What is the fuss about AI, Machine Learning and Deep Learning?

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How these Buzz words fit?

- Deep Learning is a particular type of Machine Learning, which is a particular type of Artificial Intelligence
- here is an illustration from NVIDIA:

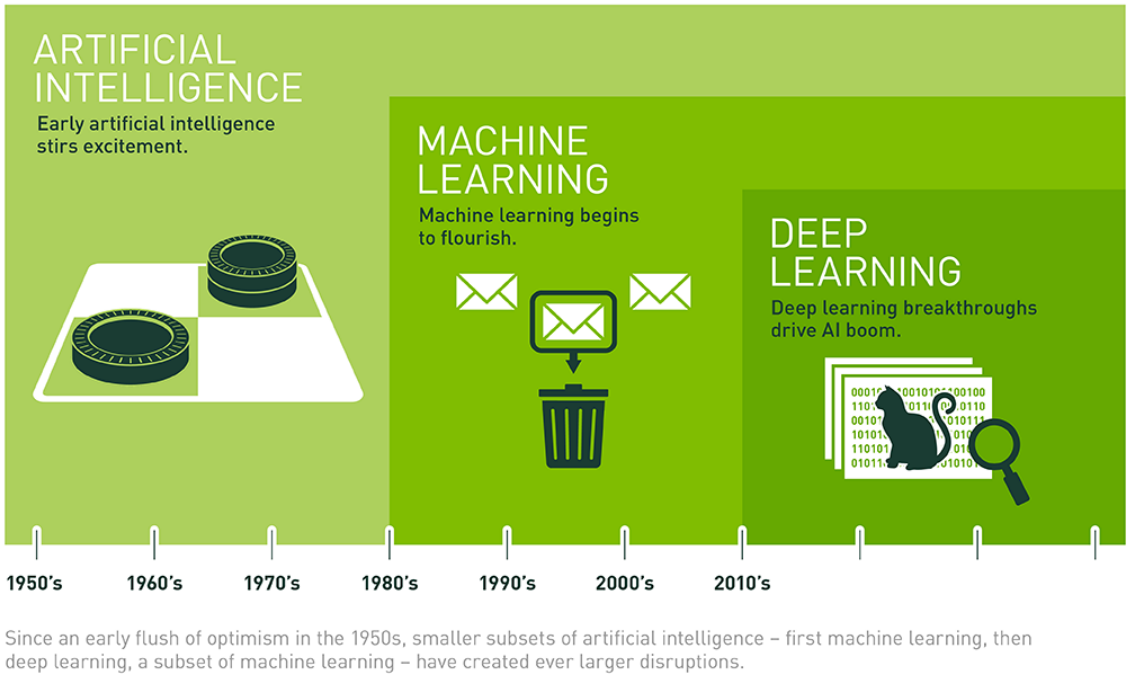
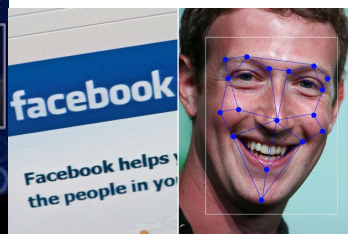


Figure: from NVIDIA Blogs `https://blogs.nvidia.com/blog/2016/07/29/`

new technologies in AI/ML

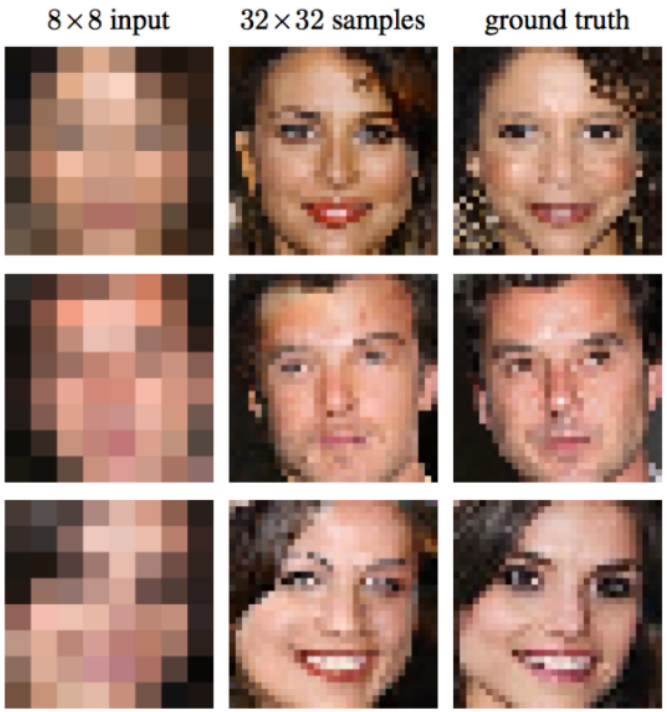
- apart from high profile AI examples:

- tones of new AI technologies are coming out every day: from research to industry

recover facial images from extremely low resolution

- recover facial images from extremely low resolution
- useful in many domains, such as surveillance cameras



- Google Brain, “Pixel Recursive Super Resolution citation”

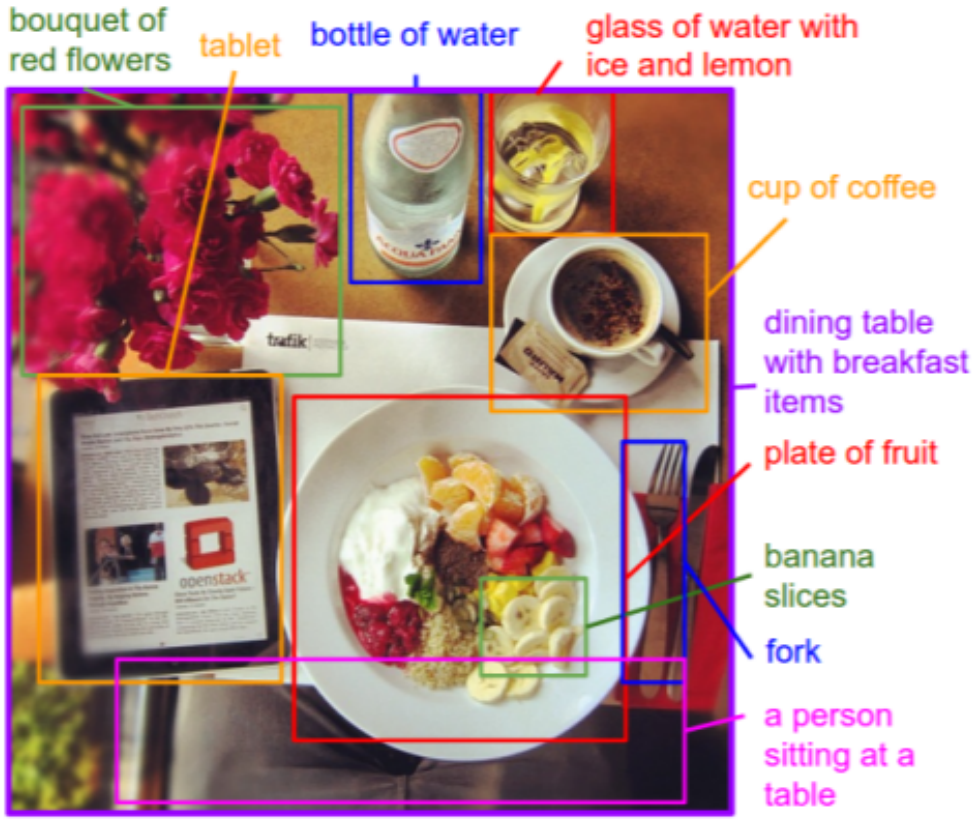
obtain poses from crowd

- obtain multiple stick figure from crowd
- useful in many setting, including retail setting for example on shopper behavior analysis

- Zhe Cao, Tomas Simon, Shih-En Wei, Yaser Sheikh, “Realtime Multi-Person 2D Pose Estimation using Part Affinity Fields”

Generating descriptions for each image parts

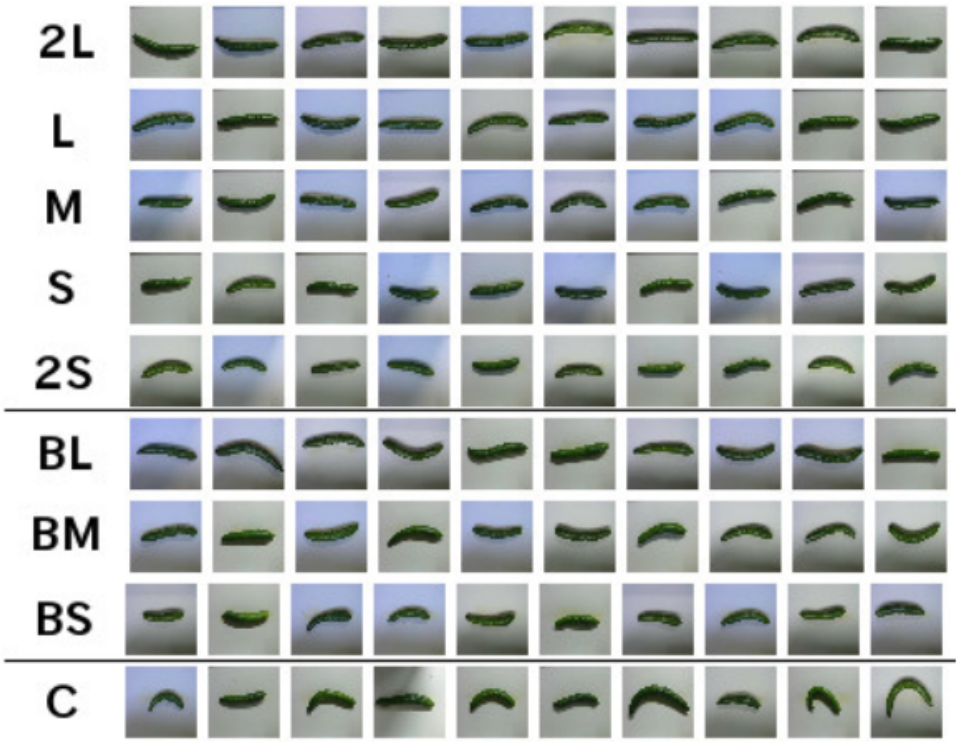
- obtain descriptions for each image parts



- useful in annotate social media images
- Andrej Karpathy and Li Fei-Fei, “Deep Visual-Semantic Alignments for Generating Image Descriptions”

Japanese farmers use deep learning to sort cucumbers

- Japanese farmers use deep learning to sort cucumbers



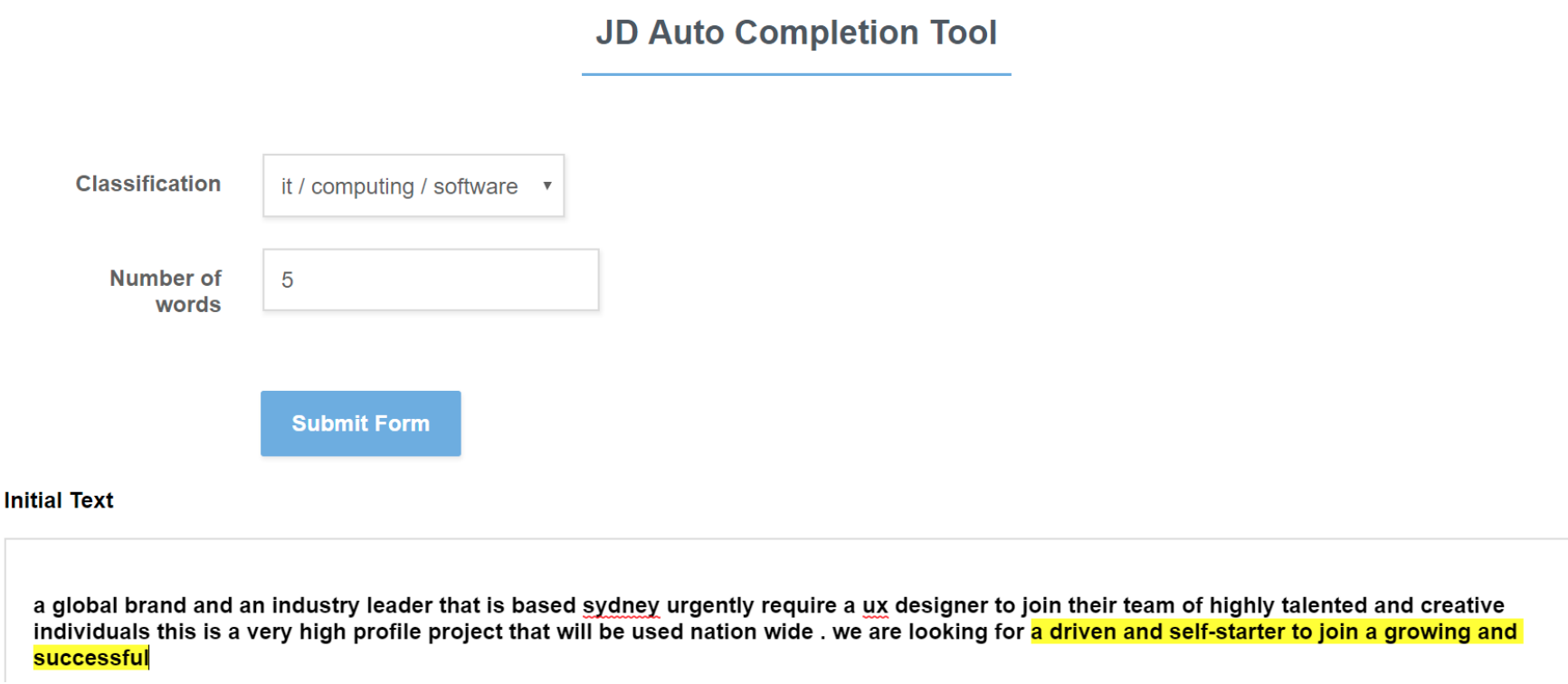
Google Sunroof

- Solar savings are calculated using roof size and shape, shaded roof areas, local weather, local electricity prices, solar costs, and estimated incentives over time

- but with slight modification, one can predict the housing price of any dwellings!

automatically writing job ads

- https://www.utsdeeplearning.com/jobgenerator/



- University of Technology Sydney:: Deep Learning

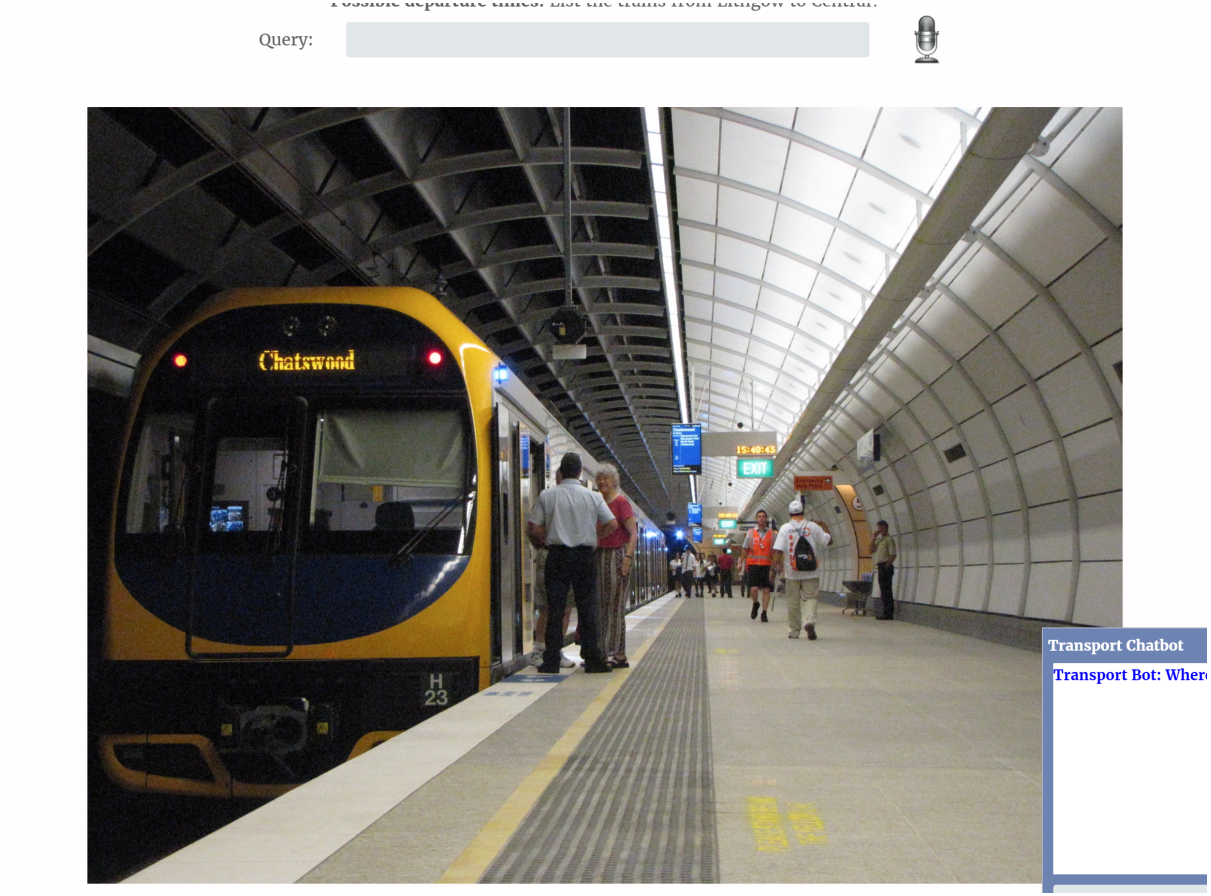
automated tennis player tagging

- recognize four type of action sequences from tennis videos:
- `https://www.youtube.com/watch?v=MWAeBWFcWbg`

- University of Technology Sydney:: Deep Learning

automated natural language to SQL Queries translation

- automated translation between natural language to SQL Queries translation (OPAL data first):



- University of Technology Sydney:: Deep Learning

How much impact is AI/ML/DL to our jobs?

- from **Frey and Osborne report, 2014**: probability of computerization of an occupation by AI:
- `http://www.oxfordmartin.ox.ac.uk/downloads/academic/The_Future_of_Employment.pdf`

312.	0.54	41-3011	Advertising Sales Agents
350.	0.63	47-4011	Construction and Building Inspectors
337.	0.61	1 13-1161	Market Research Analysts and Marketing Specialists
390.	0.71	47-4799	Construction and Related Workers, All Other
411.	0.75	47-2141	Painters, Construction and Maintenance
484.	0.85	41-4012	Sales Representatives, Wholesale and Manufacturing, Except Technical and Sci
497.	0.86	41-9022	Real Estate Sales Agents
512.	0.88	47-2061	Construction Laborers
570.	0.92	41-2031	Retail Salespersons
589.	0.94	1 13-2011	Accountants and Auditors
609.	0.94	1 23-2011	Paralegals and Legal Assistants
672.	0.98	43-6012	Legal Secretaries
702.	0.99	41-9041	Telemarketers

- basically, we have no choice but to start embrace the fact that a lot of jobs are going to be replaced by AI-driven automation.

Is Australian industry prepared for the AI revolution?

- We read more and more news such as these:
  `http://www.abc.net.au/news/2017-08-08/australia-must-embrace-ai-revolution-alphabeta-report/8774044`

- question is: how committed are Australian industries towards AI?
- from my view, we are NOT yet sharing the same enthusiasm as our overseas counterparts.

Firstly, from a talent perspective:

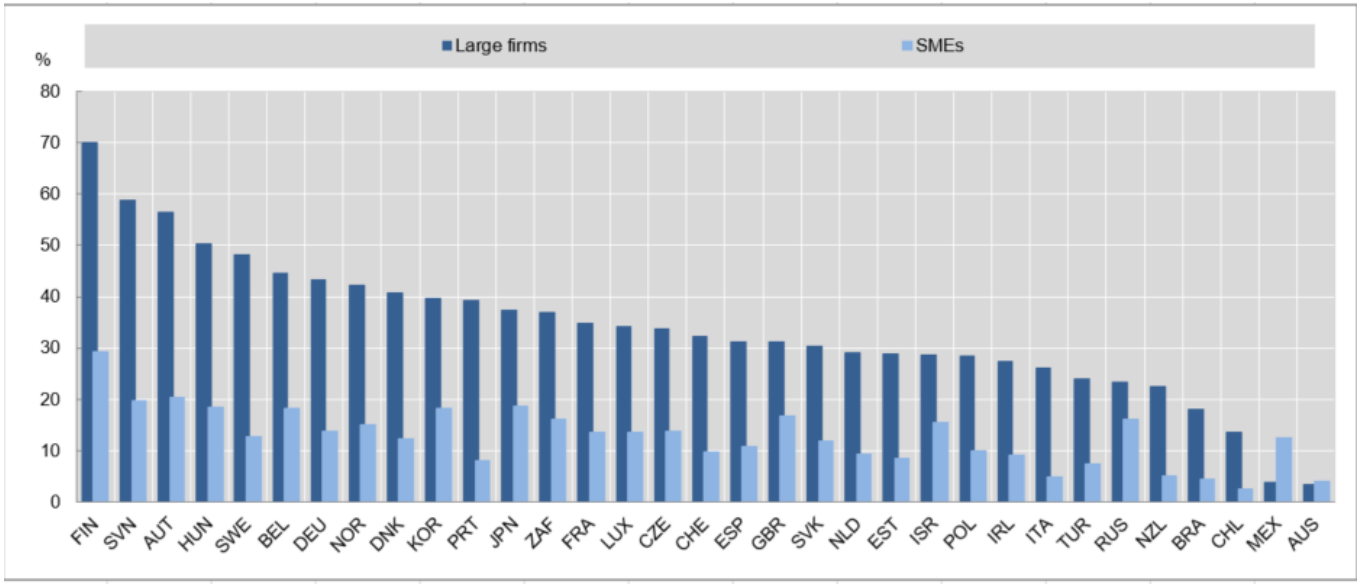
below are list of world leading AI and ML scholars employed by companies:

- Geoffery Hitton, Google and DNNresearch Inc, USA
- Richard S. Sutton, head academic advisor to Royal Bank of Canada, Canada
- Michael I Jordan, technical adviser to the Ant Financials, China
- Yann Lecun, Director of AI Research at Facebook,USA
- Zoubin Ghahramani, Uber's Chief Scientist,USA
- Fei-Fei Li, Chief Scientist of Artificial Intelligence & Machine Learning, Google Cloud USA
- Daphne Koller, Chief Computing Officer, Calico Labs USA
- Andrea Frome, Director of Research, Clarifai UK
- Carol Reiley, Co-Founder & President, Drive.ai USA
- Hua Wu, Technical Chief, Baidu Natural Language Processing (NLP) Team China
- Ayse Naz Erkan, Staff Data Scientist, Twitter USA
- Alex Smola, Amazon USA
- Andrew Ng, VP & Chief Scientist of Baidu (till May 2017), China
- David Silver, DeepMind and lead researcher on AlphaGo USA
- Hugh F. Durrant-Whyte, Chief Scientific Adviser at the UK Ministry of Defense, UK
- ...

interestingly, to the best of my knolwedge, no world-leading AI/ML scholars are working at top Australian industries

need much closer collaboration between industries and universities

- Australia produces great research but it ranks last in the OECD tables for collaboration between researchers and business
- `https://theconversation.com/poor-research-industry-collaboration-time-for-blame-or-economic-re`



- however, AI/ML is one single discipline where University and industry should work extremely closely

shorten ML knowledge gap between industry and academia

the problem almost every data strategist is facing today is, how to make the most out of the booming opportunities in machine learning:

- when it comes to esoteric nature of data science, many corporate leaders maybe missing out on the full benefit, because they may be unsure of what machine learning is and what it can do for them
- Often, it can be as simple as fearing the unknown holding corporate leaders back from embarking on machine learning projects with specialists
- academia can help in many areas. For example, University can help industry to answer some of the questions (next slides):

“Is the product a really high tech one?”

- ML vendors tries to “sell” machine learning/AI solutions to industries every day.
- how much technologies really is in its product?
- for example, vendors may sell a “cutting-edge speech recognition” solution using a wrapper around off-the-shelf Google or Amazon cloud engine

“am I hiring the right data scientist?”

- produce a “machine learning demo” is much easier today than it has ever been
- there are many open-source stuff out there on Github! - simply run them will produce an “impressive demo”
- machine learning is new to a lot of data strategists, therefore
- how can a corporate pick the right candidate, i.e., someone knowledgeable in ML versus someone just ran the code from Gibhub two days ago.

“am I using the ML tool appropriately?”

- if someone was to write a computer software, you know when something is wrong: for example, website crashes
- ML algorithm will “always” run and always produce some results
- therefore, it’s vitally important to make sure the results are meaningful and/or correct assumptions, algorithms are used

Machine Learning applications: The three-layers perspective

This is my *biased* view:

- **Layer 1: Application - Business analyst**
  - Define the problem. Obtain its business value and find out what to do.
  - Domain specific knowledge is essential
  - Each project is different, there are no identical projects!
  - knowledge on general overview of machine learning
- **Layer 2: Model Formulation - Data Scientist**
  - transform the business problem into a mathematical framework:
  - knowledge on how to apply machine learning
- **Layer 3: Solver - Machine learning practitioner/researcher**
  - Now we have the model, how we can solve these equations
  - need to consider program complexity when data is BIG
  - research knowledge on machine learning and mathematics

The three layers perspective example (1)

- **Layer 1: Application**
  From OPAL data, *the business* wants an estimate on the probability of passenger taps on at central station at various times (*e.g., what is the probability of someone taps on at central at 8:15am?)*
- **Layer 2: Model Formulation**
  Model *all* passenger tap on times using Bi-modal Gaussian Mixture Model (GMM)
- **Layer 3: Solver**
  Solve GMM using **expectation-maximization**;

see `one_d_opal_simulated.m`

The three layers perspective example (2)

- **Layer 1: Application**
  an online hotel *business* has a database containing every user's rating of their stayed hotels
  the *marketing team* wants to know which hotels to recommend to individual user in a promotional email (customized emails)

- **Layer 2: Model Formulation**
  data scientists decide to build a **recommendation system** using Non-Negative Matrix Factorization (NNMF) algorithm

- **Layer 3: Solver**
  there are many ways to solve NNMF, but the team decide to use Gradient Descend, because of the relative small size database.

The three layers perspective example (3)

- **Layer 1: Application**
  - hypothetically, UTS decides to build the world's best learning analytic system:
  - it takes into consideration of the student's histories of studies and their interest, then it produces a "future study plan" deems to be best fit for each and every student
  - *and of course, they asked Richard's team to conduct this work*
- **Layer 2: Model Formulation**
  Richard's team decides to base this model using a modified Recurrent Neural Network (RNN).
- **Layer 3: Solver**
  learn all the parameters of RNN using standard back-propagation.

Some of the Research-ish problems

Demos:

- Connected Ellipse fitting
- Automated PTZ Camera control
- Markov Random Field via Swendsen-Wang sampling
- ...

Exercise:

- In each of these settings, what are the three layers: **application**, **model**, **solver**

Real problems: (larger) projects

- Education to Employment alignment
- Data Hackerthorn
- these are the systems where machine learning plays a part.

Exercise:

- In each of these settings, what are the three layers: **application**, **model**, **solver**

For the rest of the course, we will:

- discuss a mixture of **application**, **model** and **Solver**
- very gentle introduction to some of the mathematics. For detailed coverage of topics, refer to my Machine Learning course:
  `http://www-staff.it.uts.edu.au/~ydxu/statistics.htm`
- stop me at any time if anything unclear. I will go over it again and I may even tell a **big-data joke**