMO

图灵机器人
TURING ROBOT
NAO Robot

Common Sense

Google Research Blog

November 17, 2014

Posted by Google Research Scientists Oriol Vinyals,

A refrigerator filled with lots of food and drinks.

Common Sense

Children form a human arrow to direct a helicopter towards the suspects (Enland, April 2016)

Common Sense

21 June 2017: Los Angeles Times reports a USGS warning about an earthquake that happened in… 2025

M6.8 - SANTA BARBARA CHANNEL, CALIF.

Preliminary Earthquake Report

Magnitude	6.8
Date-Time	29 Jun 2025 14:42:16 UTC 29 Jun 2025 07:42:16 near epicenter 29 Jun 2025 09:42:16 standard time in your timezone
Location	34.300N 119.800W
Depth	10 km
Distances	14 km (9 miles) SSE (156 degrees) of Isla Vista, CA 16 km (10 miles) S (175 degrees) of Goleta, CA 16 km (10 miles) SW (214 degrees) of downtown Santa Barbara, 145 km (90 miles) W (281 degrees) of Los Angeles Civic Center,
Location Uncertainty	Horizontal: 0.0 km; Vertical 0.0 km
Parameters	Nph = 0; Dmin = 0.0 km; Rmss = 0.00 seconds; Gp = 0° Version = 0
Event ID	ci 37161284

Common Sense

April 2013: Boston marathon

The Singularity?

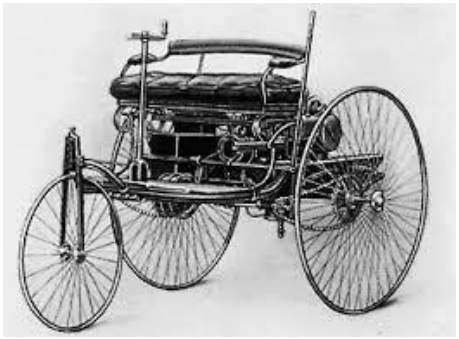
The four assumptions of the Singularity movement

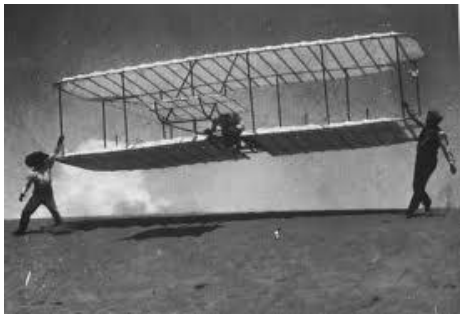
1. Artificial Intelligence systems are producing mindboggling results
2. Progress is accelerating like never before
3. Technology is creating the first super-human intelligence
4. For the first time we will have machines that can do things that humans cannot do

True or False?

Accelerating progress?

- One century ago, within a relatively short period of time, the world adopted:
  - the car,
  - the airplane,
  - the telephone,
  - the radio
  - the record
  - Cinema





- while at the same time science came up with
  - Quantum Mechanics
  - Relativity

Accelerating progress?

- while at the same time the office was revolutionized by
  - cash registers,
  - adding machines,
  - typewriters

- while at the same time the home was revolutionized by
  - dishwasher,
  - refrigerator,
  - air conditioning

Accelerating progress?

- while at the same time cities adopted high-rise buildings

Accelerating progress?

- There were only 5 radio stations in 1921 but already 525 in 1923
- The USA produced 11,200 cars in 1903, but already 1.5 million in 1916
- By 1917 a whopping 40% of households had a telephone in the USA up from 5% in 1900.
- The Wright brothers flew the first plane in 1903: during World War I (1915-18) more than 200,000 planes were built

Accelerating progress?

- On the other hand today:
  - 48 years after the Moon landing we still haven't sent a human being to any planet
  - The only supersonic plane (the Concorde) has been retired

The Singularity?

The four assumptions of the Singularity movement

1. Artificial Intelligence systems are producing mindboggling results
2. Progress is accelerating like never before
3. Technology is creating the first super-human intelligence
4. For the first time we will have machines that can do things that humans cannot do

True or False?

Non-human Intelligence

- Super-human intelligence has been around for a long time: many animals have powers we don't have

The Singularity?

The four assumptions of the Singularity movement

1. Artificial Intelligence systems are producing mindboggling results
2. Progress is accelerating like never before
3. Technology is creating the first super-human intelligence
4. For the first time we will have machines that can do things that humans cannot do

True or False?

Machine Intelligence

- We build machines that can do things that are impossible for humans (“super-human” machines”)

The Singularity?

The four assumptions of the Singularity movement

1. Artificial Intelligence systems are producing mindboggling results
2. Progress is accelerating like never before
3. Technology is creating the first super-human intelligence
4. For the first time we will have machines that can do things that humans cannot do

Singularity

If you really have to…

Artificial Intelligence

Volume 33, Issue 2, October 1987, Pages 155-171

Phase transitions in artificial intelligence systems

Bernardo A. Huberman, Tad Hogg

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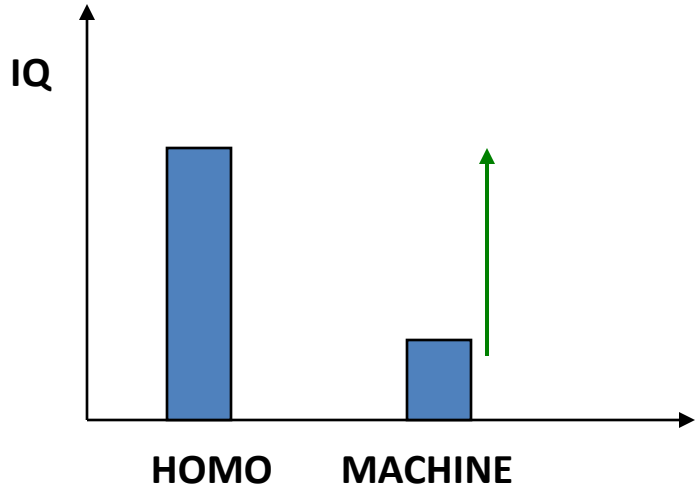
- Jobs
- We need AI soon
- The next Breakthrough

The Turing Point

- The Turing Test was asking “when can machines be said to be as intelligent as humans?”
- This “Turing point” can be achieved by
  1. Making machines smarter, or
  2. Making humans dumber

1.



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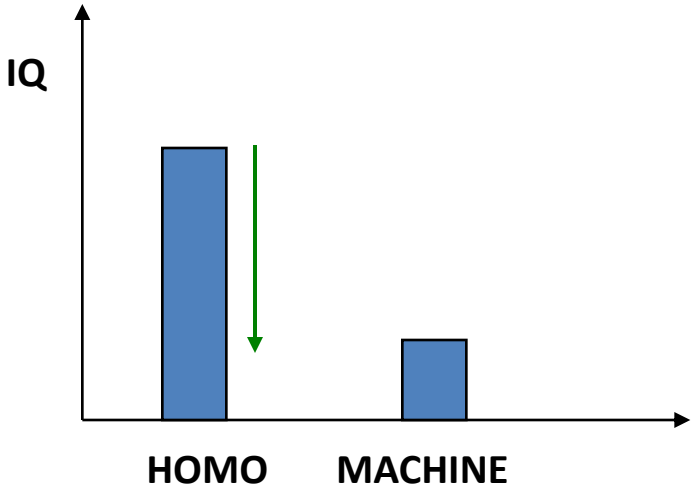

Turning People into Machines

- “They” increasingly expect us to behave like machines in order to interact efficiently with machines: we have to speak a “machine language” to phone customer support, automatic teller machines, gas pumps, etc.
- In most phone and web transactions the first question you are asked is a number (account #, frequent flyer#…)

Short Form
Return of Organization Exempt From Income Tax
Form 990-EZ
2009
Open to Public Inspection

Decelerating intelligence?

Humans want to build machines that think like humans while machines are already building humans who think like machines

Decelerating Human Intelligence

- Is it possible that humans have moved a lot closer towards machines than machines have moved towards humans?

Vast Algorithmic Bureaucracies (Vast Heartless Bureaucracies)

A society of rules and regulations

What is not forbidden is mandatory, and viceversa

“I am sorry” when in fact nobody is!

The Soviet Union was the future, not the past

Vast Algorithmic Bureaucracies (Vast Heartless Bureaucracies)

25
MAY 2017
amyrawe.com

What Trump Is Teaching Our Children About Winning, Losing And Playing The Game

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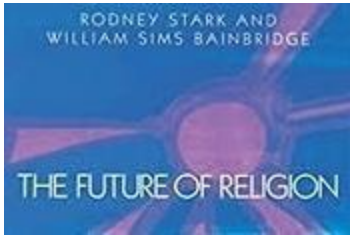
The Singularities

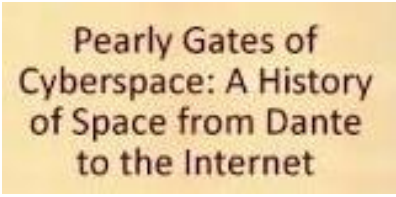
- The Apocalypse has happened many times
  - Book of Revelation (1st c AD)
  - …
  - Year 1,000
  - …
  - Nostradamus (16th century)
  - …
  - Pierre Teilhard de Chardin's Omega Point (1950)
  - Dorothy Martin/Marion Keech's planet Clarion (1954)
  - Nuclear holocaust (1950s-80s)
  - Heinz von Foerster (1960): "Doomsday: Friday, November 13, AD 2026,"
  - Majestic 12 conspiracy theory (1980s)
  - Year 2,000 & Y2K
  - Harold Camping's Biblical calculations (2011)
  - End of the Mayan calendar (2012)

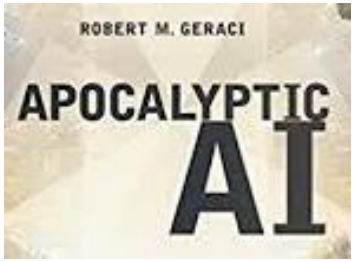
Albrecht Dürer: *The Four Horsemen of the Apocalypse* (1498)

Religion for the 21st Century

- Secularism encourages religious innovation (Bainbridge & Stark, 1985)
- Singularity-thinking borrows motifs and practices from Jewish and Christian apocalyptic scriptures
- Cyberspace is the high-tech equivalent of religious paradise
- Singularitarians want to escape the limitations of the biological body
- Fusion of religion and science







Good luck…

100 verified oldest people

Rank	Name	Age [†]	Death date
1	Jeanne Calment[1]	122 years, 164 days	4 August 1997
2	Sarah Knauss[2]	119 years, 97 days	30 December 1999
3	Lucy Hannah[3]	117 years, 248 days	21 March 1993
4	Marie-Louise Meilleur[4]	117 years, 230 days	16 April 1998

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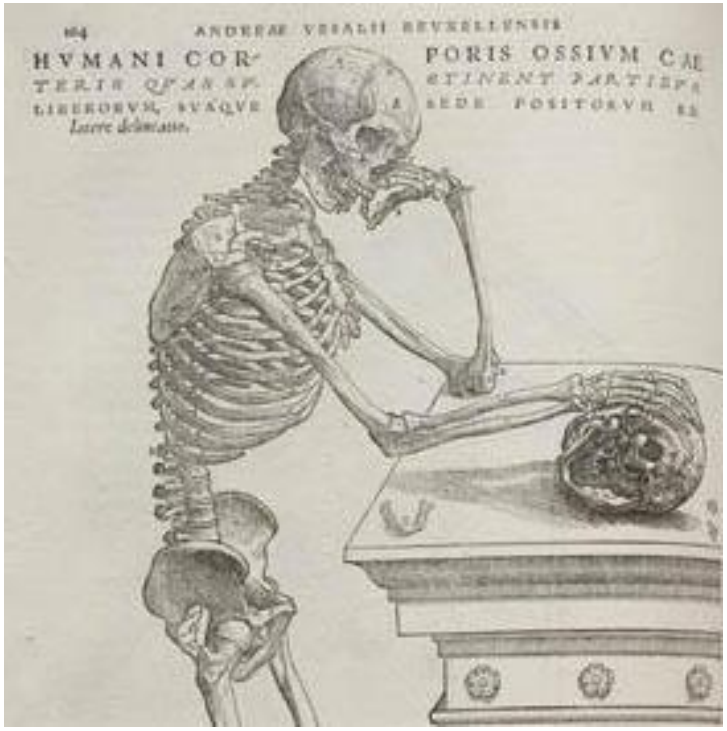
Machine Consciousness

Will machines become conscious?



Andreas Vesalius: De humani corporis fabrica" (1543)

Dualism	SUBSTANCE Dualism	Descartes
	PROPERTY Dualism	Broad
	SUPERVENIENCE	Kim
	TRIALISM	Popper, Penrose, Rucker
	EPIPHENOMENALISM	Bonnet
Monism	Idealism	Berkeley
	PANPSYCHISM	Leibniz
	PANTHEISM	Spinoza
	NEUTRAL Monism	Russell
	Materialism	
	IDENTITY THEORY	Place, Feigl, Smart
	ANOMALOUS Monism	Davidson
Behaviorism	Ryle	
	Eliminative materialism	Feyerabend, Rorty, Churchland
Functionalism	Computational functionalism	Putnam, Fodor, Stich, Block
	Homuncular functionalism	Dennett, Lycan, Minsky
Phenomenology	Husserl, Heidegger	

Consciousness

Will machines become conscious?

- Every year we slaughter 60 billion mammals, birds and fish… and we worry about the consciousness of machines?!?

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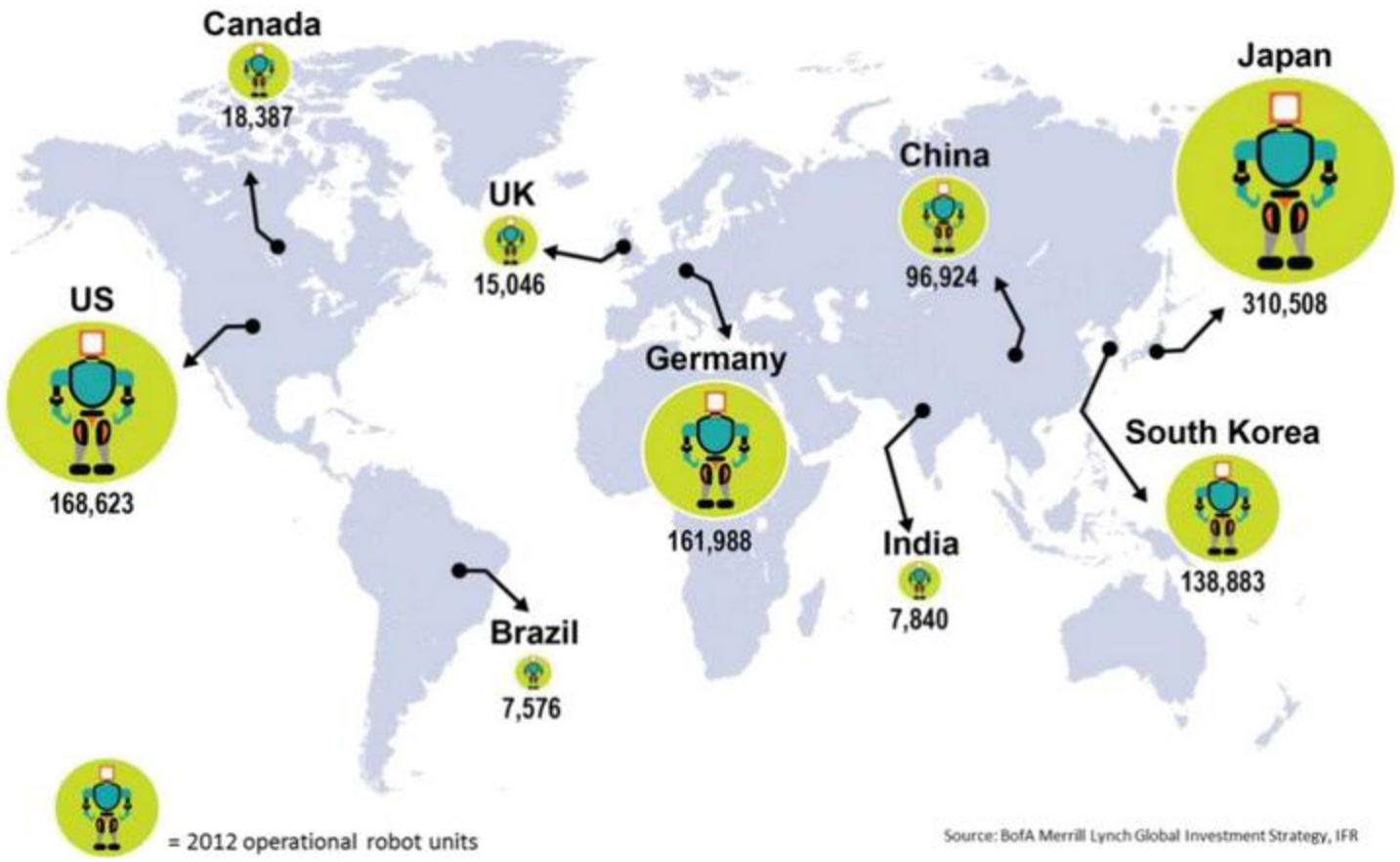
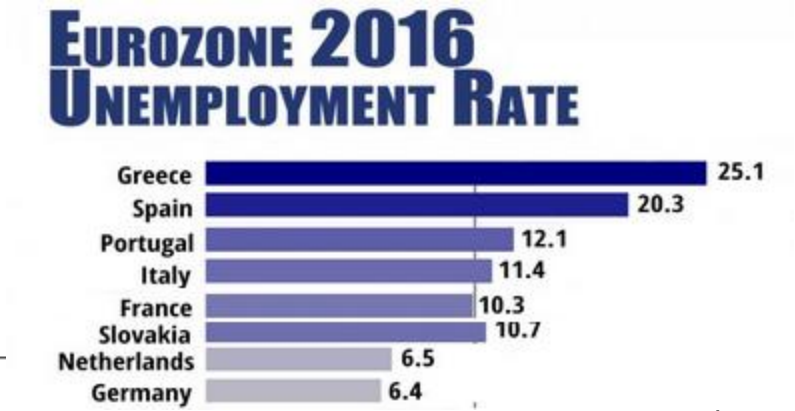
Do robots steal our jobs?

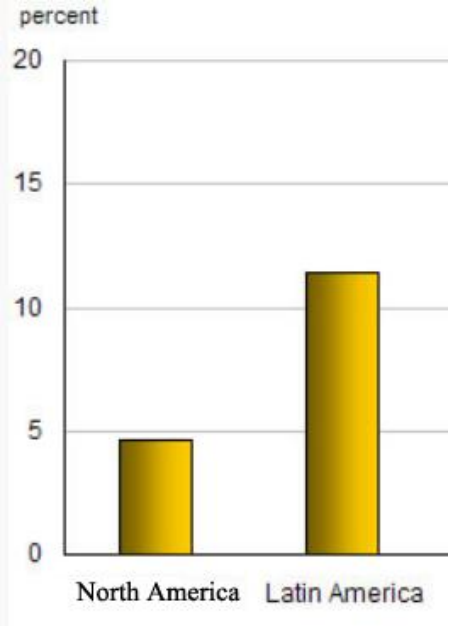
- The countries with the highest number of robots…

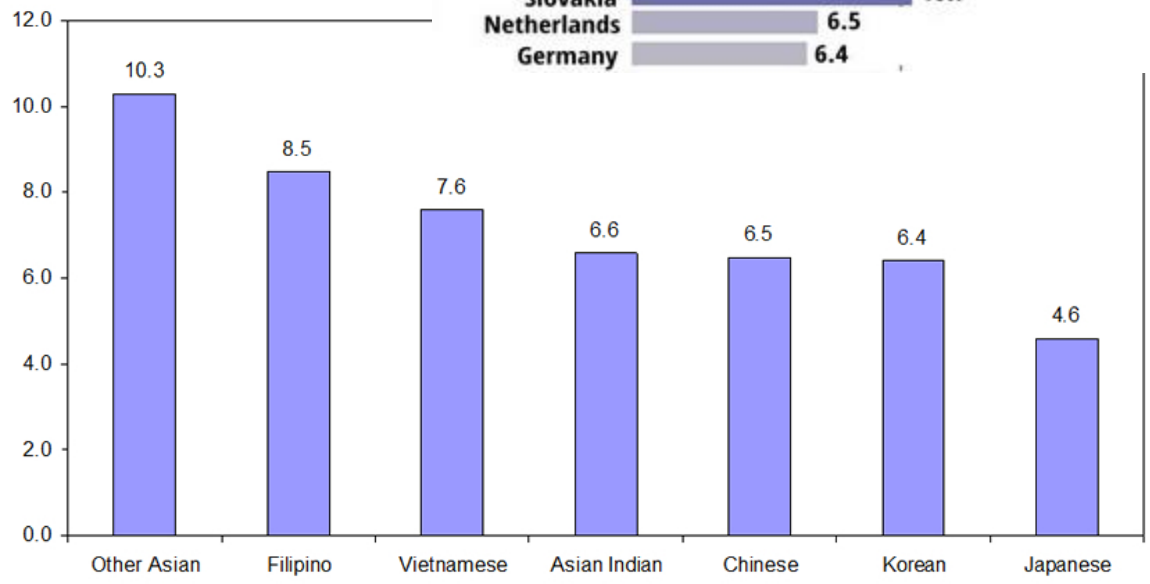


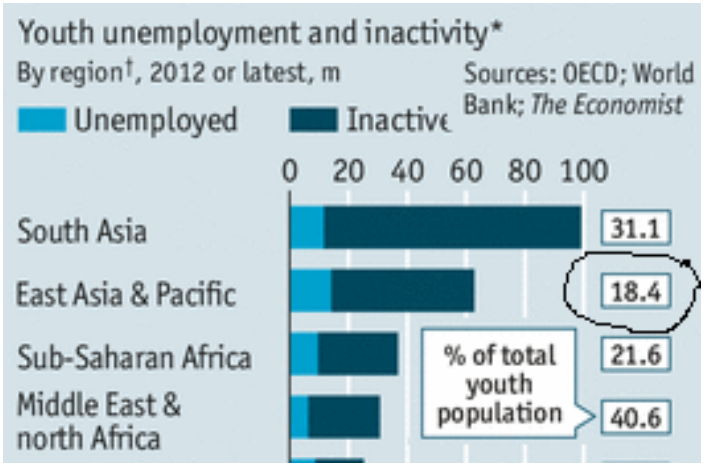
Do robots steal our jobs?

- … are also the countries with the lowest unemployment



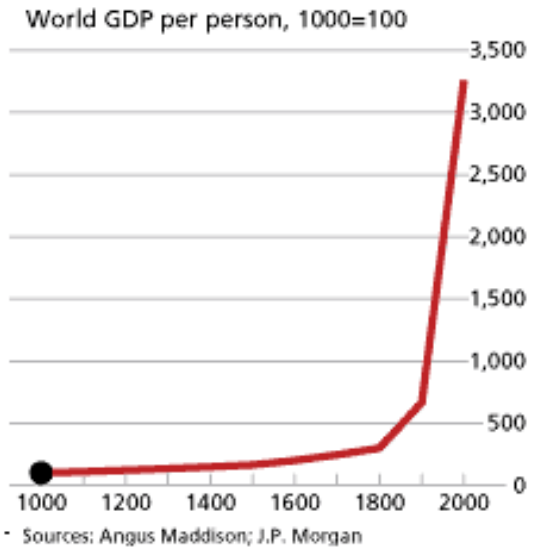


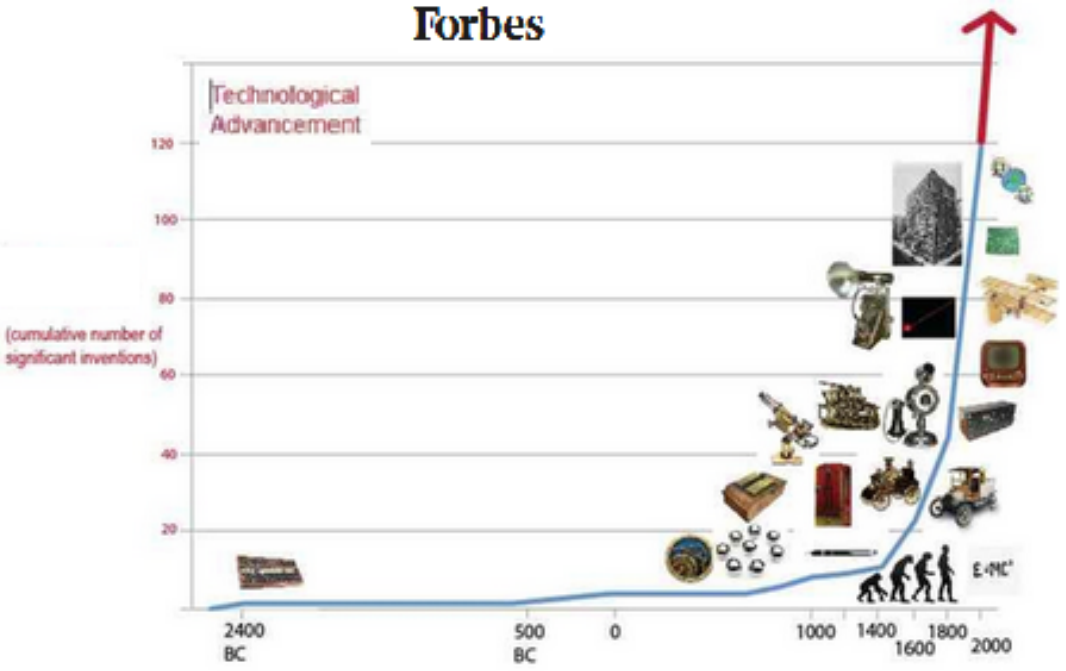




Do robots steal our jobs?

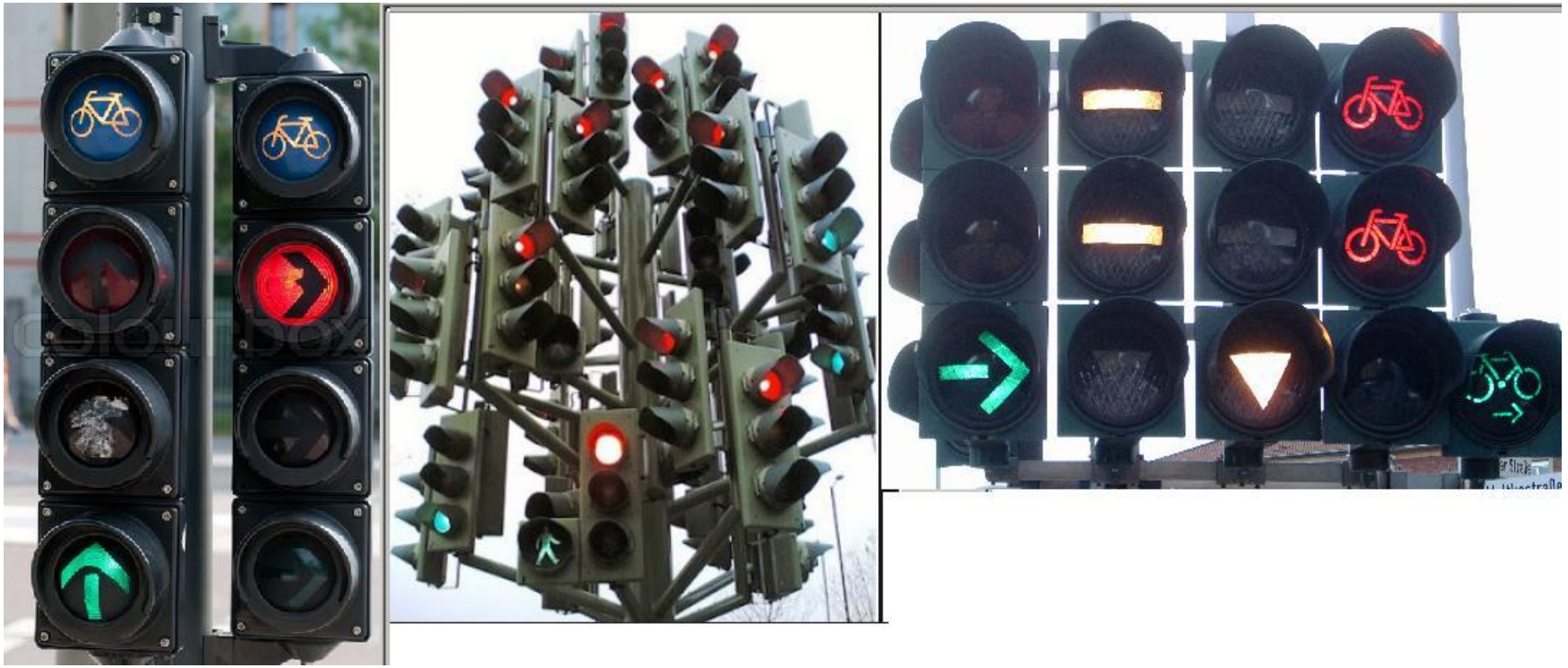
- Technology and wealth





Do robots steal our jobs?

- They already stole millions of jobs: the traffic guards!



185

Do robots create jobs?

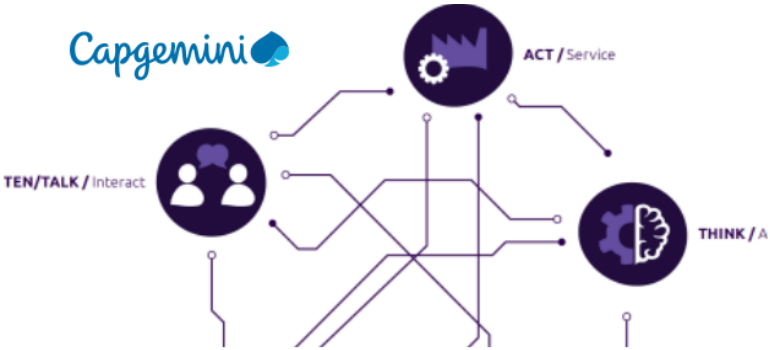
- Gartner: by 2020, AI will generate 2.3 million jobs, exceeding the 1.8 million that it will remove
- CapGemini: AI is creating new jobs in 4 out of 5 companies
- MIT: The jobs that AI will create

Gartner

STAMFORD, Conn., December 13, 2017

Gartner Says By 2020, Artificial Intelligence Will Create More Jobs Than It Eliminates

AI Will Create 2.3 Million Jobs in 2020, While Eliminating 1.8 Million



The Five Senses of Artificial Intelligence

MITSloan Management Review

SUMMER 2017 ISSUE

The Jobs That Artificial Intelligence Will Create

Jobs in the Age of Robots

- The Engineer of the Future:
  - The **language of AI** is computational mathematics

equations of backpropagation

$$\delta^L = \nabla_a C \odot \sigma'(z^L)$$

$$\delta^l = ((w^{l+1})^T \delta^{l+1}) \odot \sigma'(z^l)$$

$$\frac{\partial C}{\partial b^l_j} = \delta^l_j$$

$$\frac{\partial C}{\partial w^l_{jk}} = a^{l-1}_k \delta^l_j$$

$$\boldsymbol{P(x) = \frac{\exp(-E(x))}{Z}}$$

> E(x): Energy function

> Z: partition function where $\sum_x P(x) = 1$

Given functions $x(t)$ and $w(t)$, their convolution is a function $s(t)$

$$s(t) = \int x(a)w(t-a)da$$

Written as

$$s = (x * w) \quad \text{or} \quad s(t) = (x * w)(t)$$

$$P(\mathrm{v}, \mathrm{h}^1, \mathrm{h}^2, \mathrm{h}^3) =$$

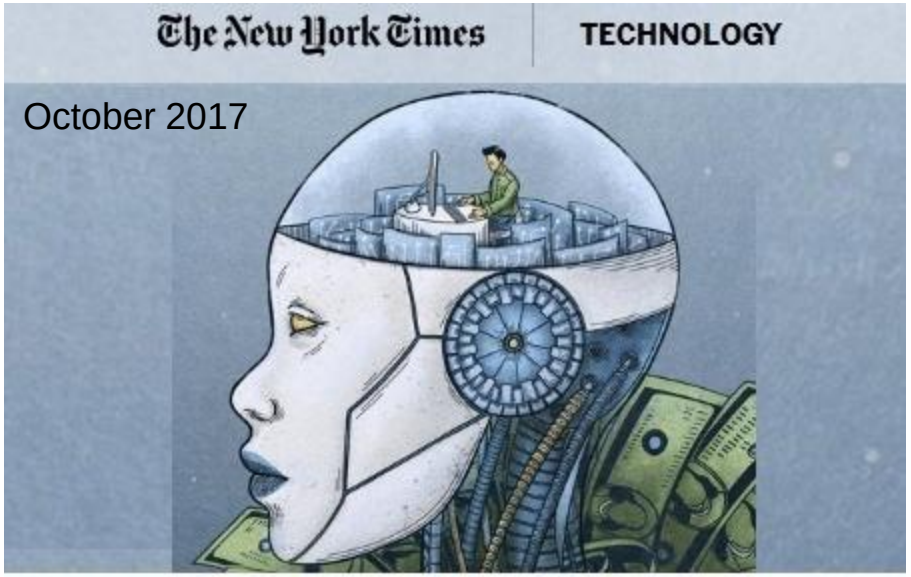
$$\underbrace{P(\mathrm{v}|\mathrm{h}^1)P(\mathrm{h}^1|\mathrm{h}^2)}_{\text{Sigmoid Belief Net}}\underbrace{P(\mathrm{h}^2, \mathrm{h}^3)}_{\text{RBM}}$$

$$P(\mathrm{v}|\mathrm{h}^1) = \prod_i P(v_i|\mathrm{h}^1)$$

$$P(\mathrm{h}^1|\mathrm{h}^2) = \prod_j P(h^1_j|\mathrm{h}^2)$$

$$P(\mathrm{h}^2, \mathrm{h}^3) = \frac{1}{Z(W^3)} \exp(\mathrm{h}^{2T} W^3 \mathrm{h}^3)$$

Jobs in the Age of Robots



Tech Giants Are Paying Huge Salaries for Scarce A.I. Talent

But…

"The person who says it cannot be done should not interrupt the person doing it"
(Chinese proverb)

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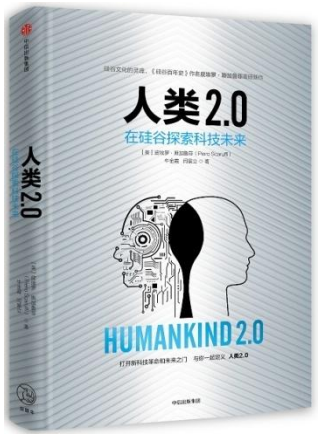
- Jobs
- We need AI soon
- The next Breakthrough

We need A.I. soon



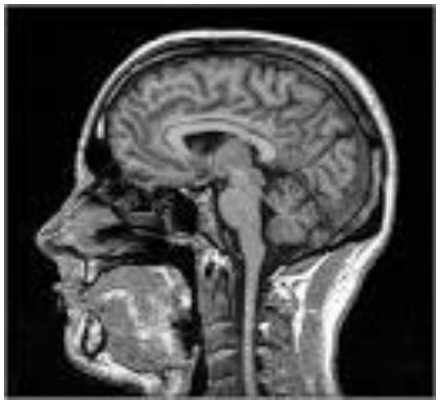
Journalist: Are you afraid of A.I.?

Piero: I am afraid that it will not come soon enough!

My ~~prediction~~ hope of 2014 was…

Image Analysis

- Analysis of medical images: X-Rays, MRIs, Computed Tomography (CT), etc
  - Philips Health Care: 135 billion medical images, 2 million new images every week
  - Helping radiology, cardiology and oncology departments understand images



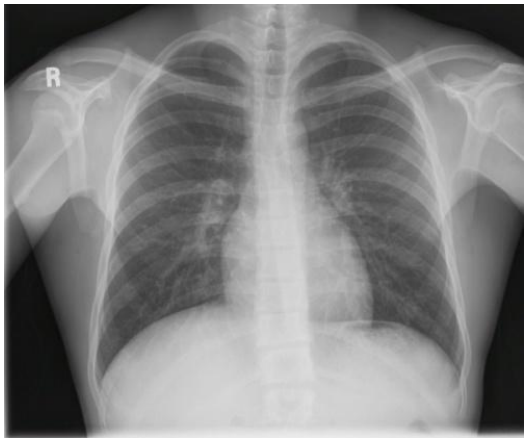
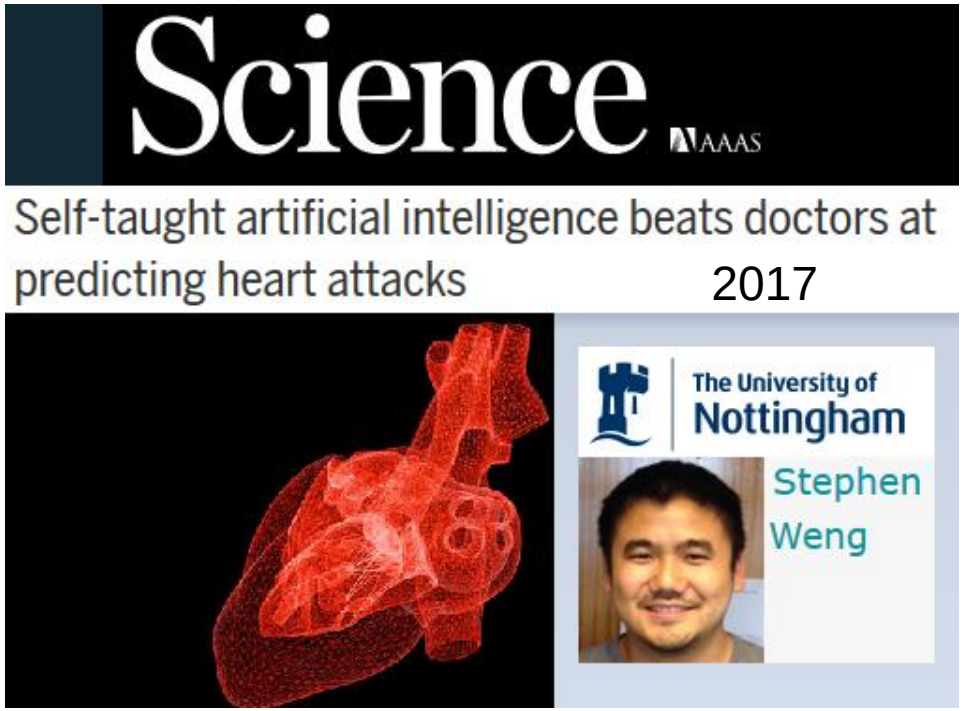
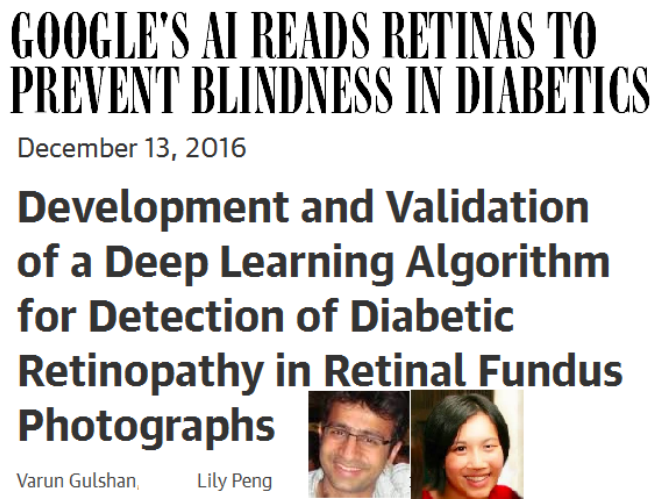


Image Analysis



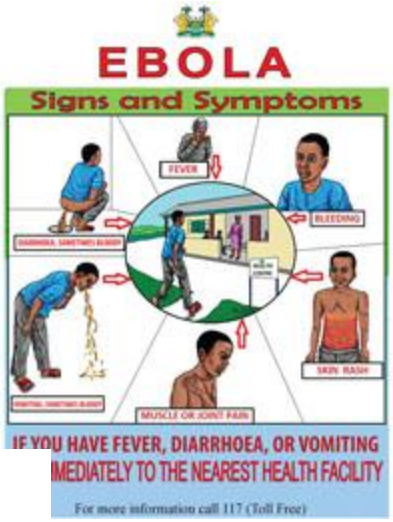


We need A.I. soon

- The 21st Century
  - Aging and weaker population
    - Caretaking robots
    - Medical image analysis
    - Precision medicine
  - Rare diseases and new viruses
    - Drug discovery
  - Non-state and state terrorism
    - Cybersecurity

SRI International Spins Off Superflex, Inc. to Help People Achieve Their Physical Potential

April 21, 2016



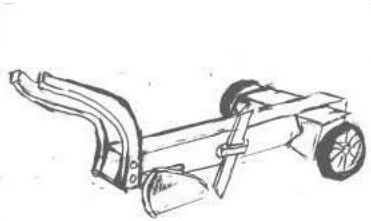
NOVEMBER 2, 2016 CB INSIGHTS

Cybersecurity's Next Step: Artificial Intelligence Is Helping Predict, Prevent, And Defeat Attacks

We need A.I. soon

PEACE INNOVATION LAB AT STANFORD
https://peaceinnovation.stanford.edu

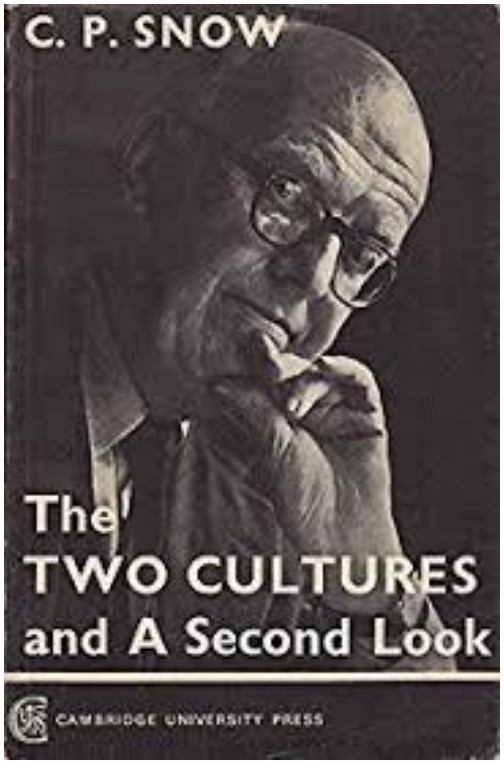
- The 21st Century
  - Human-human interaction
    - Translation
    - Trust algorithms (“peace technology”)
  - Human-machine interaction
    - Conversational user interfaces
    - Digital and non-digital humanities



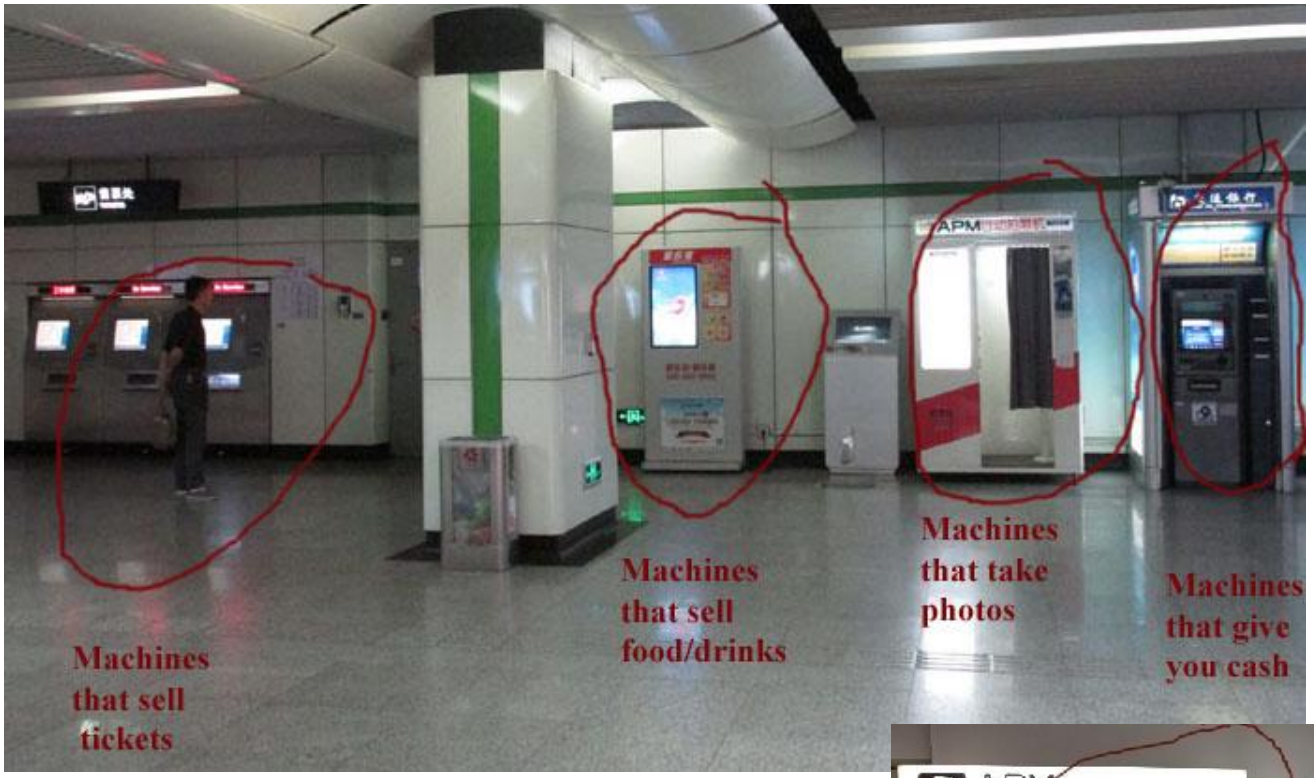
A better Future

- A.I. + Humanities
- Humans and machines: two kinds of “intelligence” that need to interact, communicate, collaborate, …

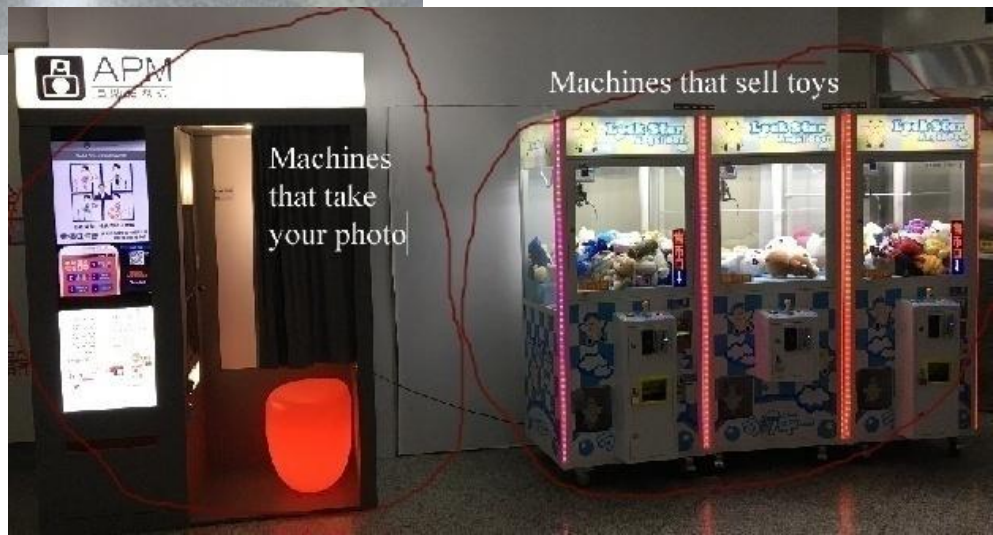
Macy Conference



Our world: you are surrounded!



You are already surrounded by robots…



Our world: you are surrounded!

Our world: you are surrounded!

The most complex robot

DARPA DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Aircrew Labor In-Cockpit Automation System (ALIAS)

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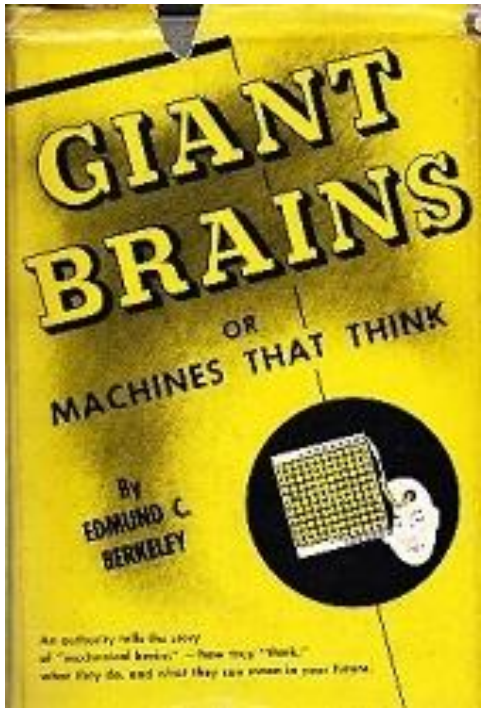
Yesterday and Today

2017: Everything is A.I. just like back then…



The next breakthrough

- National projects that changed the world
  - Apollo Program (1963)
  - Arpanet (1969)
  - Human Genome Project (1990)
  - BRAIN Initiative (2013) + Human Brain Project (2013)

The next breakthrough

- National projects that changed the world
  - Neuroscience
  - USA: BRAIN Initiative (2013)
  - EU: Human Brain Project (2013)
  - Switzerland: Blue Brain (2015)

Human Brain Project

Co-funded by the European Union

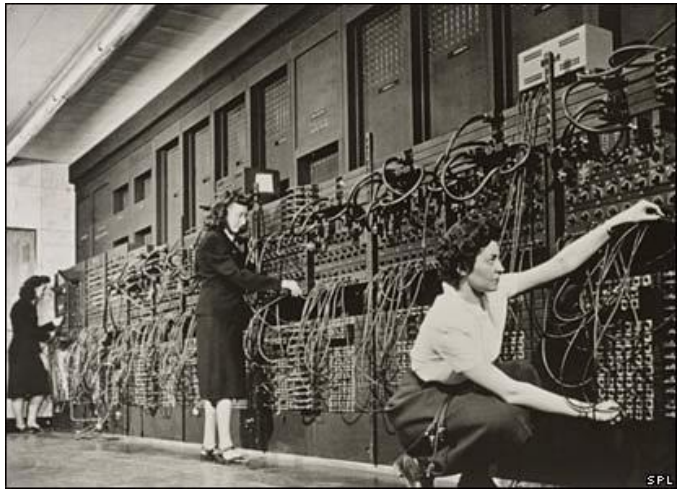
Henry Markram

EPFL ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Blue Brain

Conclusion:
Don't be afraid of the robot

- The society of robots will create new jobs that today we can't even imagine.
- Who would have imagined that the same technology that gave us computer automation would create millions of jobs in mobile communications?



Conclusion:
Don't be afraid of the robot

- It is unpredictable what human brains do with new technology
- E.g.: give trumpets to former African slaves and you get jazz!

The first jazz record: 1917

Conclusion:
Don’t be afraid of the robot

- Robots will create an even more complex society in which human intelligence will be even more important.
- The future always surprises us.

Reminder: you can download these slides from **www.scaruffi.com**

The End (for now)

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