Machine Learning

Lec 1: Intro

Prof. Da-Cheng Juan

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  - Prof. Chang, Prof. Chou, Prof. Lai, Prof. Hsu.
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- Google Research

Agenda

- Logistics
- ML in Real Life
- ML Markets
- ML Jobs
- Machine Learning concepts
- Q & A

About Me

Current Positions:

- Eng @ Google Research
- Lead AI Instructor @ BitTiger
- Prof. @ National Tsing Hua University

Experience:

- PhD Fellow @ Intel Labs
- PhD @ Carnegie Mellon University
- RA @ Stats, Academia Sinica
- Alumnus @ NTHU CS’05, ‘07

Logistics: ml.syllabus.dacheng.info

- Prerequisite
- Textbook
- Grading
- Lecture schedule

Logistics: Prerequisite

- Prerequisite
  - Linear algebra
  - Mathematical statistics and probability
  - Calculus
  - Algorithms
  - Programing language: Python
  - Optional: operating system: Linux and basic shell scripts.
  - Optional: experience in using Latex

Logistics: Textbooks

- Textbook
  - **Deep Learning, by Ian Goodfellow (link)**
  - Pattern Recognition and Machine Learning, by Christopher Bishop (link)
  - All of Statistics, by Larry Wasserman (link)
  - Lecture notes

Logistics: Grading

- Grading
  - 5%: Paper presentation
  - 25%: Taking lecture notes with Latex
    - Ref: https://www.slideshare.net/jbhuang/research-101-paper-writing-with-latex
    - Example: note
  - 25%: Homeworks or pop quizzes
    - HWs need to be done in ipynb files, and uploaded to GitHub.
  - 45%: Semester-long projects
    - 4 milestones

If a student fails to attend the class twice (2 times) without proper notice in advance, he/she automatically fails this course. No exception.

Logistics: Project

- Goal:
  - Gain hands-on experience in applying machine learning on real-world problems.
  - Add solid, reputable achievements to students' resume, by checking in codes to GitHub (link) or Codalab (link), and submitting reports to ArXiv (link).
- Data sources:
  - Kaggle (link)
  - Other sources: ImageNet (link), Stanford Q&A (link)
- Default:
  - **Devise http://papers.nips.cc/paper/5204-devise-a-deep-visual-semantic-embedding-model.pdf**

Logistics: Project (cont'd)

- 4+1 milestones
  - Milestone 0
    - Teamup: 2 ppl in a team
    - Setup your GitHub repo & working environment
  - Milestone 1
    - Read paper & project proposal
  - Milestone 2
    - Implement baseline (Devise)
  - Milestone 3
    - Improve the baseline
  - Milestone 4
    - Report write-up

Logistics: ml.syllabus.dacheng.info

- Lecture schedule

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- Lecture schedule

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What is Machine Learning?

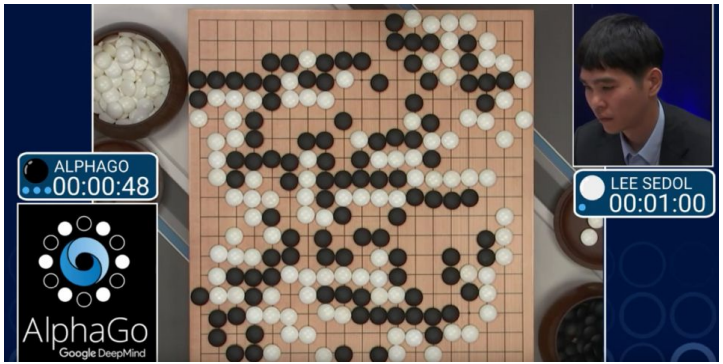
Machine Learning in Movies

Machine Learning in Real Life

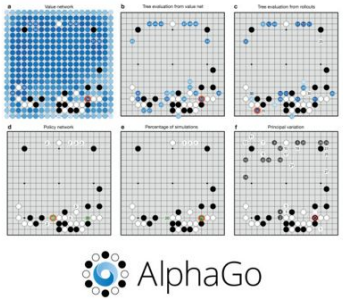
- Apple Siri
- Amazon Echo (Alexa)
- Tesla Autopilot
- Google AlphaGo
- Baidu 小度
- etc.

AlphaGo

- Google DeepMind AlphaGo

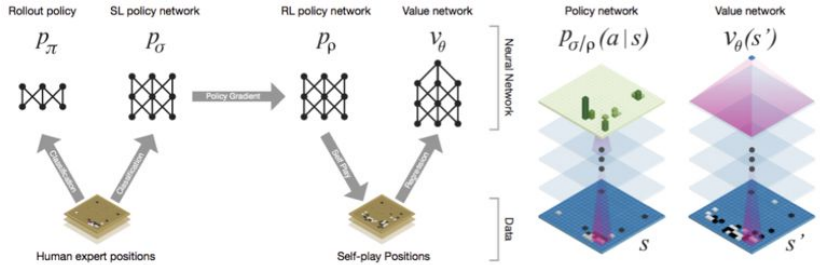


Silver, David, et al. "Mastering the game of Go with deep neural networks and tree search." *Nature* 529.7587 (2016): 484-489.

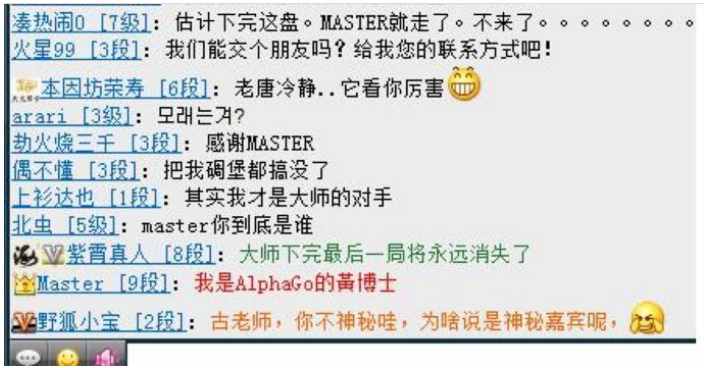


AlphaGo (cont'd)

- Google DeepMind AlphaGo

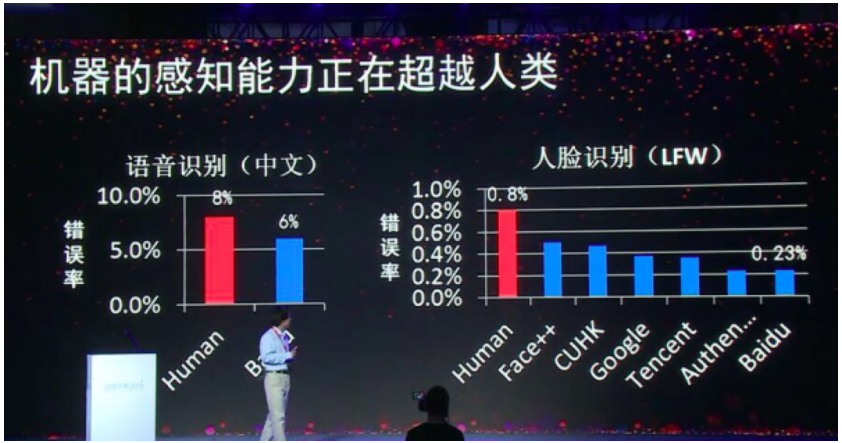


The value network can be viewed as a computer vision problem, it is a supervised learning where the input is 19x19 image.



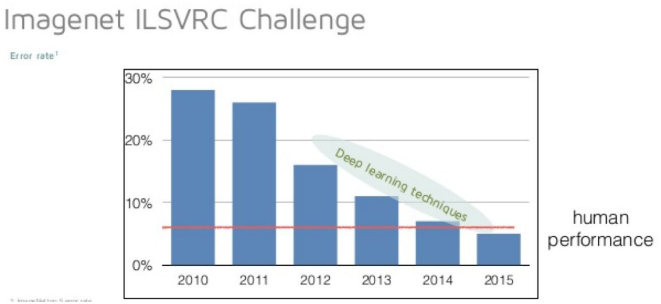
Machine Learning: “Superhuman”

- Face recognition, audio recognition, etc.



Machine Learning: “Superhuman”

- Image recognition



[Source: Szegedy et al., CVPR’15]

Machine Learning: Creativity

白鹭窥鱼立,	满怀风月一枝春,
Egrets stood, peeping fishes.	Budding branches are full of romance.
青山照水开.	未见梅花亦可人.
Water was still, reflecting mountains.	Plum blossoms are invisible but adorable.
夜来风不动,	不为东风无此客,
The wind went down by nightfall,	With the east wind comes Spring.
明月见楼台.	世间何处是前身.
as the moon came up by the tower.	Where on earth do I come from?

[Source: Zhang et al., EMNLP'14]

TOEFL

- **TOEFL Listening Comprehension Test by Machine**
- Example:

  Audio Story: (The original story is 5 min long.)

  Question: “ What is a possible origin of Venus’ clouds? ”

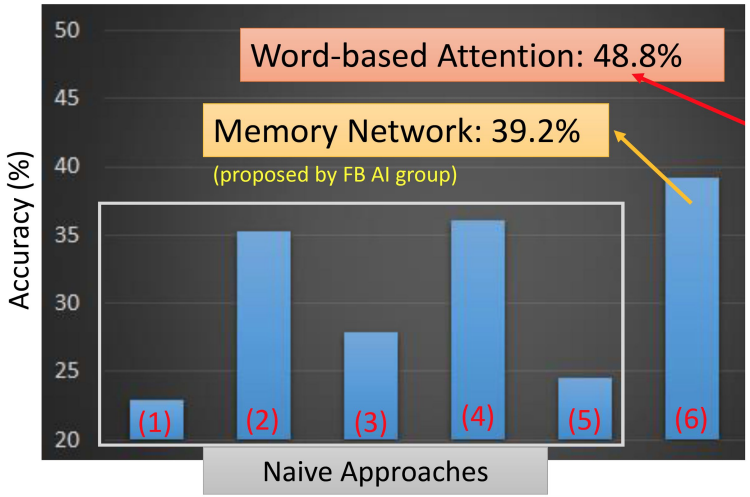
  Choices:

  (A) gases released as a result of volcanic activity

  (B) chemical reactions caused by high surface temperatures

  (C) bursts of radio energy from the plane's surface

  (D) strong winds that blow dust into the atmosphere



[Tseng & Lee, Interspeech16]
[Fang & Hsu & Lee, SLT 16]
[Hung-Yi Lee, http://www.slideshare.net/tw_dsconf/ss-62245351]

Agenda

- ML Markets
- ML Jobs
- Machine Learning concepts
- Q & A

Investment

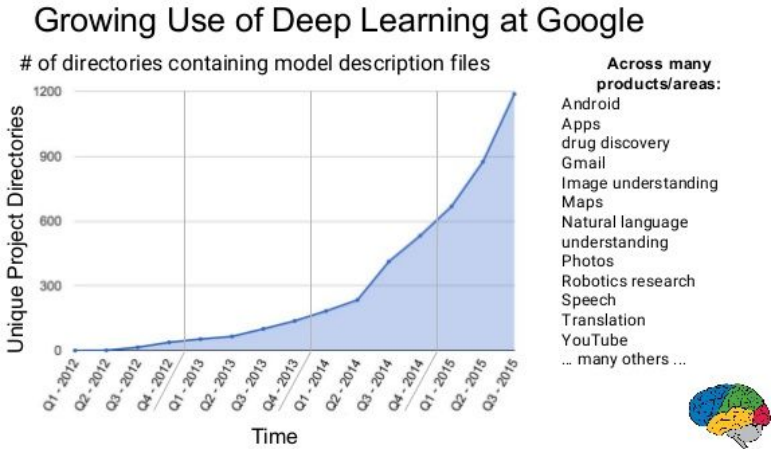
Artificial Intelligence: Most Active Corporate Investors

2011-2016YTD (as of 6/15/2016)

Investor	Rank	Select Investments
Intel Capital	1	DataRobot, prelert, lumiata, MAANA, incoming, saffron, PERFANT, EMOTIENT, Reflektion, Parallel Machines, MindMeld, smartzip, api.ai, indisys, COLDLIGHT
Google Ventures	2	BUILDING ROBOTICS, clarifai, KENSHO, FRAMED, ZEPHYR HEALTH, Unbabel, tamr, MindMeld, Orbital Insight, Predilytics
GE Ventures	3	SIGHT MACHINE, ARTERYS, AYASDI, BITSTEW, MedAware, PingThings, stem, Predixion, MAANA
Samsung Ventures	4	vicarious, sentiance, MaluubA, iDiBON, jibo, MindMeld, AI AUTOMATED INSIGHTS
Bloomberg Beta	4	deep genomics, context relevant, AVISO, howdy., DOMINO, Orbital Insight, DigitalGenius, DIFFBOT
FundersClub	6	SIGHT MACHINE, analyticsMD, CLOUDMEDX, hoBagel, Unbabel, rainforest
In-Q-Tel	6	MindMeld, CYLANCE, celect, INTERSET, Digital Reasoning, DOMINO
Tencent	8	DIFFBOT, CLOUDMEDX, SI, SCALED INFERENCE, iCarbonX, skymind
Nokia Growth Partners	9	rocketfuel, WorkFusion, rapidminer, indix.
Microsoft Ventures	9	BUILDING ROBOTICS, NEURA, insidesales, CrowdFlower
Qualcomm Ventures	9	clarifai, Predilytics, Welltok, tempo
Salesforce Ventures	9	DigitalGenius, insidesales, 6sense
AXA Strategic Ventures	9	NEURA, BLUEBEATS, medlanes, pricemethod
New York Life Insurance Company	9	context relevant, DataRobot, Skycure, captricity

Trend

- Google
- Facebook
- Microsoft
- Apple
- Amazon
- $1B starting up OpenAI
- Toyota spent $1B starting up AI labs

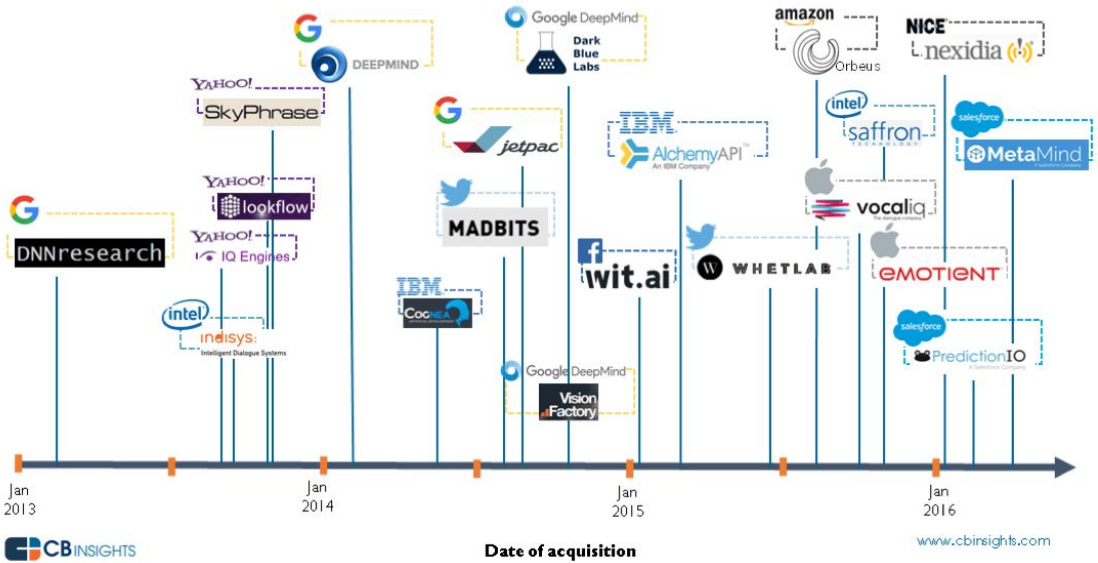


Source: Large-Scale Deep Learning for Building Intelligent Computer Systems," a Keynote Presentation from Google by Jeff Dean

Big Guys

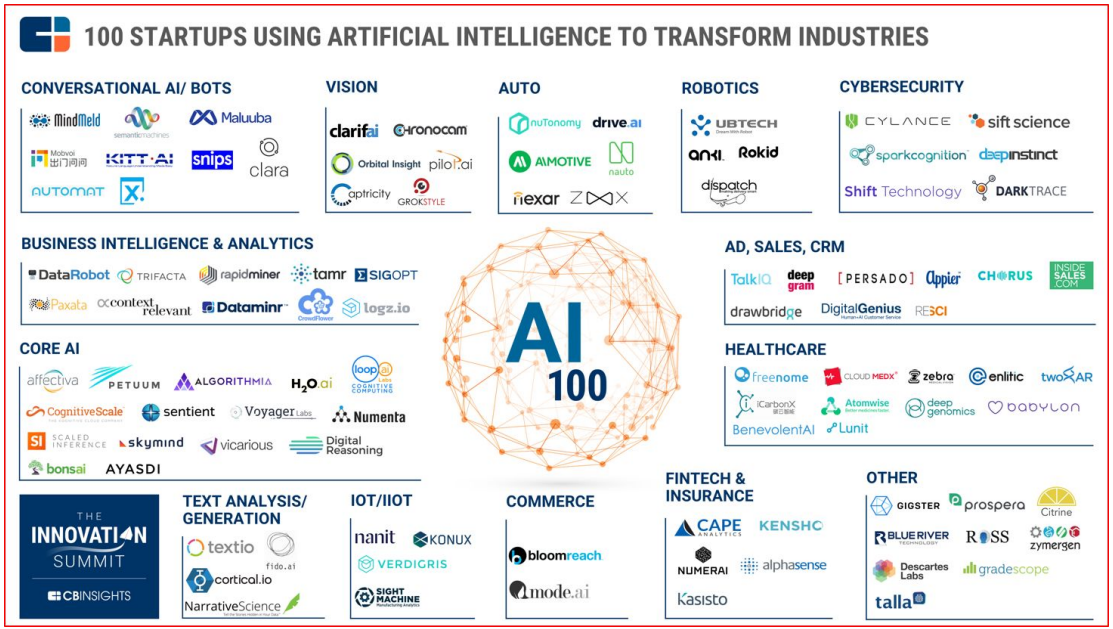
- Invest and Acquire

排名	企业	次数
1	Google	27
2	Apple	13
3	Microsoft	8
4	Salesforce	7
4	Yahoo!	7
6	Intel	6
7	Cisco	5
8	Amazon	4
8	IBM	4
8	Nokia	4
8	Nuance Communications	4



Startups

- The startups have raised **$3.8B** in aggregate funding across 263 deals since 2012



Market in China

- 200-250 startups (up to 2016)

投资机构（成立时间）	人工智能领域主要投资公司（参与投资轮次）	主要关键词
IDG资本 (1992年)	SenseTime（B）；Rokid（B）；科沃斯（A）；智齿科技（A）；极验验证（B）；柔宇科技（C）；小源科技（B）；Yogo（Pre-A）；傅利叶智能（Pre-A）；Zoox（A）；OpenCV.ai（天使轮）	计算机视觉；深度学习；人脸识别；家庭服务；机器人等
北极光创投 (2015年)	Drive.AI(A)；图普科技(A)；进化动力(A)；Savioke(A)；Meta(B)；佳顺智能(A)；数字绿土(B)；镭神(A)；禾川(A)；Atman；智航；	自动驾驶；图像识别；计算机视觉；机器人；激光雷达；无人机等
红杉资本中国基金 (2005年9月)	出门问问；依图；格灵深瞳；DJI大疆创新；Ninebot；第四范式；地平线机器人；华米；极验验证；EverString；学群自动化；汇纳科技；神策数据；明略数据；恒安嘉新；百融金服；助理来也；	语音识别；计算机视觉；深度学习；无人机等
联想之星 (2008年)	微纳芯(A)；中科虹霸（Pre-A）；旷视科技（天使轮）；思必驰（天使轮）；好买衣（天使轮）；快收银（Pre-A）；燃石医学（Pre-A）；学吧教育（天使轮）；丁盯（天使轮）；作业盒子（天使轮）；	虹膜技术；人脸识别；图像识别；语音识别等
明势资本 (2014年7月)	车和家（天使、Pre-A）；造数科技（Pre-A）；大耳马科技（Pre-A）；知觉科技（Pre-A）；中科视拓（Pre-A）；易航智能（Pre-A）；神策数据（Pre-A）；澎峰科技（Pre-A）；企名片（Pre-A）；	自动驾驶；视觉识别；传感器；大数据分析等
真格基金 (2011年)	依图；格灵深瞳；助理来也；出门问问；异构智能；渡鸦科技；奇弩科技；库范；驭势科技；云天励飞；零零无限科技；孤光无人机；杉数科技；万维思源	计算机视觉；深度学习；智能机器人；自动驾驶；无人机；大数据等
纪源资本GGV Capital (200年)	Vincross（A）；亿航（A）；小牛电动（A）；智米（B）；Zepp（B）；Operator（B）；英语流利说（A）；作业帮（B）；petkit（Pre A(Lead)；misfit手环（B）；	机器人；大数据分析；AI算法；可穿戴设备；电动车等
顺为资本 (2011年11月)	飞米；owlreality；Darma	无人机；医疗大数据；
创新工场 (2009年9月)	旷视科技；驭势科技；第四范式；地平线机器人	深度学习；计算机视觉；自动驾驶等；
英诺天使 (2013年4月)	宙心科技（天使轮）；异视科技（天使轮）；推想科技（天使轮）；信车信息科技（天使轮）；图正信息科技（天使轮）；异构智能Novumind（天使轮）；微孚智能科技（天使轮）	无人机；深度学习；机器人；指纹识别芯片；机器人芯片等

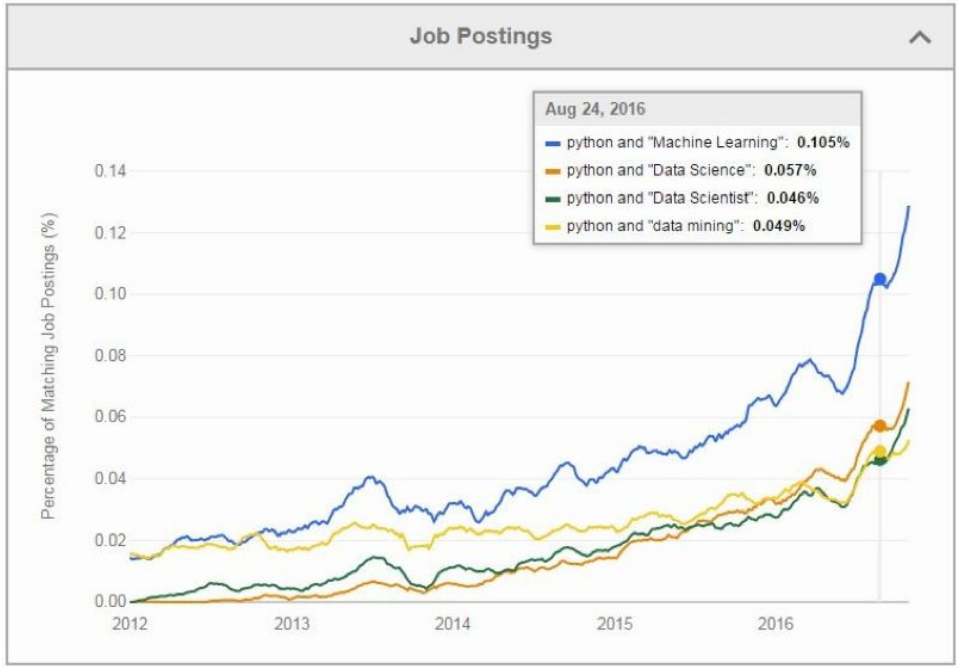
Agenda

- ML Jobs
- Machine Learning concepts
- Q & A

Jobs

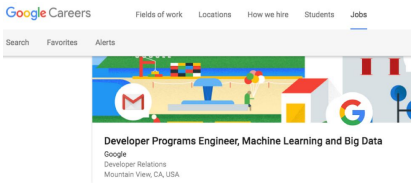
- Applications
  - ML + specific domains (self-driving, audio recognition)
- Model/Technology
  - Deep learning, open-source acquisition
- Infrastructure
  - Parallel computing, GPUs, etc

Positions


Job Postings
Aug 24, 2016
python and "Machine Learning": 0.105%
python and "Data Science": 0.057%
python and "Data Scientist": 0.046%
python and "data mining": 0.049%
Percentage of Matching Job Postings (%)
0.14
0.12
0.10
0.08
0.06
0.04
0.02
0.00
2012
2013
2014
2015
2016

Software Engineers

- **Software Engineer**
  - BA/BS degree in Computer Science or related technical field, or equivalent practical experience.
  - 1 year of experience in software engineering, and **coding experience in Python.**
  - Experience working directly with third-party developers.
  - **Experience in Deep Learning.**
  - Preferred qualifications: MS/PhD degree in Computer Science or related technical field
  - 5 years of relevant work experience in software engineering.
  - Experience designing APIs
  - Experience as a contributor to an open source project. Contributor to communities such as GitHub and/or Stack Overflow.
  - Industry **experience in Deep Learning,** Caffe, Big Data in R, and/or Machine Learning.
  - Experience in Distributed Deep Neural Networks.

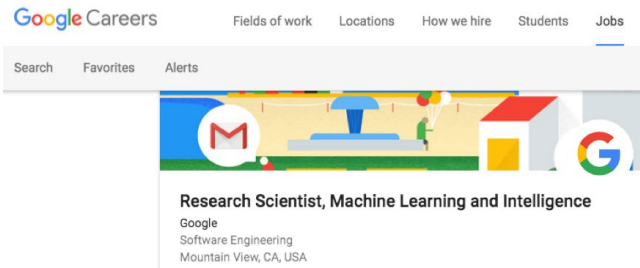


Applied Scientists

- **Applied Research Scientist**
  - Minimum Qualifications
  - 5+ years of experience.
  - C/C++ rapid programming in an expert level on linux os.
  - Experienced with **training deep neural networks**, prototyping in scripting languages like MATLAB, **python,** math performance libs (e.g. IPP, MKL), CPU optimization methods (e.g. assembly SIMD instructions)
  - Experience with developing on mobile/embedded platforms, e.g. Android NDK, armv7 NEON, is a plus.
  - PhD/MS with relevant experience in Computer Science with published projects in the fields of **machine learning, deep learning and/or computer vision.**

Research Scientists

- Research Scientist
  - Experience in Natural Language Understanding, **Computer Vision, Machine Learning**, Algorithmic Foundations of Optimization, Data Mining or Machine Intelligence (**Artificial Intelligence**)
  - Programming experience in one or more of the following: C, **C++, Python**
  - Contribution to research communities and/or efforts, including publishing papers at conferences such as NIPS, ICML, ACL, CVPR, etc.
  - Preferred qualifications: Relevant work experience, including full time industry experience or as a researcher in a lab
  - Strong publication record
  - Ability to design and execute on research agenda.



Summary for Jobs/Positions

- **Summary**
  - **Programming**
    - Python, C/C++, etc.
  - **Machine Learning**
    - machine learning (deep learning), computer vision, etc.
  - **Projects**
    - Machine learning / computer vision system
  - **IDE**
    - caffe/tensorflow libs, machine learning libraries, opencv library, etc.

Agenda

- Machine Learning concepts
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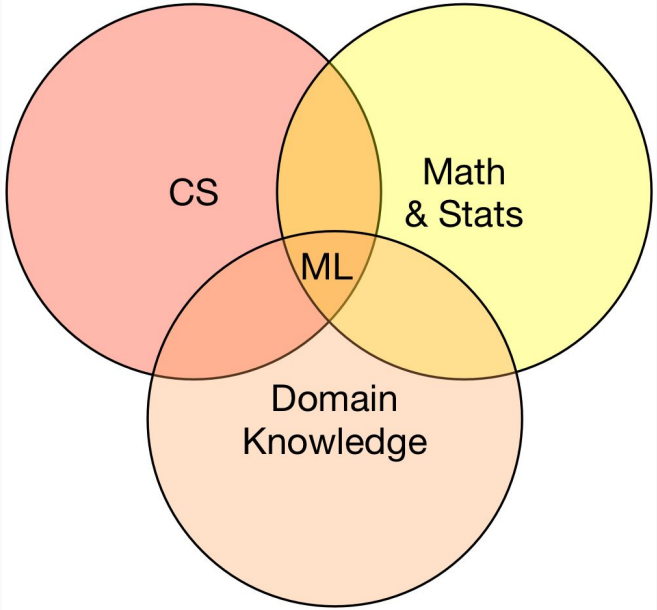
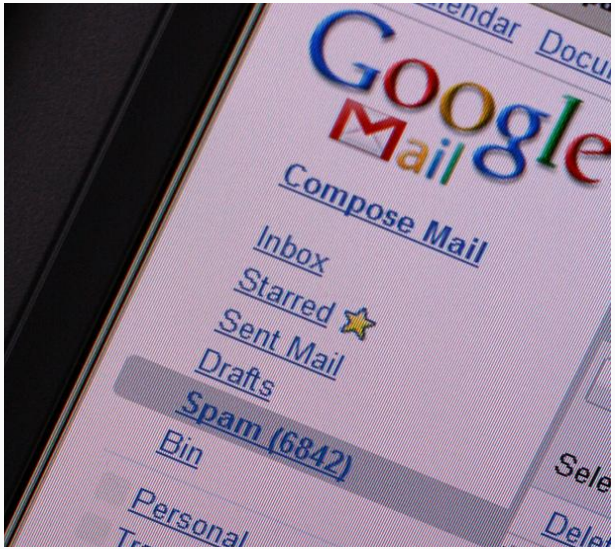
What is Machine Learning?

- “Extract information from data for making better decisions”
  - More examples later.
- Deep learning is a branch of machine learning.
  - Impactful and popular.



Spam Filter

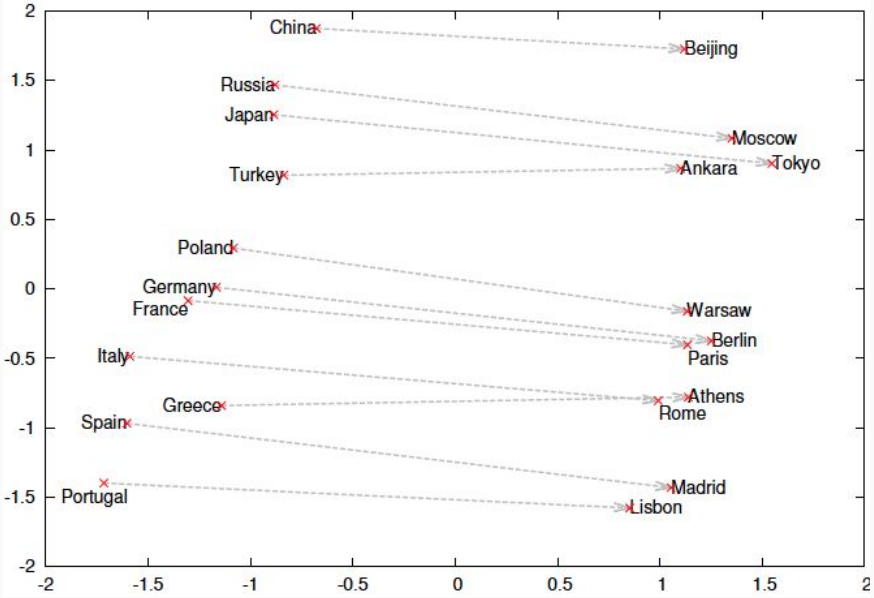
- Email spam filter
  - People use it every day.
- Seems not difficult?
  - Other machine learning models also perform well.



[Source: https://www.flickr.com/photos/comedynose/4236355151]

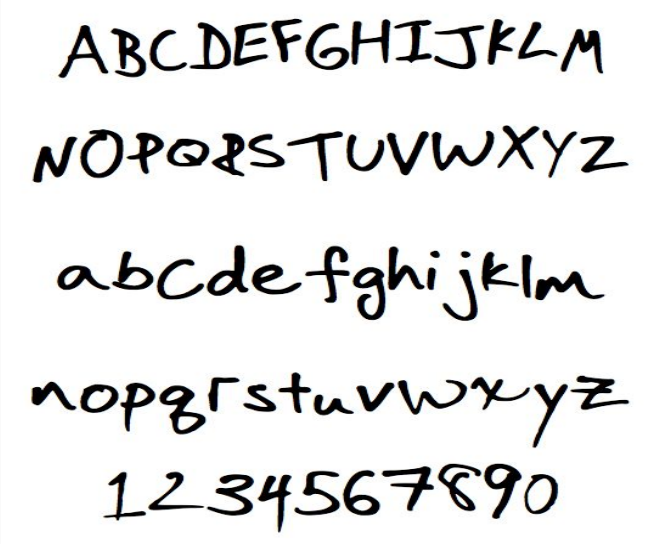
Semantic Understanding

- How about this one?
  - Tokyo - Japan + Russia = Moscow
  - Cool!
- Why do we care?
  - Machine understands texts!
  - Exclusive for deep learning
  - Idea of using “embedding”

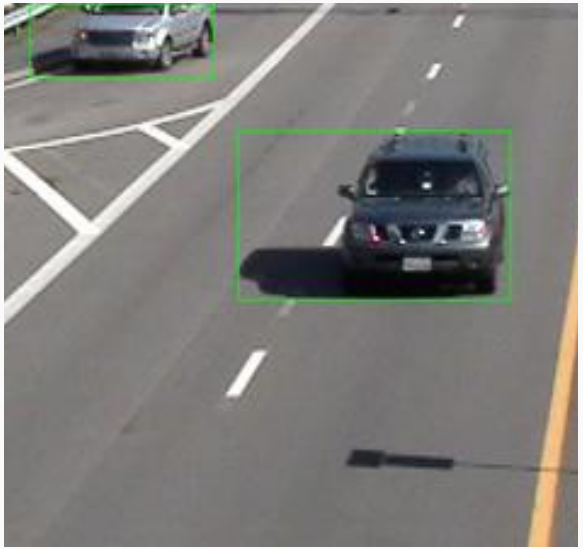


[Source: Mikolov et al, NIPS’13]

Object Detection



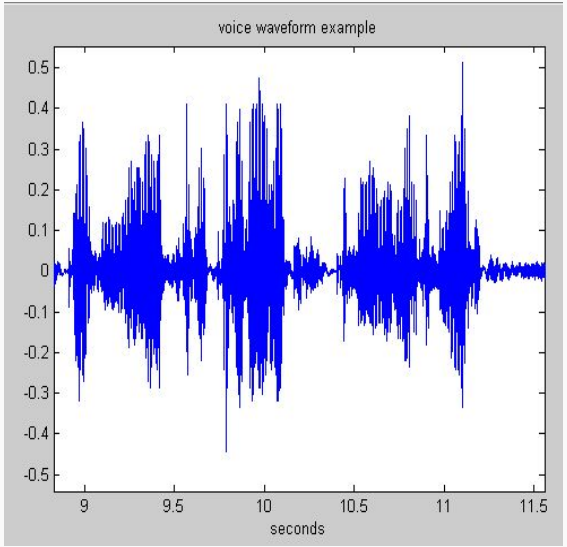
[Source: Jason Brennan, https://www.flickr.com/photos/jason_ff/4208758491]



[Source: https://www.mathworks.com/discovery/object-detection.html]

Speech Recognition

- Deep Learning improves the accuracy by double-digit percent
  - Sequence-to-sequence learning

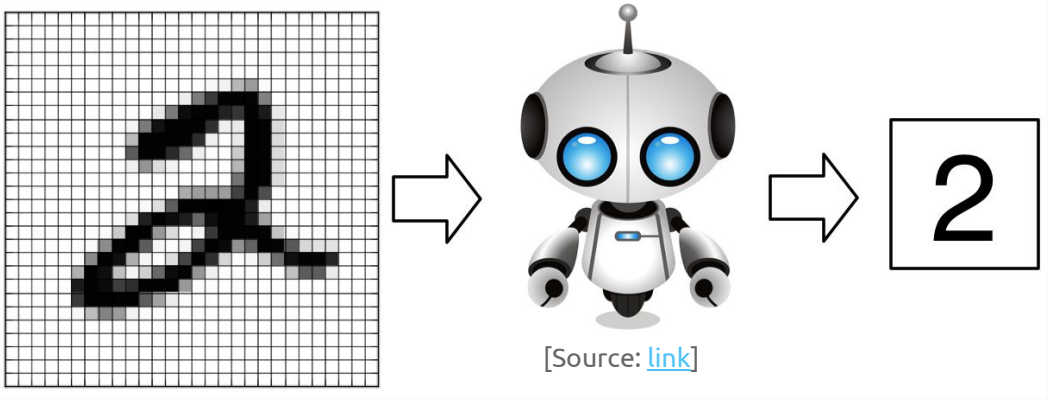


吃過了沒?

[Source: Maksim, https://commons.wikimedia.org/wiki/File:Voice_waveform_and_spectrum.png]

Magic Behind the Scene

- Supervised Learning
  - Mostly, also unsupervised learning. Wait, where is deep learning?



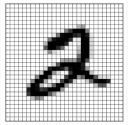
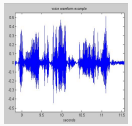
[Source: link]

Features
(referred as “**x**”)

Function
(Not a robot, yet)

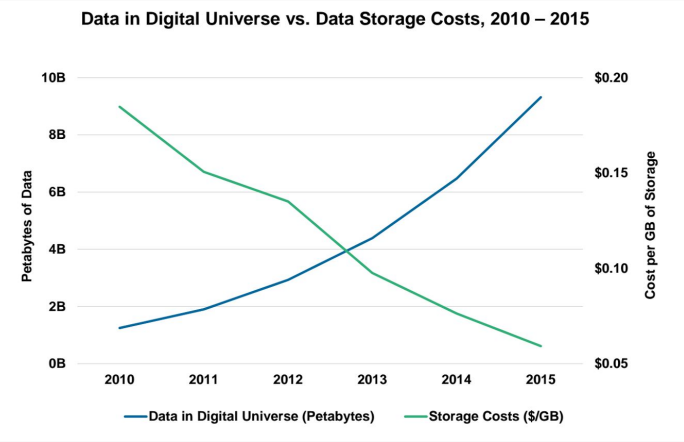
Labels
(referred as “y”)

Just a Function: Supervised Learning

- Handwriting recognition: *f* () = “2”
- Speech recognition: *f* () = “吃飽了沒?”
- Playing Go: *f* () = “4-5” (next move)
- How should we pick “*f*”?
  - **Deep Neural Nets** (sounds easy!)

Didn’t Work 40 Years Ago - Why Now?

- **More relevant data**



[Source: Meeker@ KPCB’16]

Method	LFW 10 fold Accuracy	# of Networks	Size of Training Data
DeepFace [CVPR2014]	97.35%	3	4 Million
DeepID [CVPR2014]	97.35%	25	0.2 Million
DeepID2 [CVPR2014]	99.15%	25	0.2 Million
DeepID2+ [CVPR2015]	99.47%	25	0.29 Million
WSTFusion [CVPR2015]	98.37%	-	1 Million
VGGFace [BMVC 2015]	98.95%	1	2.6Million
FaceNet [CVPR 2015]	99.67%	1	0.2 Billion

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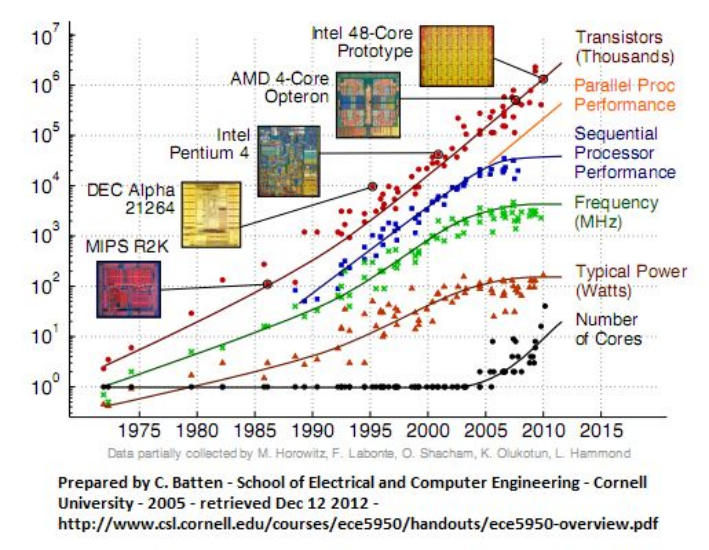
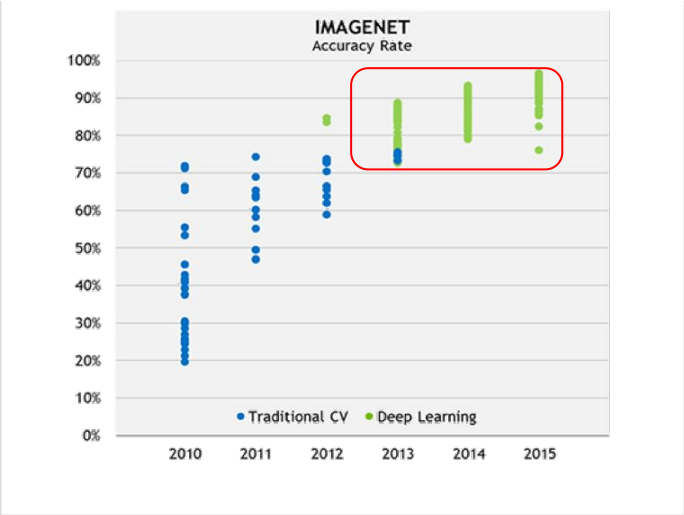
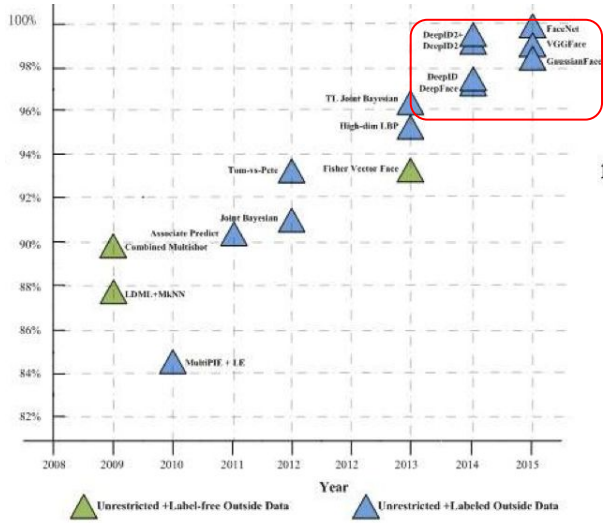
- **More computing power**



And several theory breakthrough :)

Deep Learning





Want to Learn More? Stay Tuned :)

Q & A