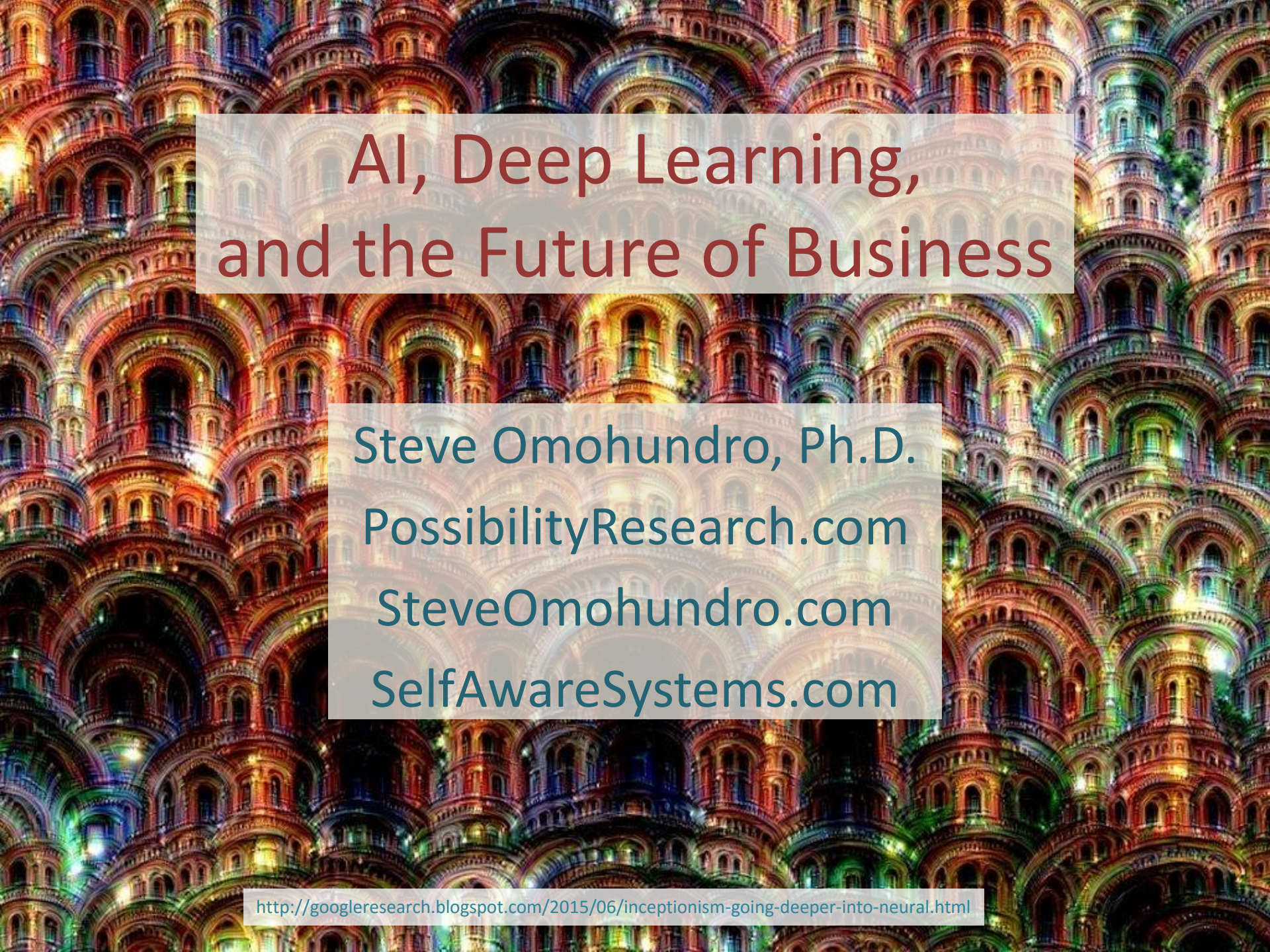
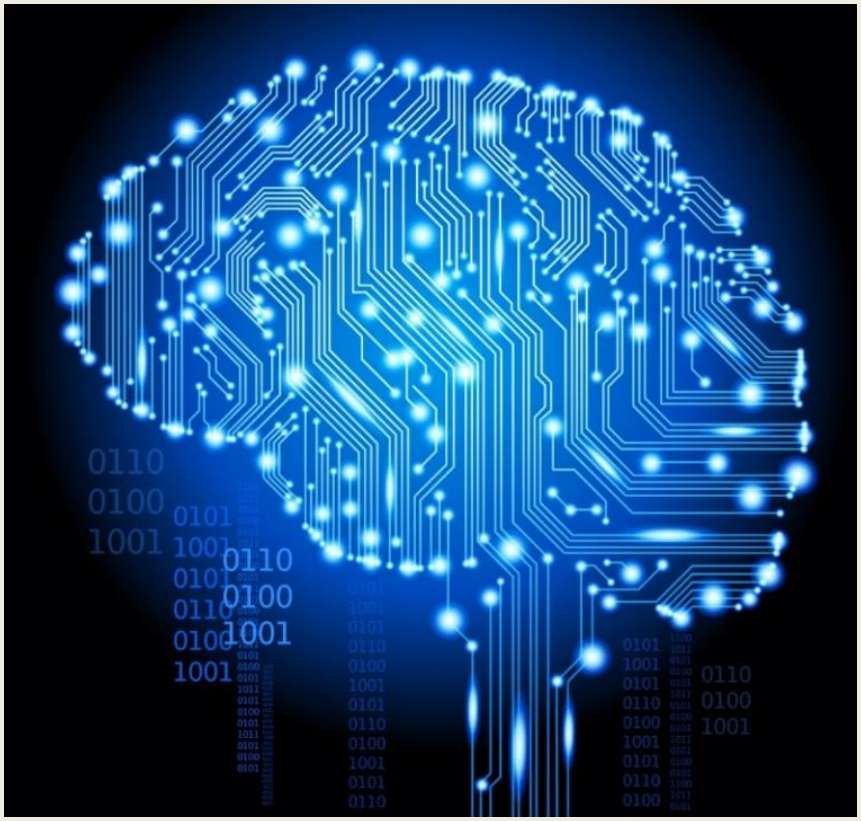


AI, Deep Learning, and the Future of Business

Steve Omohundro, Ph.D.
PossibilityResearch.com
SteveOmohundro.com
SelfAwareSystems.com

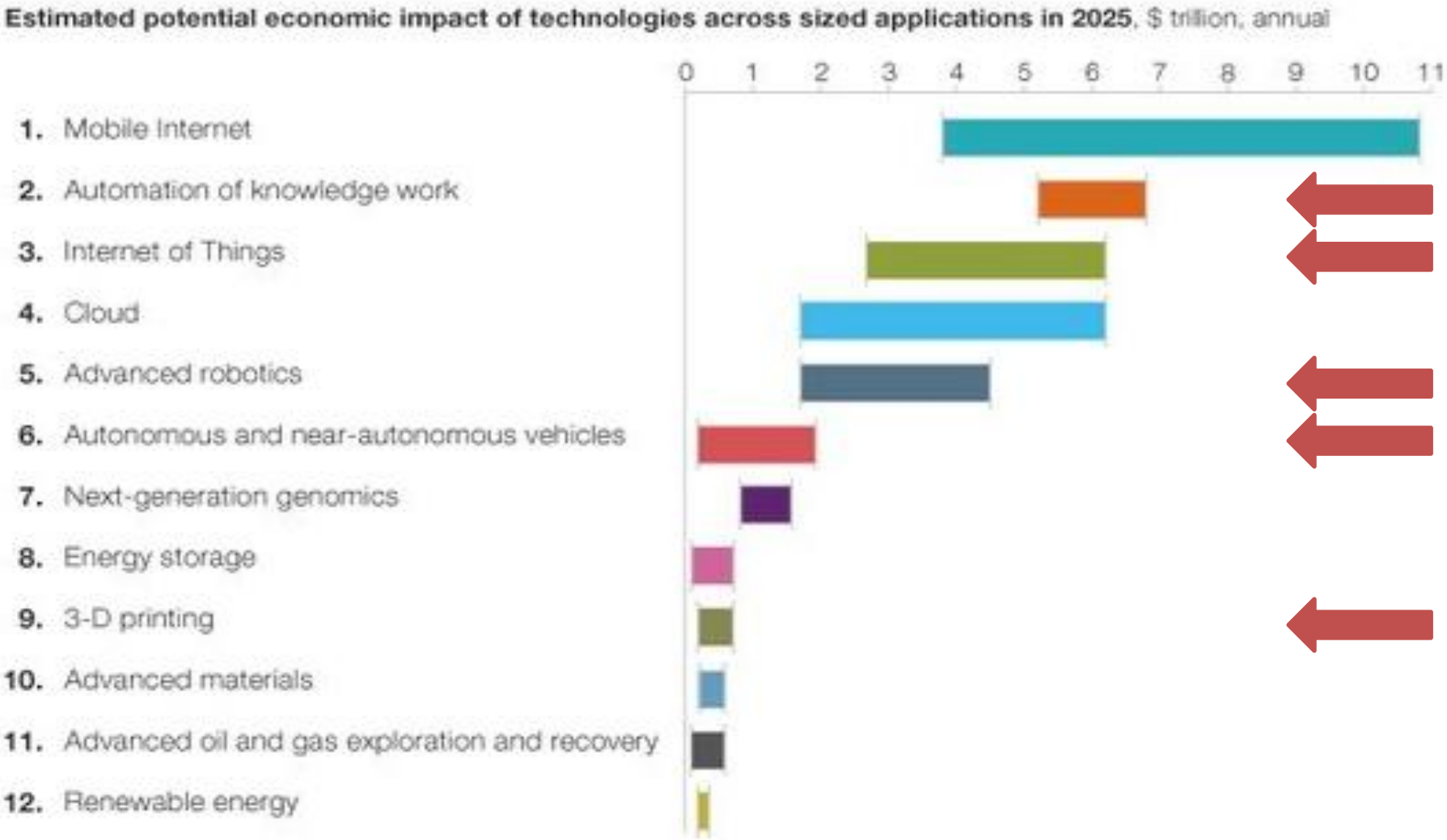
http://googleresearch.blogspot.com/2015/06/inceptionism-going-deeper-into-neural.html

Multi-Billion Dollar Investments



- 2013 Facebook – AI lab, DeepFace
- 2013 Yahoo - LookFlow
- 2013 Ebay – AI lab
- 2013 Allen Institute for AI
- 2013 Google – DNNresearch, SCHAFT, Industrial Perception, Redwood Robotics, Meka Robotics, Holomni, Bot & Dolly, Boston Dynamics
- 2014 IBM - $1 billion in Watson
- 2014 Google - DeepMind $500 million
- 2014 Vicarious - $70 million
- 2014 Microsoft – Project Adam, Cortana
- 2015 Fanuc – Machine Learning for Robotics
- 2015 Toyota – $1 billion AI and Robotics Lab, Silicon Valley

McKinsey: $50 Trillion to 2025



http://www.mckinsey.com/insights/business_technology/disruptive_technologies

AI Knowledge Work: $25 Trillion to 2025

Marketing, ERP, Big Data, Smart Assistants

http://thismasquerade.me/wp-content/uploads/blogger/-84ftTg_azwY/Um8up3j4zTI/AAAAAAAABJ8/9_-dxg23Uac/s1600/9979402_ml.jpg

Internet of Things: $15 Trillion to 2025

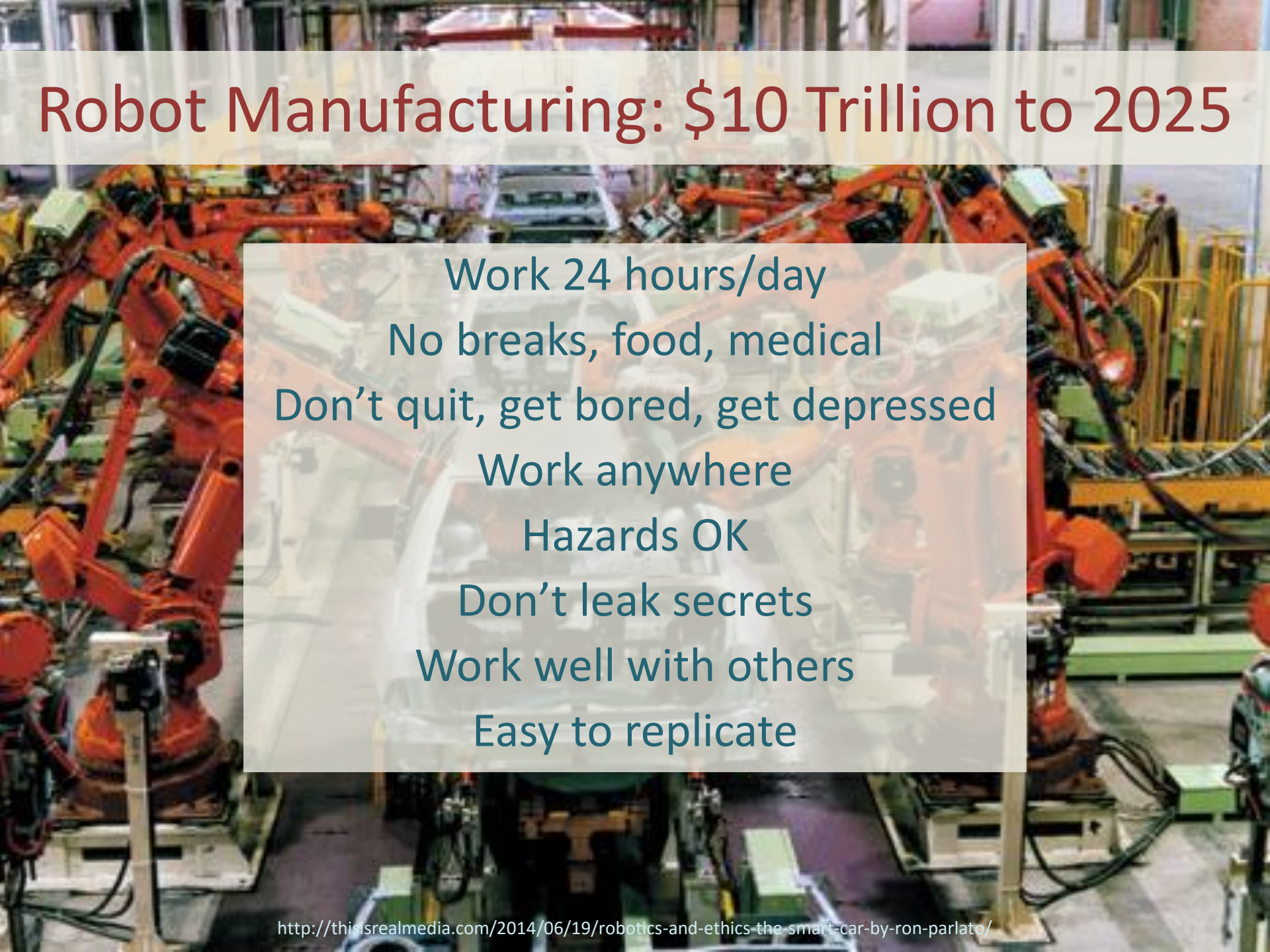
100 Billion devices by 2025

Cars, Appliances, Cameras, Meters, Wearables, etc.

http://www.forbes.com/sites/gilpress/2014/08/22/internet-of-things-by-the-numbers-market-estimates-and-forecasts/

https://www.summitbusiness.net/images/Internet.jpg

Robot Manufacturing: $10 Trillion to 2025



Work 24 hours/day

No breaks, food, medical

Don’t quit, get bored, get depressed

Work anywhere

Hazards OK

Don’t leak secrets

Work well with others

Easy to replicate

http://thisisrealmedia.com/2014/06/19/robotics-and-ethics-the-smart-car-by-ron-parlato/

Foxconn Technology Group

- World's largest contract manufacturer
- Assembles 40% of all consumer electronics
- iPhone, iPad, Kindle, Xbox, Playstation 4, etc.
- 1.3 million employees, $8K salary
- Employee suicides
- "Foxbot" robots, cost $25K, 2nd generation now
- Building 30K robots/year

http://www.tomshardware.com/news/foxcponn-apple-iphone-ipad-robot,19088.html

420 Chinese Robot Companies

1500 Dongguan “Robot Replace Human” factories

http://thestack.com/china-robot-market-overstimulated-291014 http://www.reuters.com/article/2014/10/28/china-robots-idUSL3N0RB2WX20141028

March 2015: China Brain

Robin Li Yanhong, CEO of Baidu proposed a state-level Chinese initiative to develop AI "comparable to the Apollo space programme".

LIFESTYLE • TECHNOLOGY • ARTIFICIAL INTELLIGENCE

'China brain' project seeks military funding as Baidu makes artificial intelligence plans

Robin Li wants China to become a world leader in artificial intelligence

Bien Perez
bien.perez@scmp.com

PUBLISHED : Tuesday, 03 March, 2015, 3:
UPDATED : Wednesday, 04 March, 2015, 1

Baidu founder Robin Li Yanhong speaks to reporters at the Great Hall of the People about his plans to develop artificial intelligence. Photo: Simon Song

http://www.scmp.com/lifestyle/technology/article/1728422/head-chinas-google-wants-country-take-lead-developing

Health Care: $10 Trillion to 2025

Robot surgery, medical records, AI diagnosis

https://osuwmcdigital.osu.edu/sitetool/sites/urologypublic/images/Robotics/robotic_surgery_table.jpg

Self-Driving Vehicles: $10 Trillion by 2025

Disrupt Dealers, Insurance, Parking, Finance, Trucking, Taxis
10 million jobs

http://www.theverge.com/2014/5/28/5756852/googles-self-driving-car-isnt-a-car-its-the-future
http://zackkanter.com/2015/01/23/how-ubers-autonomous-cars-will-destroy-10-million-jobs-by-2025/

Tesla: “Autopilot” mode

Google: Fully Self-Driving in 2020

Mercedes, GM, Volvo, Apple, Uber,…

http://www.flickr.com/photos/quikbeam/6896564084/

http://en.wikipedia.org/wiki/Autonomous_car

http://zackkanter.com/2015/01/23/how-ubers-autonomous-cars-will-destroy-10-million-jobs-by-2025/

Uber valuation: $51 billion, 20% of fares

http://www.wsj.com/articles/ubers-new-funding-values-it-at-over-41-billion-1417715938

World's largest job creator: 50,000 per month

http://www.businessinsider.com/uber-offering-50000-jobs-per-month-to-drivers-2015-3

Center for research on self-driving cars

http://bits.blogs.nytimes.com/2015/02/02/uber-to-open-center-for-research-on-self-driving-cars/?_r=0

36 second wait, $.50/mile, 100% of fares

http://zackkanter.com/2015/01/23/how-ubers-autonomous-cars-will-destroy-10-million-jobs-by-2025/

U B E R

https://d185ox70mr1pkc.cloudfront.net/post_image_teaser/1403883171000-uber-force.png

Pedestrian Chicken

"We jokingly play chicken with them when we're trying to cross the street," he said. "You see one about to make a right turn at a light, and they're obviously trying to decide if we're going to step into the street or not. It's so tempting to sort of step toward the curb, which makes the car stop instantly and wait for you to go, except you don't go.

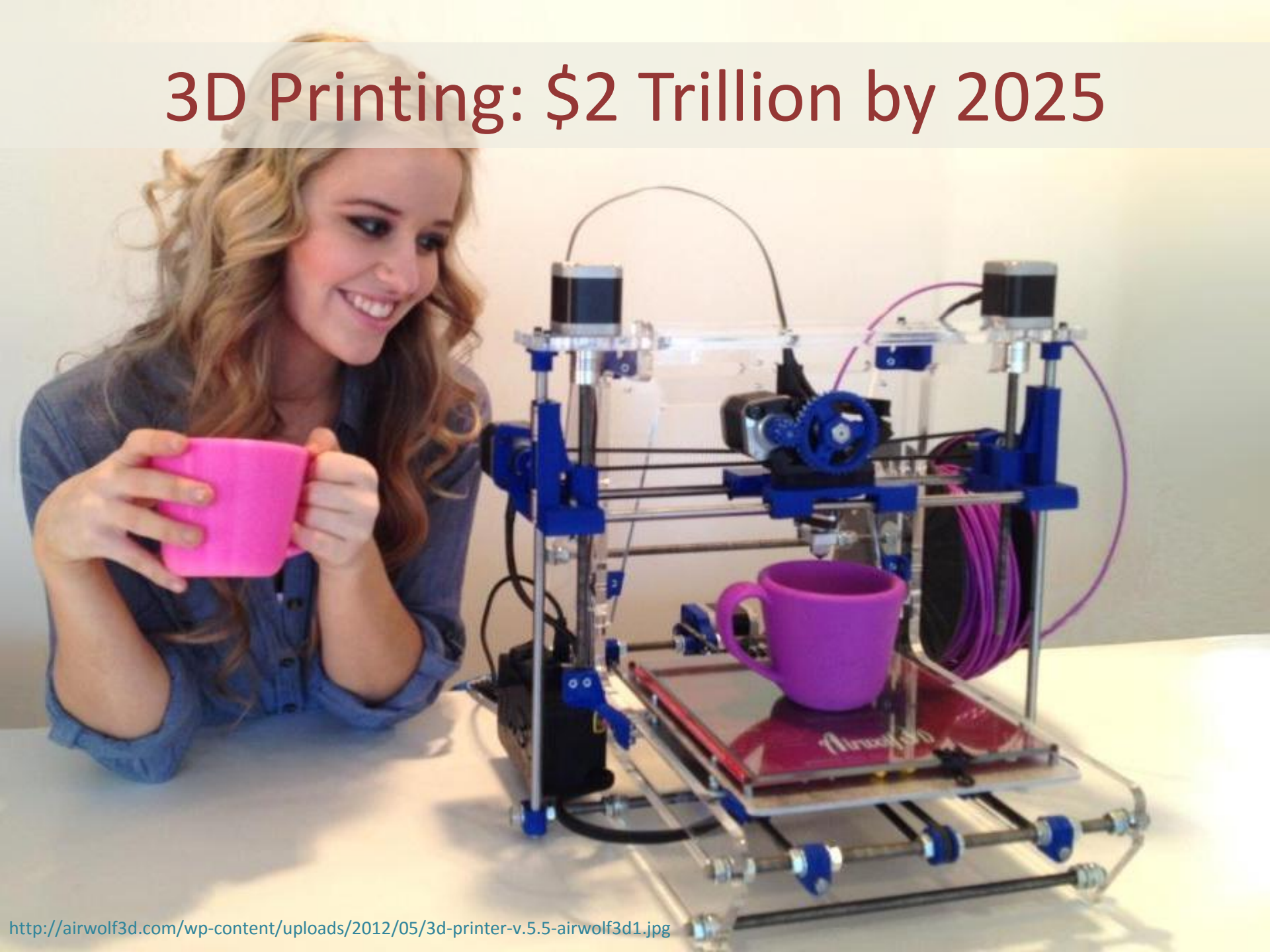
"We're just messing with it," he said, "to see what it'll do."

– Zandr Milewski

http://www.siliconvalley.com/business/ci_29114891/driverless-google-car-stopped-traffic-violation-and-story

https://medium.com/@mitchturck/self-driving-cars-and-sound-cannons-an-indecent-proposal-43ebf99fafc#.m648686fv

3D Printing: $2 Trillion by 2025



http://airwolf3d.com/wp-content/uploads/2012/05/3d-printer-v.5.5-airwolf3d1.jpg

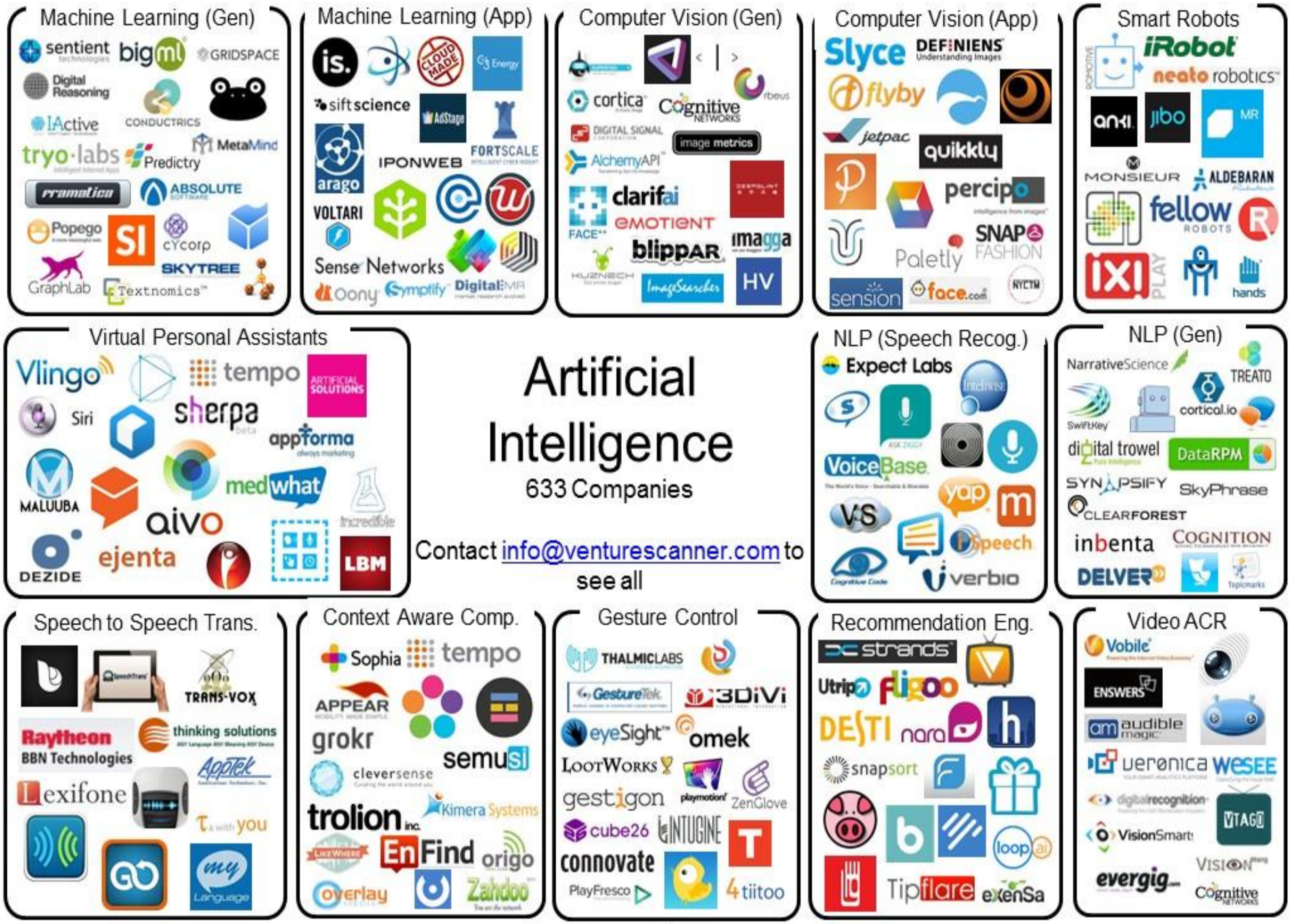
April 2014: Chinese WinSun 3D printed 10 houses, 2100 sq ft, $4800

http://m.newsru.co.il/realty/20jan2015/3d_house_i101.html

WinSun 3D printed 12,000 sq ft villa

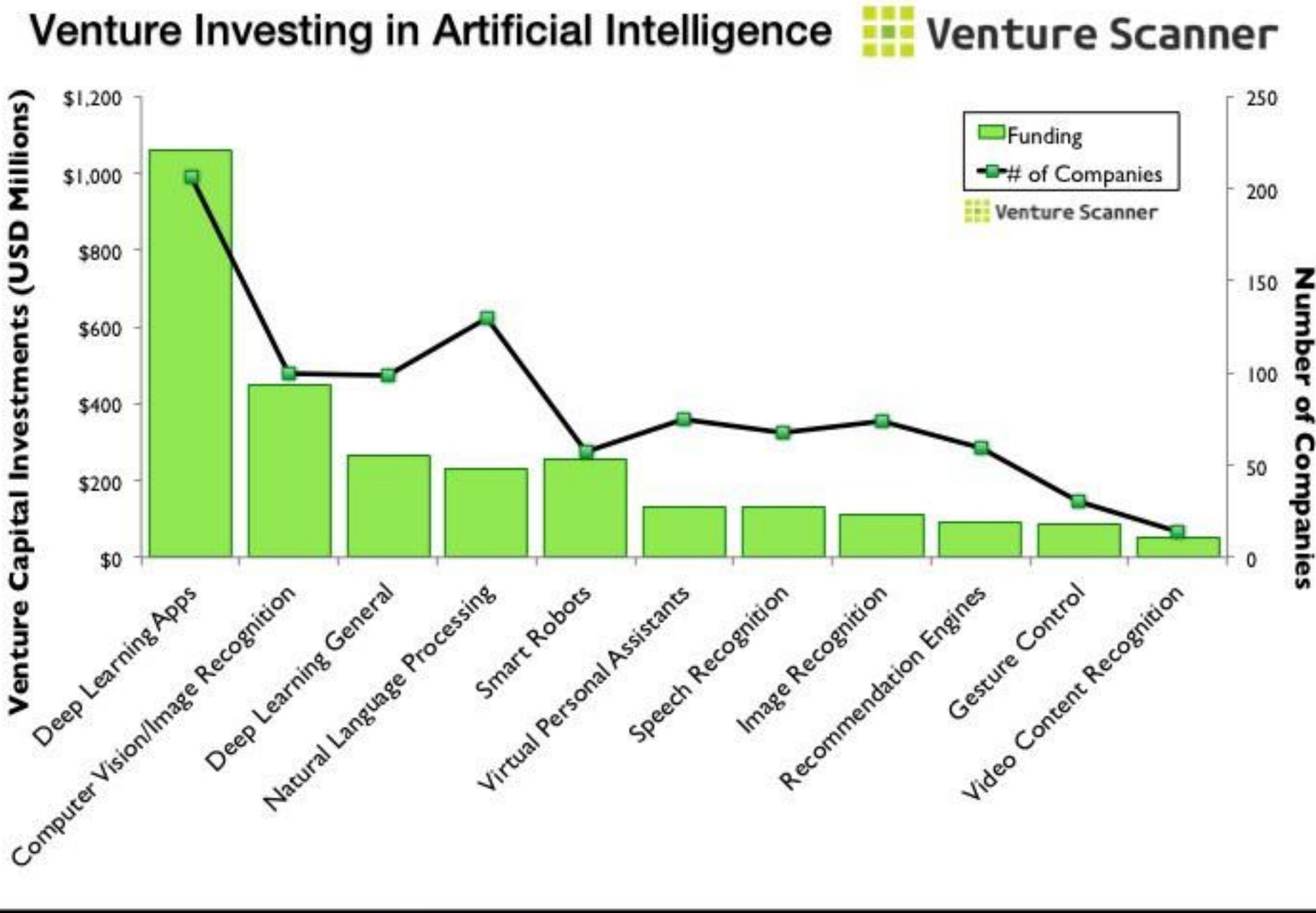
US Building construction: $1 Trillion/yr
5.8 million employees

http://3dprint.com/38144/3d-printed-apartment-building/



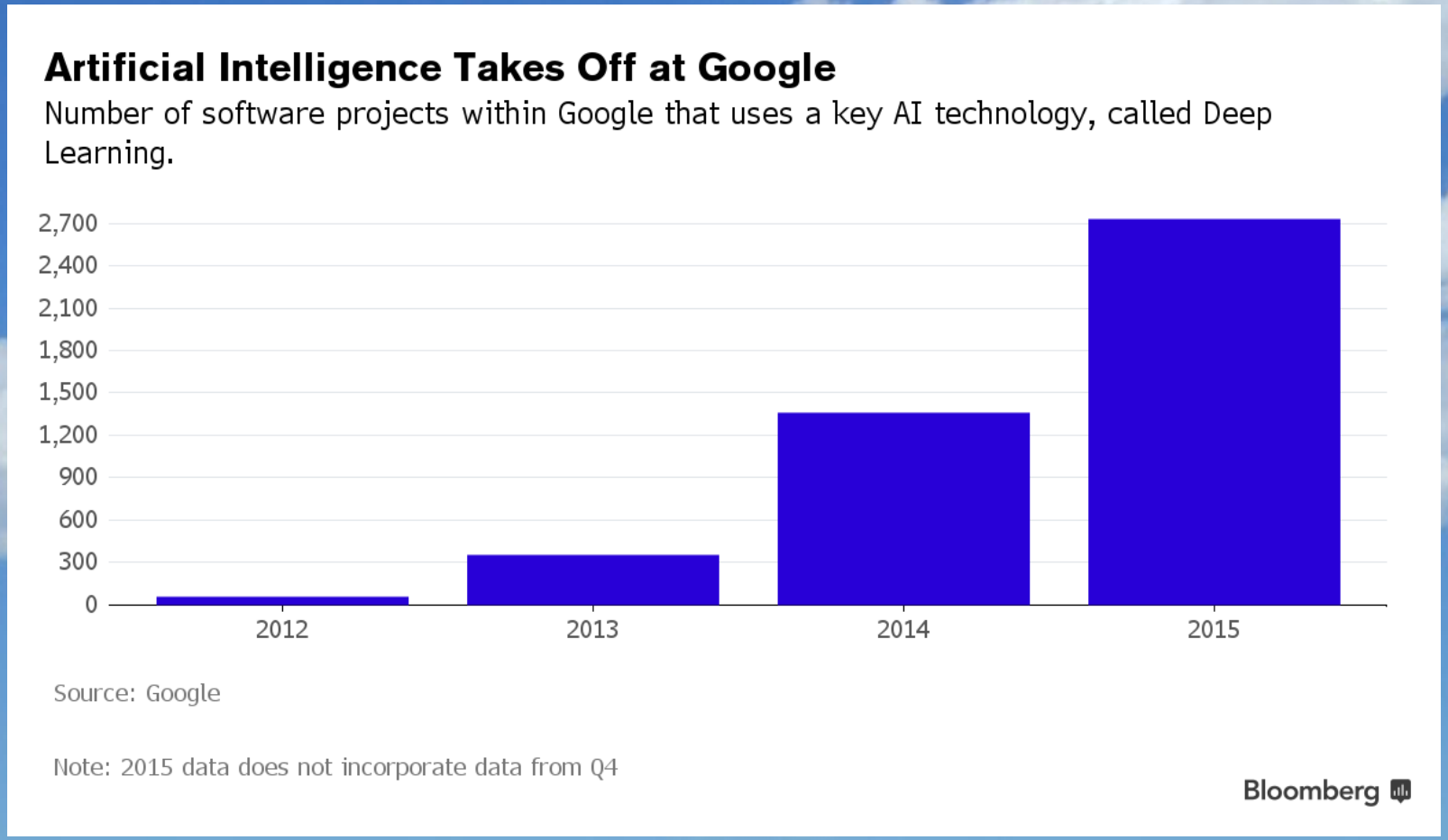
https://venturescannerinsights.files.wordpress.com/2015/01/artificial-intelligence-map.jpg

https://venturescannerinsights.files.wordpress.com/2015/09/ai4.jpeg



Contact us at info@venturescanner.com to see all 855 AI Startups

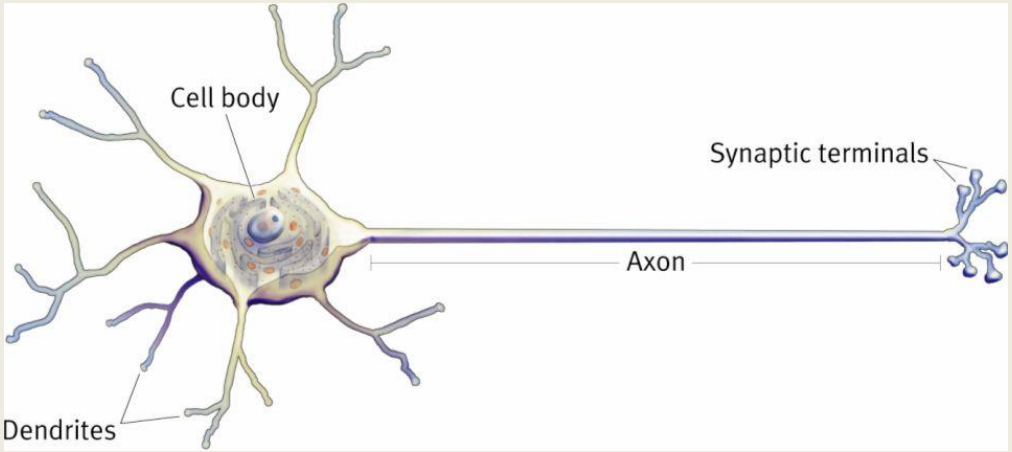
2,700 Google Projects Use Deep Learning!



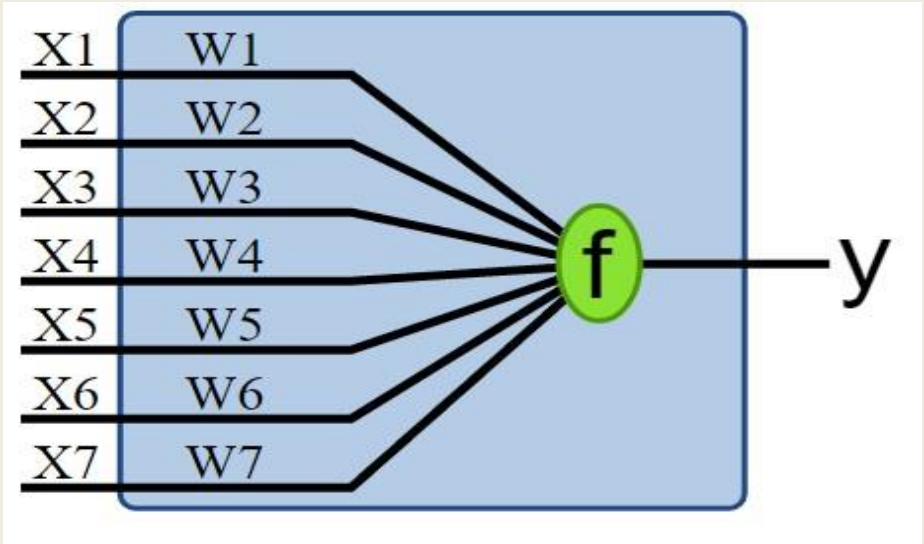
http://www.bloomberg.com/news/articles/2015-12-08/why-2015-was-a-breakthrough-year-in-artificial-intelligence

http://www.rutherfordjournal.org/article040101.html

1957: Rosenblatt's "Perceptron"



http://bio3520.nicerweb.com/Locked/chap/ch03/3_11-neuron.jpg

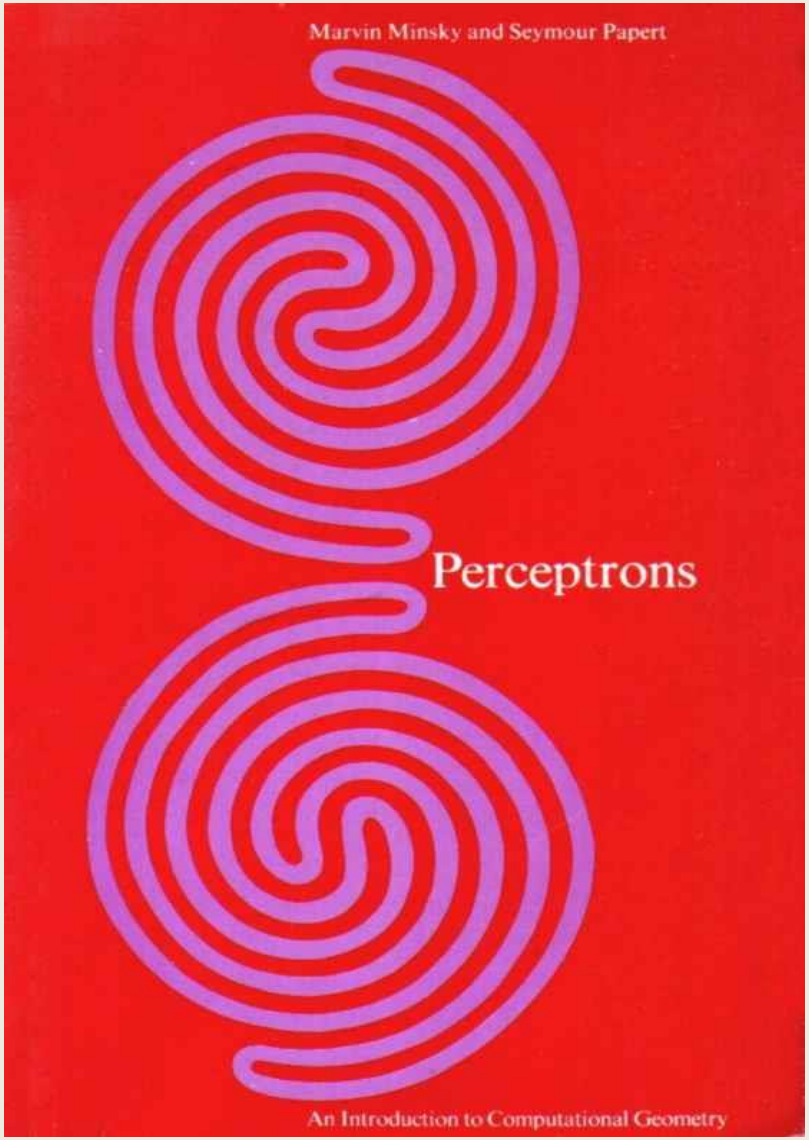


https://upload.wikimedia.org/wikipedia/commons/3/31/Perceptron.svg

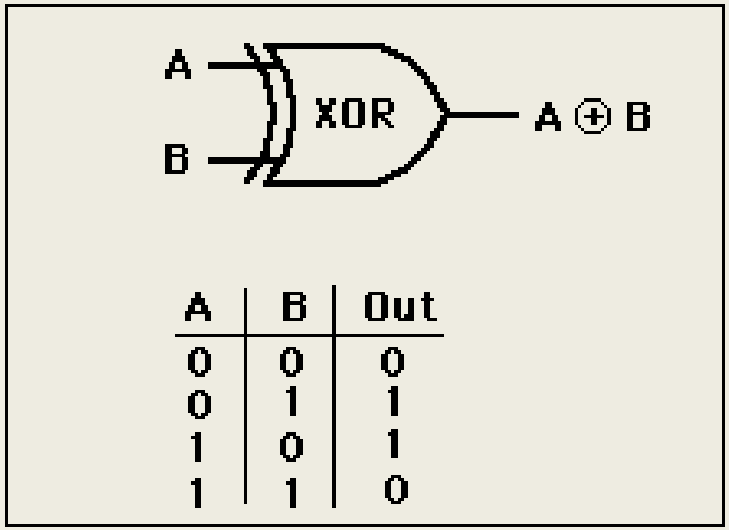
"The embryo of an electronic computer that [the Navy] expects will be able to walk, talk, see, write, reproduce itself and be conscious of its existence."
- Office of Naval Research

https://en.wikipedia.org/wiki/Perceptron

1969: Perceptrons can’t do XOR!



http://www.i-programmer.info/images/stories/BabBag/AI/book.jpg



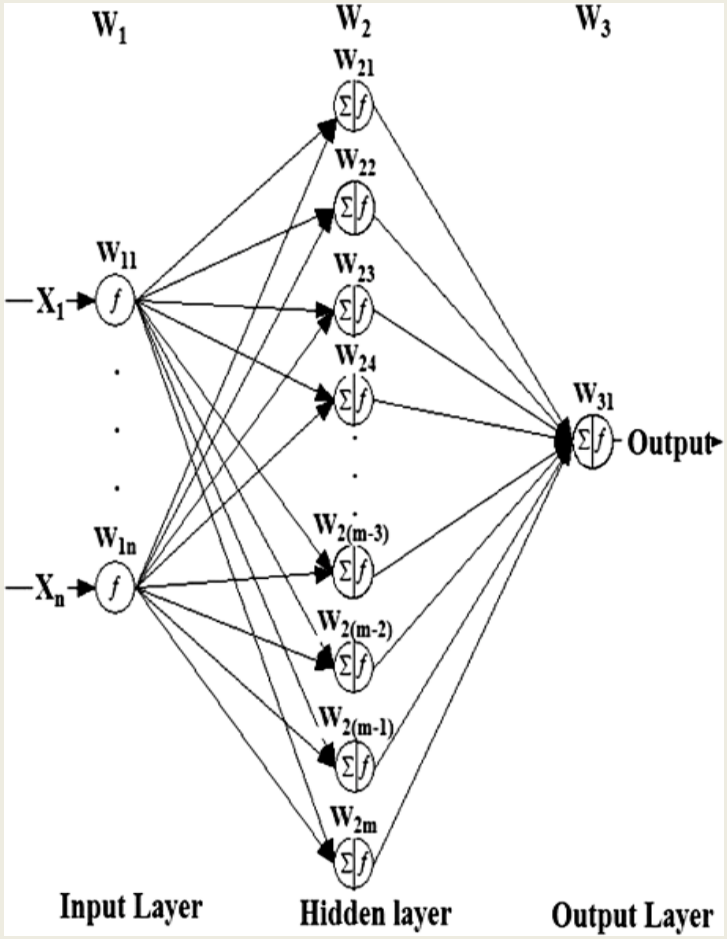
A	B	Out
0	0	0
0	1	1
1	0	1
1	1	0

http://hyperphysics.phy-astr.gsu.edu/hbase/electronic/ietron/xor.gif

Minsky & Papert

https://constructingkids.files.wordpress.com/2013/05/minsky-papert-71-csolomon-x640.jpg

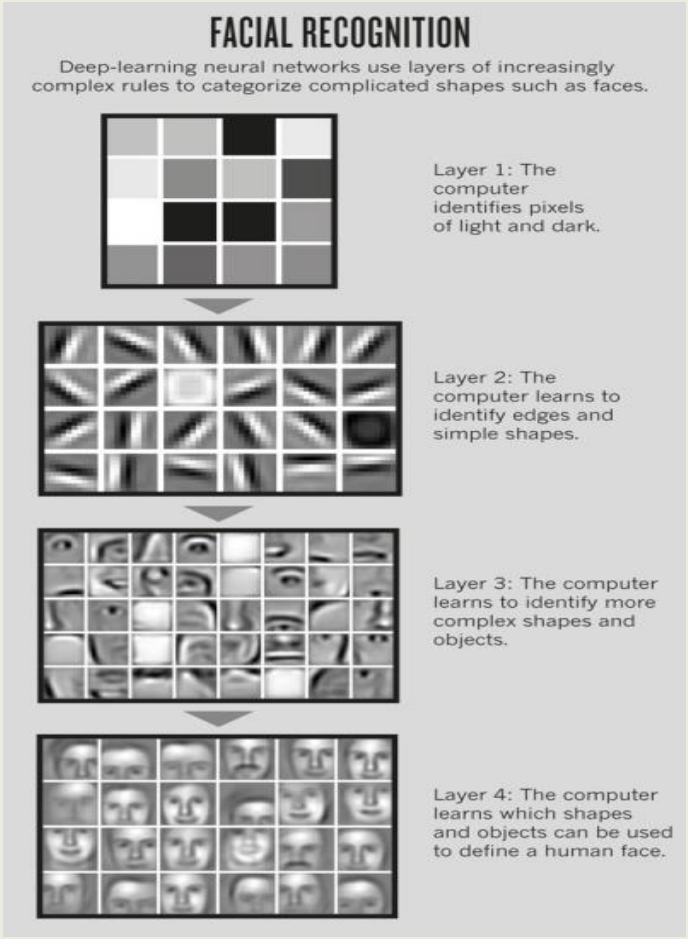
1986 and 2007: Multilayer Neural Nets



Backpropagation

1986 Rumelhart

(1963 Bryson, 1974 Werbos)



Deep Learning

2007 Hinton

(1989 LeCun, 1992 Schmidhuber)

http://opticalengineering.spiedigitallibrary.org/article.aspx?articleid=1714547

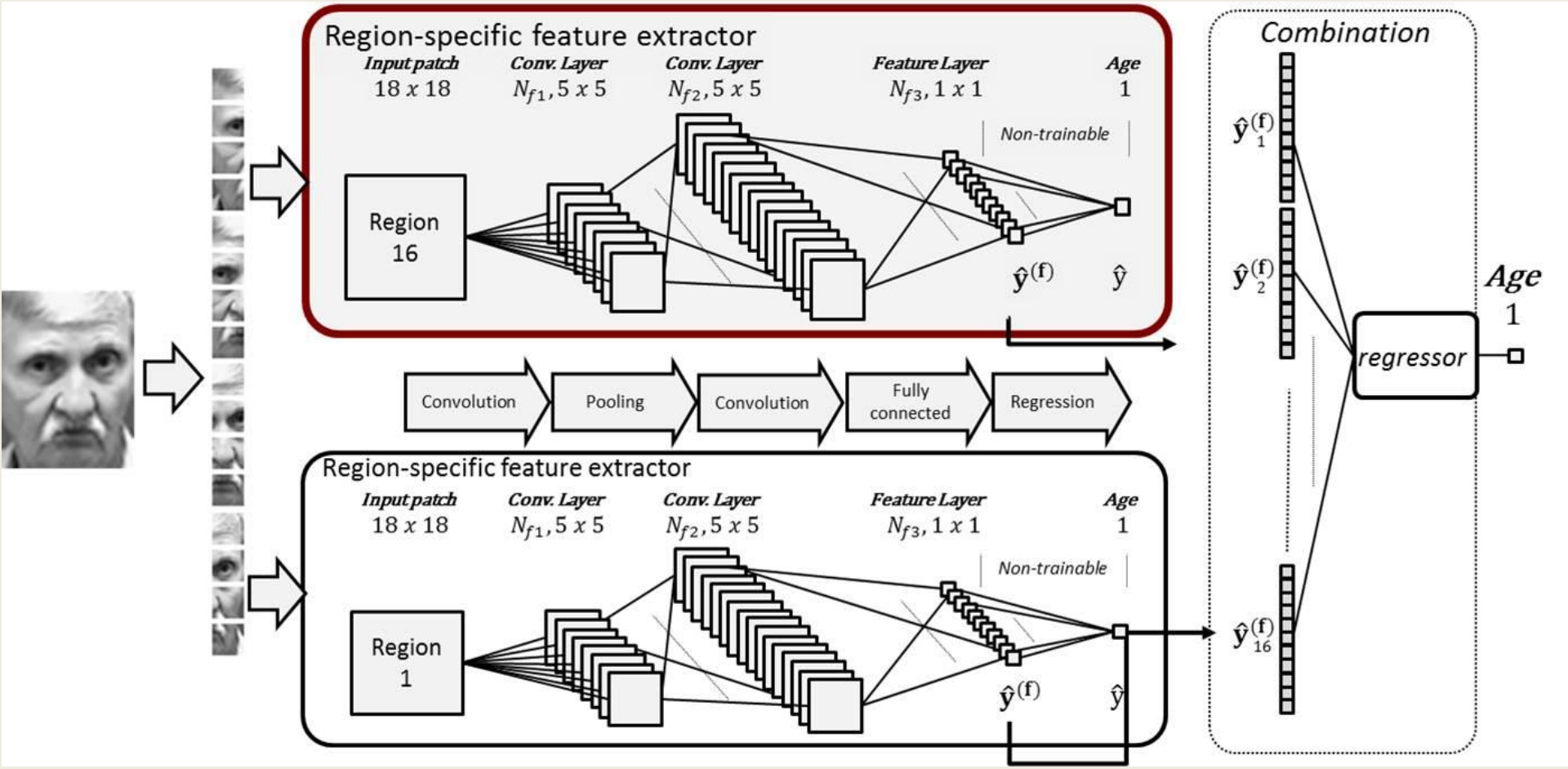
http://www.nature.com/polopoly_fs/7.14689.1389093731!/image/deep-learning-graphic.jpg_gen/derivatives/landscape_400/deep-learning-graphic.jpg

Deep Learning Successes

- 2009 Speech Recognition TIMIT: Cortana, Skype, Google Now, Siri, Baidu, Nuance, etc.
- 2012 Image Recognition ImageNet
- 2012 Drug Discovery Merck Challenge
- 2013 Natural Language Sentiment
- 2014 Image Captioning
- 2014 Natural Language Translation
- 2015 Atari Video Games DeepMind

https://en.wikipedia.org/wiki/Deep_learning

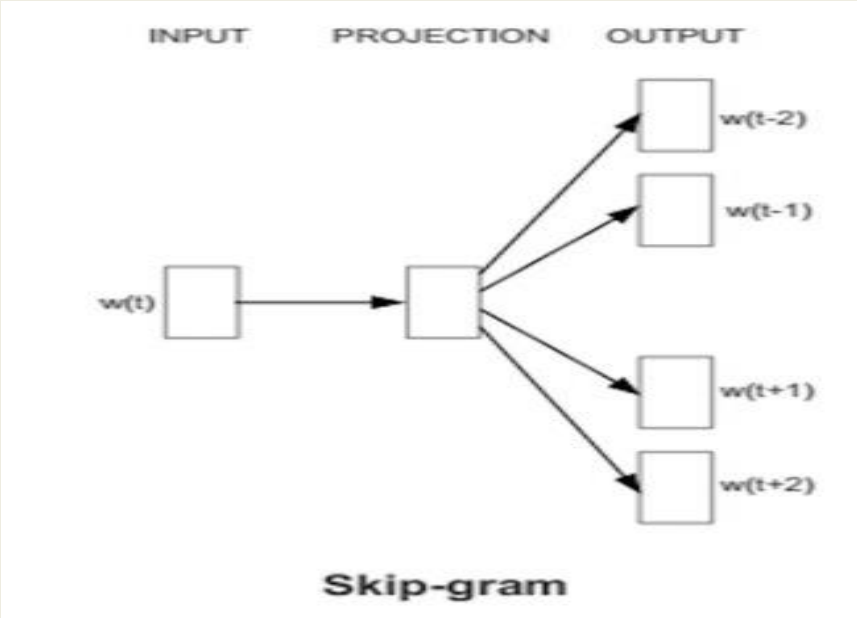
Feedforward Networks



http://www.nicta.com.au/content/uploads/2015/02/deep.jpg

2013: The Algebra of Meaning

King – Man + Woman = Queen



Mikolov's Word2Vec

http://deeplearning4j.org/word2vec.html

Paris – France + Italy = Rome

https://code.google.com/p/word2vec/

Obama – USA + Russia = Putin

http://byterot.blogspot.com/2015/06/five-crazy-abstractions-my-deep-learning-word2doc-model-just-did-NLP-gensim.html

Picasso – Einstein + Scientist = Painter

http://arxiv.org/pdf/1301.3781.pdf

Forearm – Leg + Knee = Elbow

http://deeplearning4j.org/word2vec.html

2015: Face Recognition

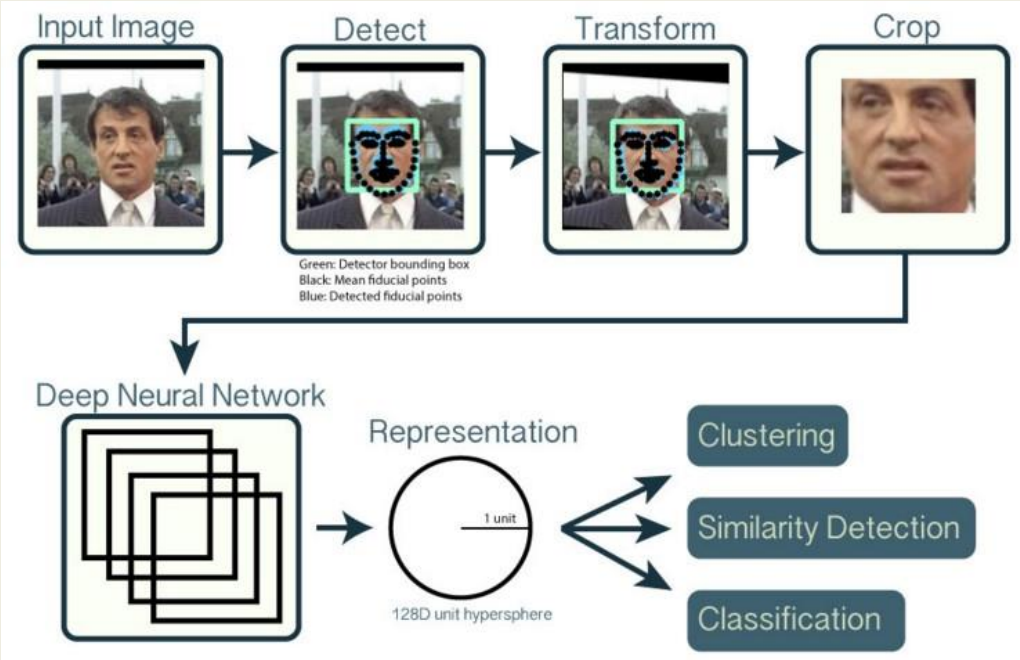
June: Google FaceNet

http://arxiv.org/abs/1503.03832

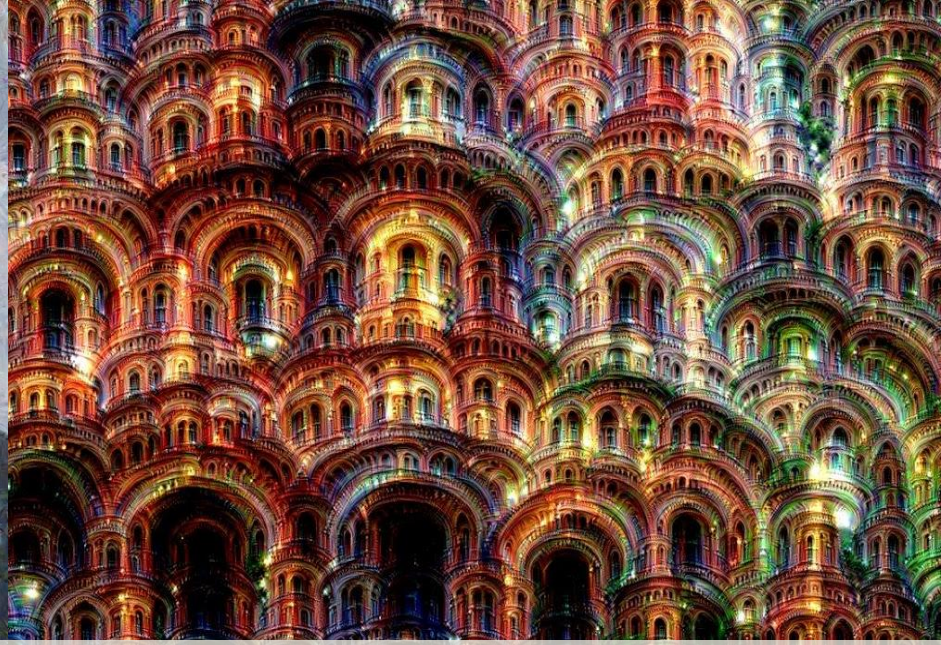
Record accuracy 99.63% on Labeled Faces in the Wild dataset
Cuts best previous error rate by 30%
22 layer feedforward net, 140M weights, 1.6 GFLOP/image, conv/pool/norm
Trained on triples pushing same faces together, different apart

Oct.: CMU OpenFace

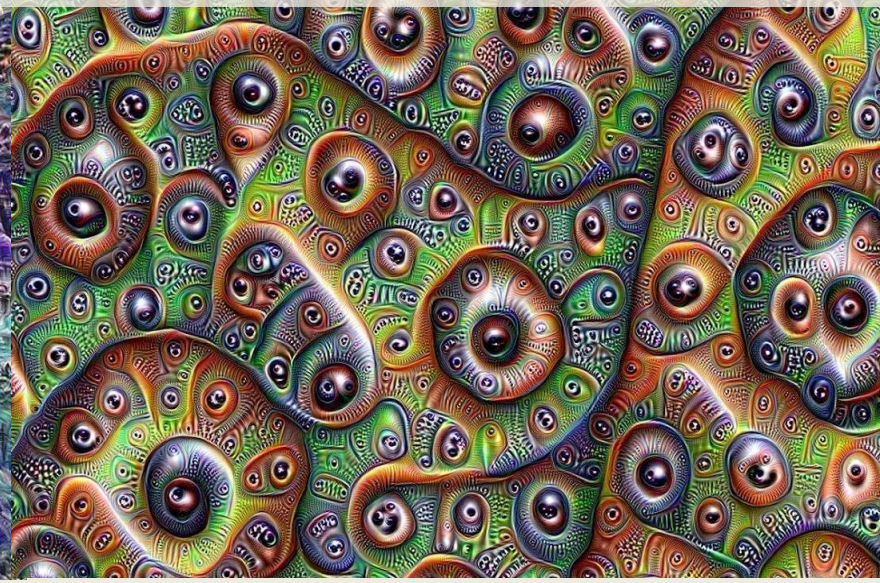
Open Source version of FaceNet
84.83% accuracy, <.1 training faces



https://github.com/cmusatyalab/openface



June 2015: Google Deep Dream



http://googleresearch.blogspot.com/2015/06/inceptionism-going-deeper-into-neural.html

Nov. 2015: Synthetic Bedrooms

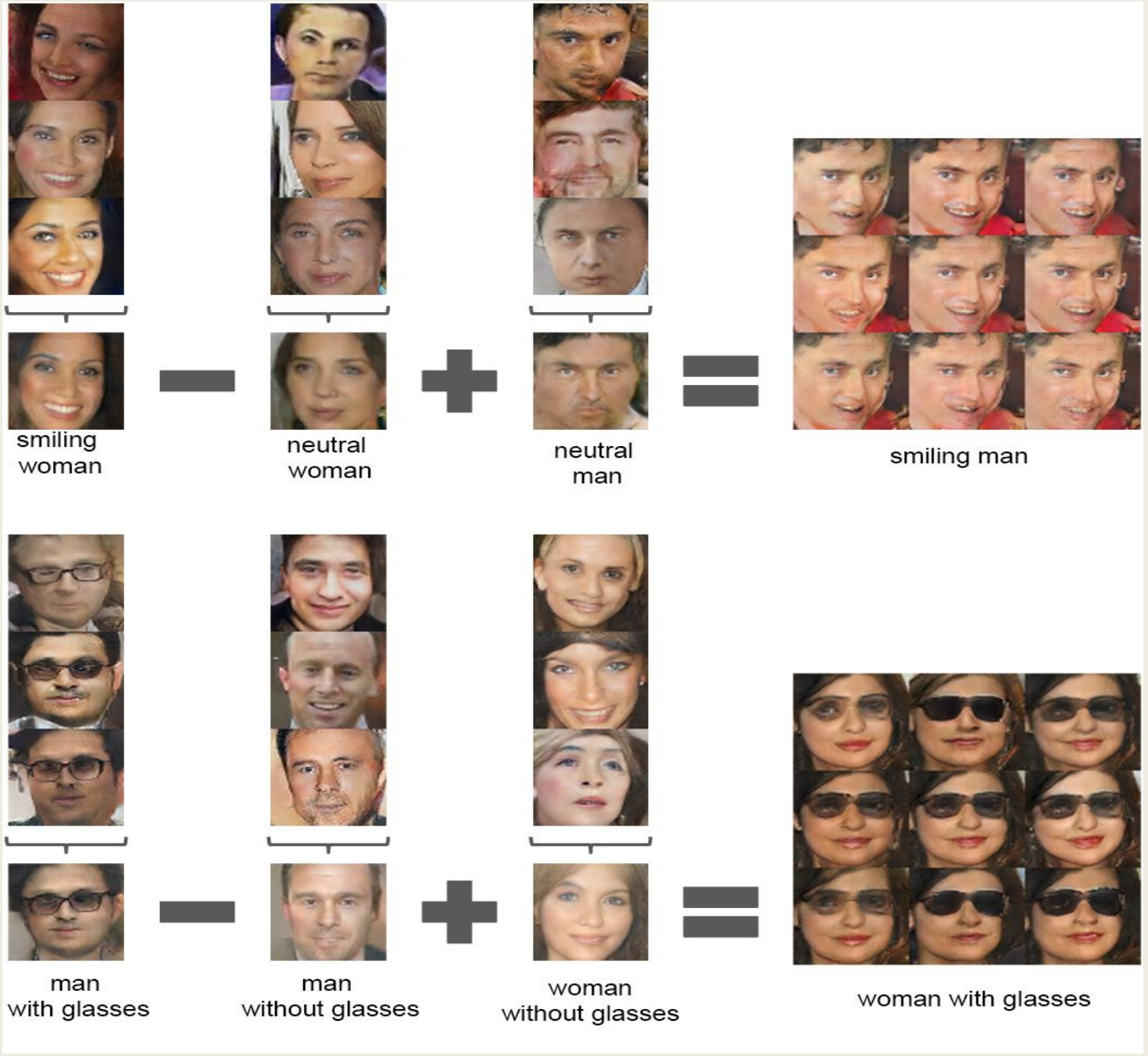
Unsupervised Representation Learning with Deep Convolutional Generative Adversarial Networks

Alec Radford, Luke Metz, Soumith Chintala

(Submitted on 19 Nov 2015)

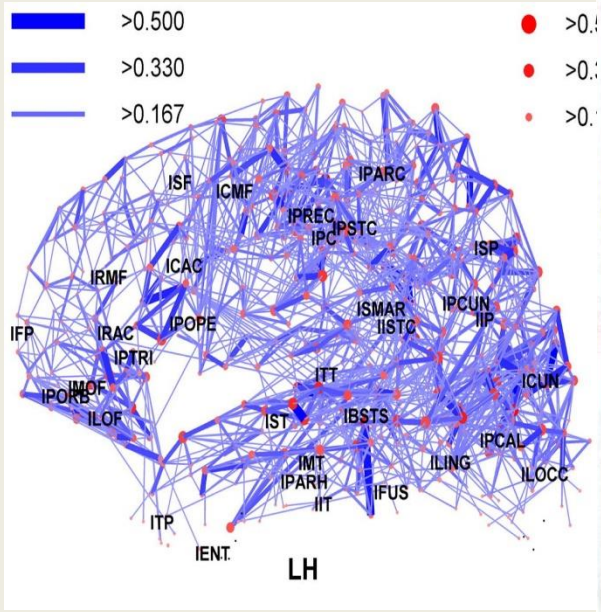
https://github.com/Newmu/dcgan_code/tree/gh-pages

Nov. 2015: Synthetic Record Albums

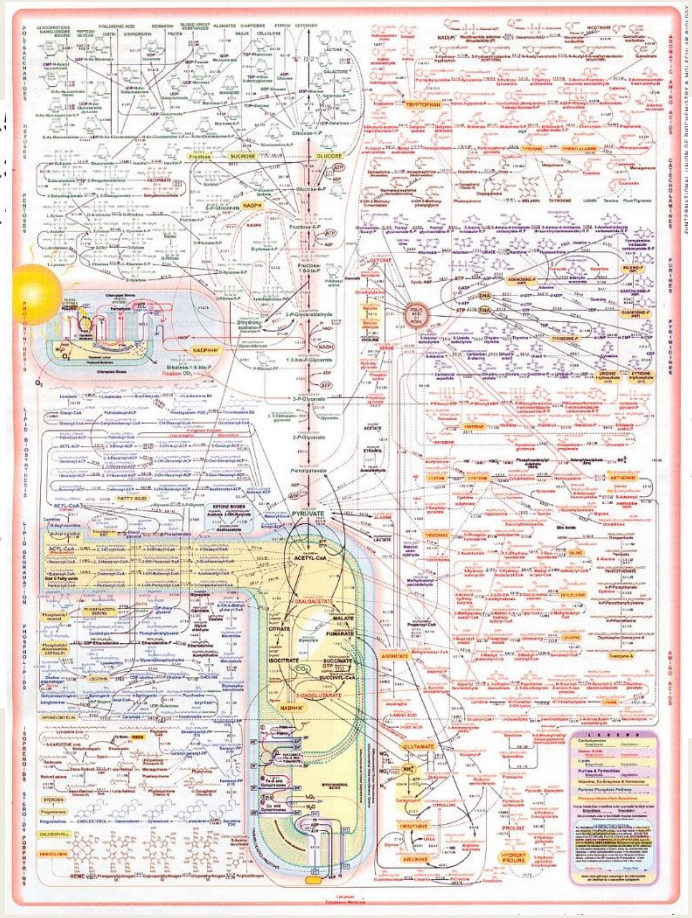


https://github.com/Newmu/dcgan_code/tree/gh-pages

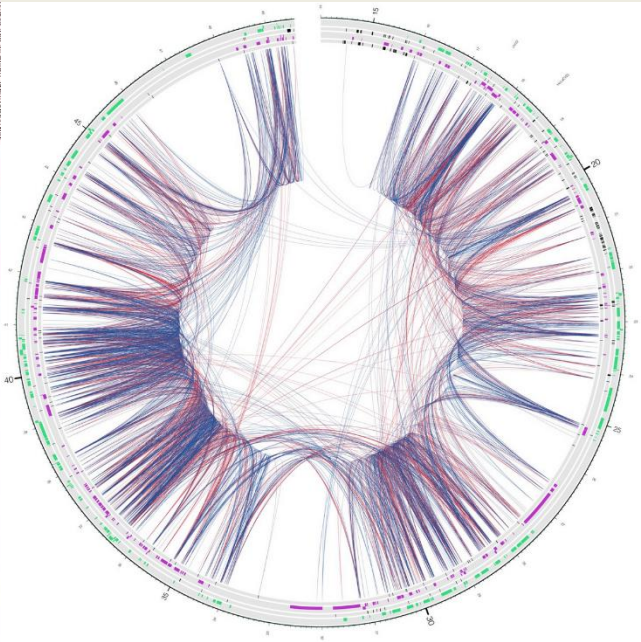
Biological Networks Have Loops



Brain Connectome



Human Metabolome



Gene network
Chromosome 22

https://en.wikipedia.org/wiki/Hub_(network_science_concept)

https://41.media.tumblr.com/tumblr_m5l6rzlqwc1r1171mo1_1280.jpg

http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0028213#pone-0028213-g010

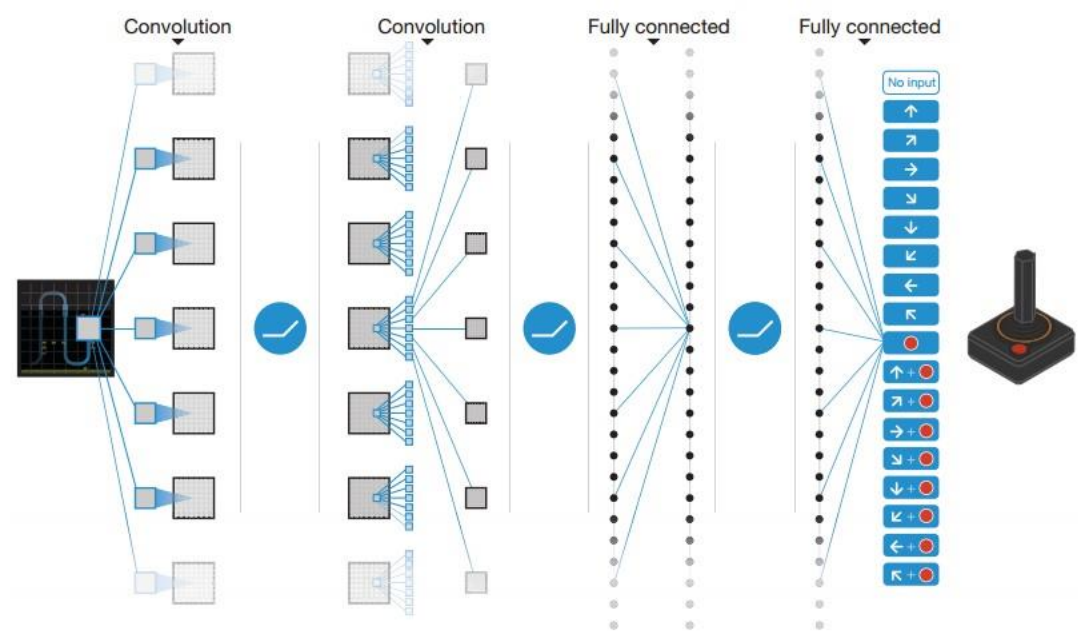
Nov. 2015: NeuralTalk and Walk Demo

https://vimeo.com/146492001

2015: DeepMind Deep-Q Networks

http://www.nature.com/nature/journal/v518/n7540/full/nature14236.html

Feb.: 49 Atari Games
Beat previous Ais
Beat humans on half



May: 100's of games

https://www.youtube.com/watch?v=08Cl7ii6viY&feature=youtu.be&t=15m31s

May: 3D games
TORCS racing
Beat Ais from pixels

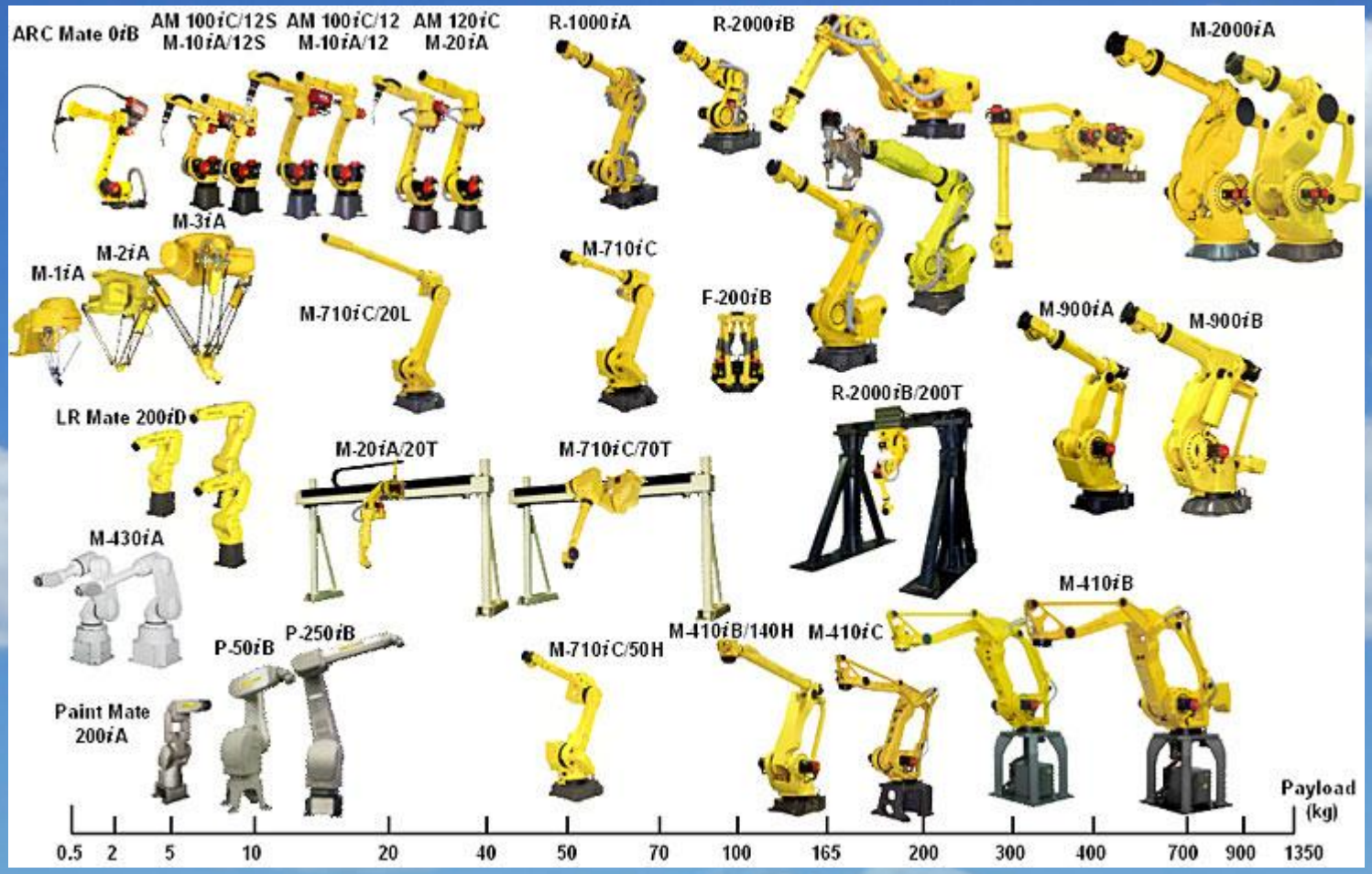
http://mint-tek.com/wp-content/uploads/2015/08/commercialdronesforhire.jpg

Nov. 2015: Kespry and Nvidia Deep Learning for Drones

Drones: $98 Billion by 2025

http://www.businessinsider.com/the-market-for-commercial-drones-2014-2
http://www.flybestdrones.com/best-5-drones-with-camera-under-50-dollars/

Dec. 2015: Fanuc Deep Learning Robots



Deep Learning to Bin Pick in 8 hours

http://australianroboticsreview.com/wp-content/uploads/2015/08/Fanuc.jpg

http://www.bloomberg.com/news/articles/2015-12-03/zero-to-expert-in-eight-hours-these-robots-can-learn-for-themselves

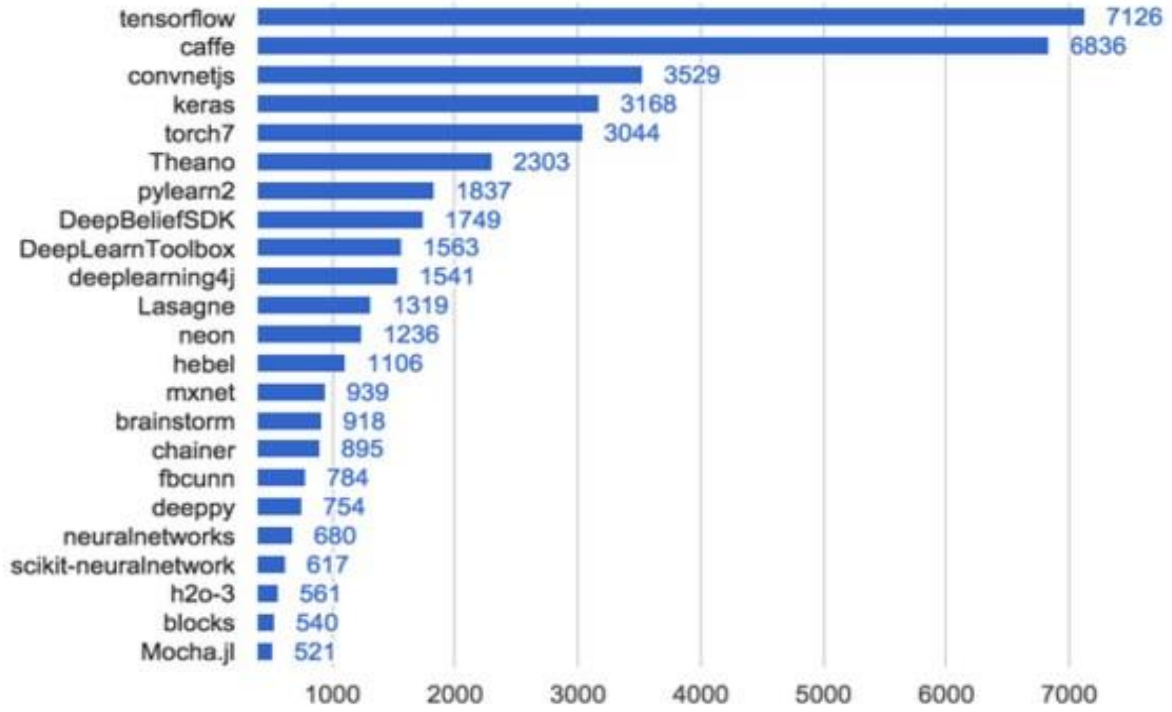
Open Source Toolkits

Kyle McDonald
@kcimc

Follow

https://twitter.com/kcimc/status/664217437840257024/photo/1?ref_src=twsrc%5Etfw

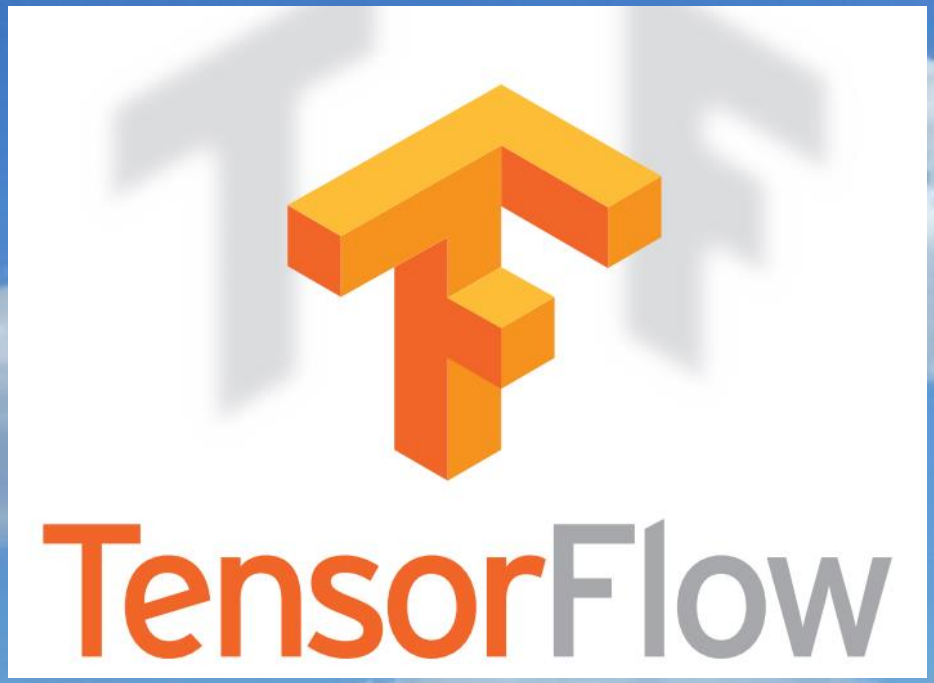
2010-2014: a new deep learning toolkit is released every 47 days. 2015: every 22 days. tensorflow & caffe top github

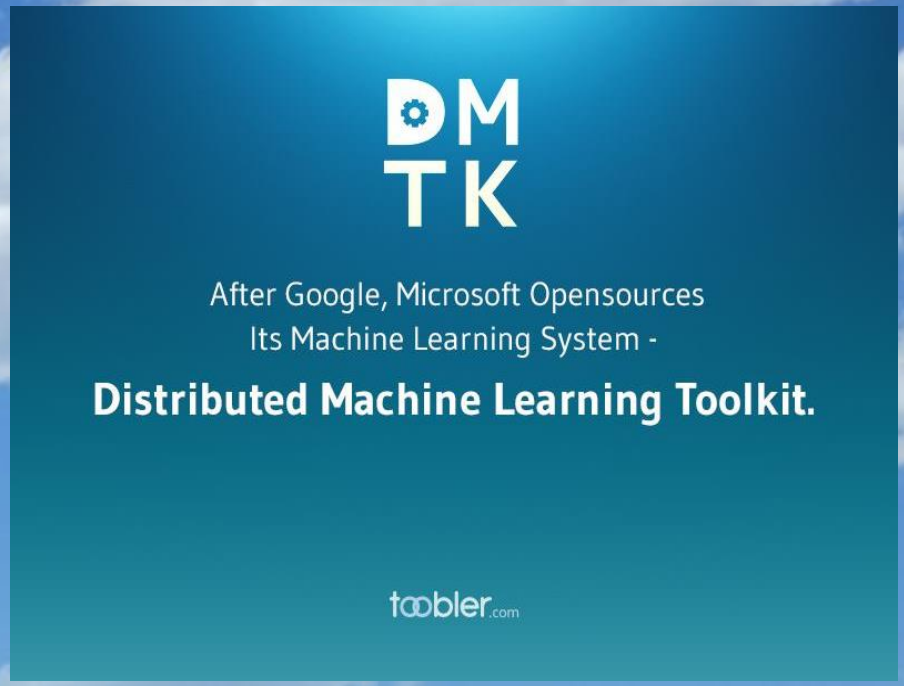


RETWEETS 150 LIKES 153

3:05 PM - 10 Nov 2015

Google and Microsoft Open Source Toolkits





https://googleblog.blogspot.com/2015/11/tensorflow-smarter-machine-learning-for.html

https://www.linkedin.com/company/toobler

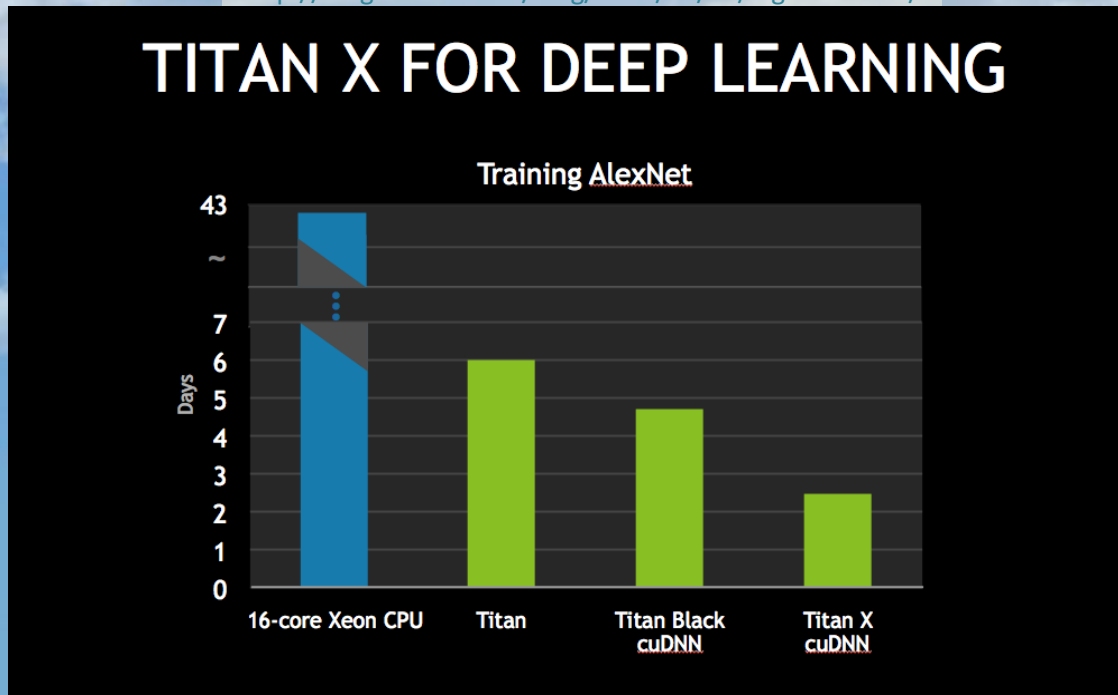
Deep Learning Hardware

NVIDIA GPUs
AMD GPUs
FPGAs

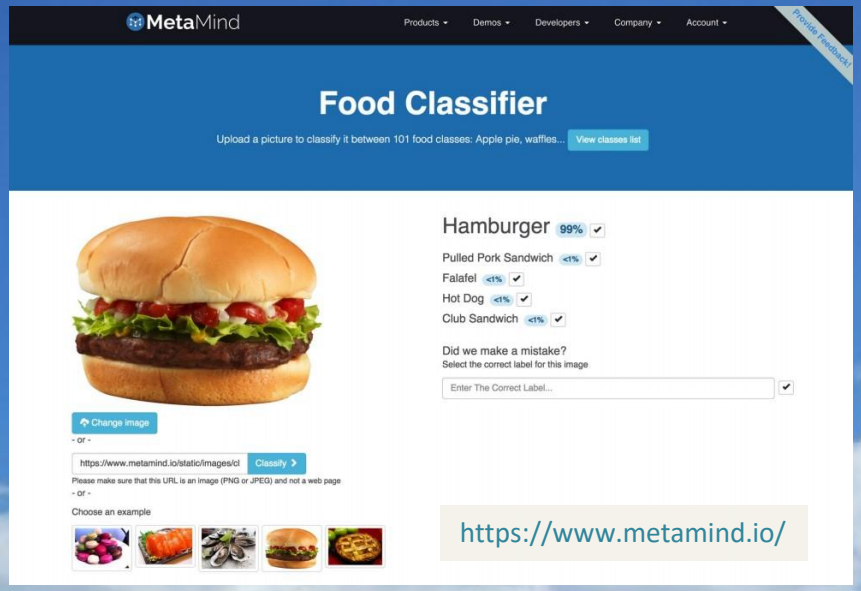
Intel ConvNet core
Movidius: embedded
Mobileye: automotive
Orcam: low power vision
Qualcomm: mobile
Samsung: mobile
Teradeep: startup
Nervana: startup

http://timdettmers.com/wp-content/uploads/2014/08/gpu-pic.jpg

http://blogs.nvidia.com/blog/2015/03/17/digits-devbox/



Cloud: MetaMind, Google, Microsoft, Amazon



https://www.metamind.io/

http://www.slideshare.net/Azure4Research/azure-ml-webinarjuly2014

http://www.pyimagesearch.com/2014/10/13/deep-learning-amazon-ec2-gpu-python-nolearn/

http://googlecloudplatform.blogspot.com/2015/12/Google-Cloud-Vision-API-changes-the-way-applications-understand-images.html

The Future Looks Bright!

- $50 trillion of value
- Hundreds of startups
- Billions of investment
- Rapid performance improvement
- Free and cheap software
- Rapidly improving hardware
- Many innovative applications
- Opportunity to improve the world