CPSC 340 and 532M:
Machine Learning and Data Mining

Mark Schmidt
University of British Columbia, Fall 2019
www.cs.ubc.ca/~schmidtm/Courses/340-F19

Some images from this lecture are taken from Google Image Search, contact me if you want the reference

Big Data Phenomenon

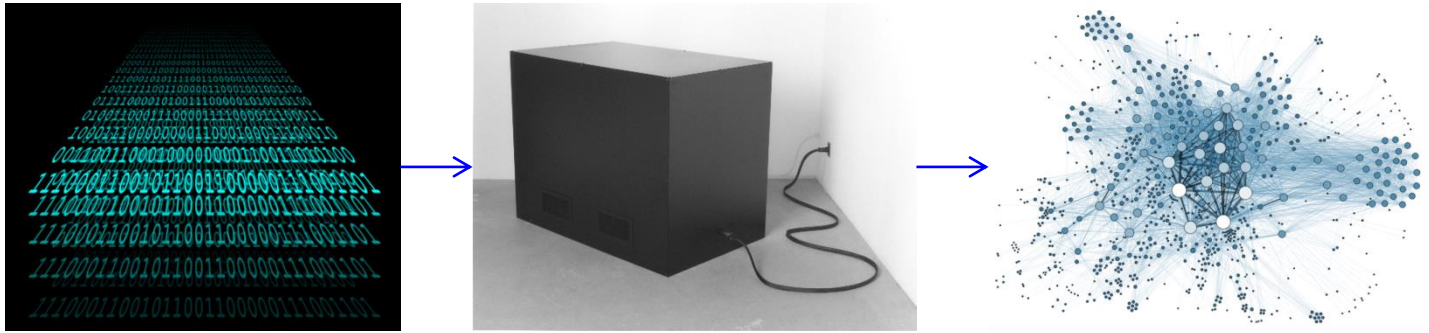
- We are collecting and storing data at an unprecedented rate.
- Examples:
  - YouTube, Facebook, MOOCs, news sites.
  - Credit cards transactions and Amazon purchases.
  - Transportation data (Google Maps, Waze, Uber)
  - Gene expression data and protein interaction assays.
  - Maps and satellite data.
  - Large hadron collider and surveying the sky.
  - Phone call records and speech recognition results.
  - Video game worlds and user actions.

Big Data Phenomenon

- What do you do with all this data?
  - Too much data to search through it manually.
- But there is valuable information in the data.
  - How can we use it for fun, profit, and/or the greater good?
- Data mining and machine learning are key tools we use to make sense of large datasets.

Data Mining

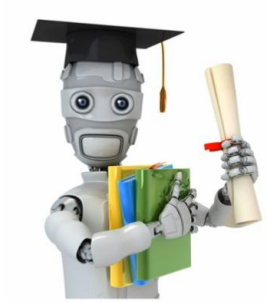
- Automatically extract useful knowledge from large datasets.

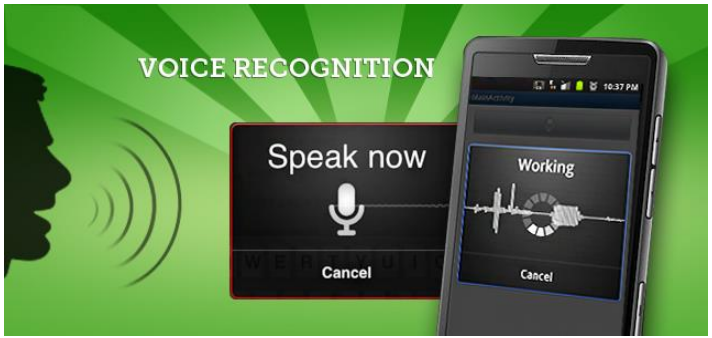


- Usually, to help with human decision making.

Machine Learning

- Using computer to automatically detect patterns in data and use these to make predictions or decisions.

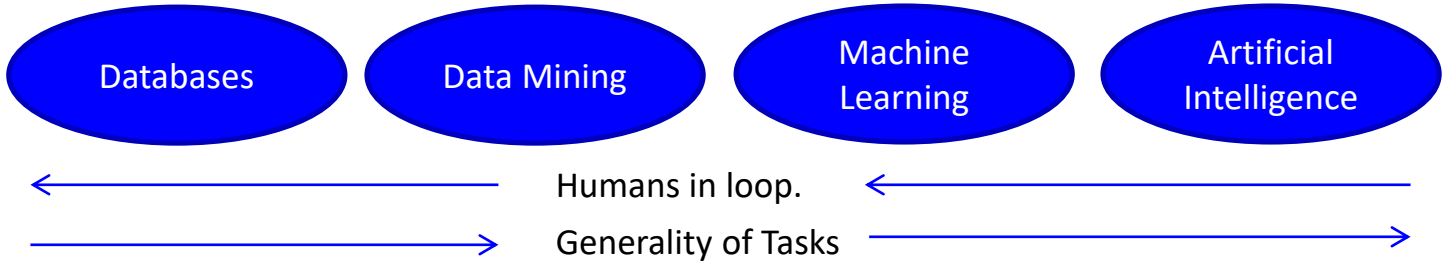




- Most useful when:
  - We want to automate something a human can do.
  - We want to do things a human can't do (look at 1 TB of data).

Data Mining vs. Machine Learning

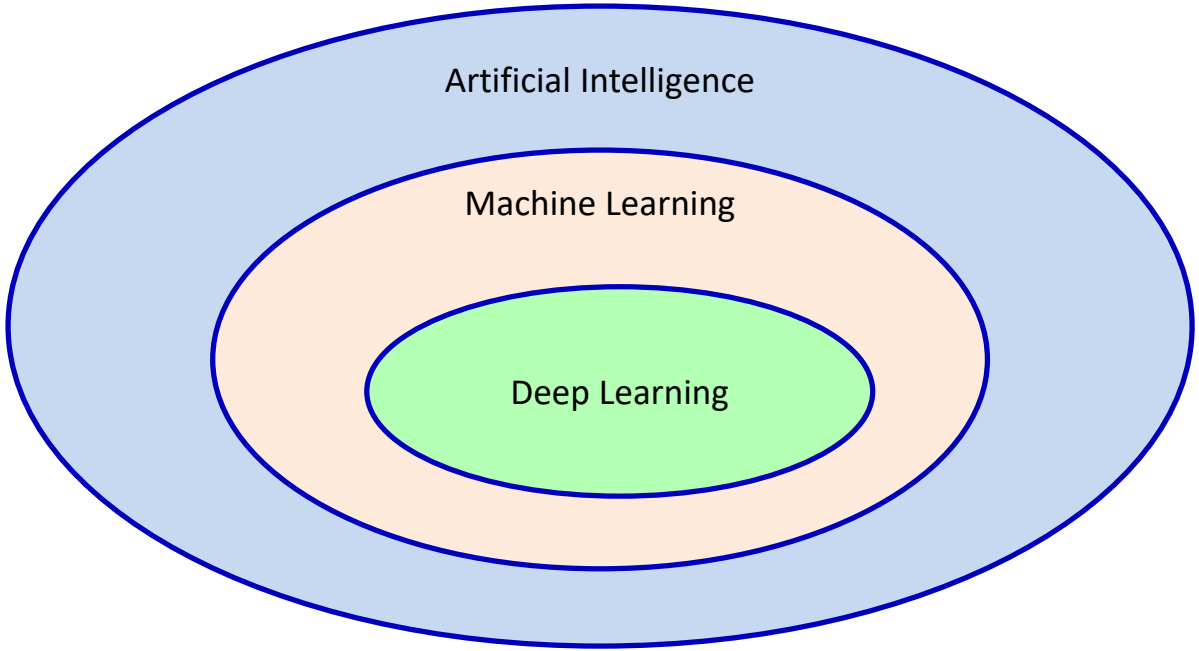
- Data mining and machine learning are very similar:
  - Data mining often viewed as closer to databases.
  - Machine learning often viewed as closer AI.



- Both are similar to statistics, but more emphasis on:
  - Large datasets and computation.
  - Predictions (instead of descriptions).
  - Flexible models (that work on many problems).

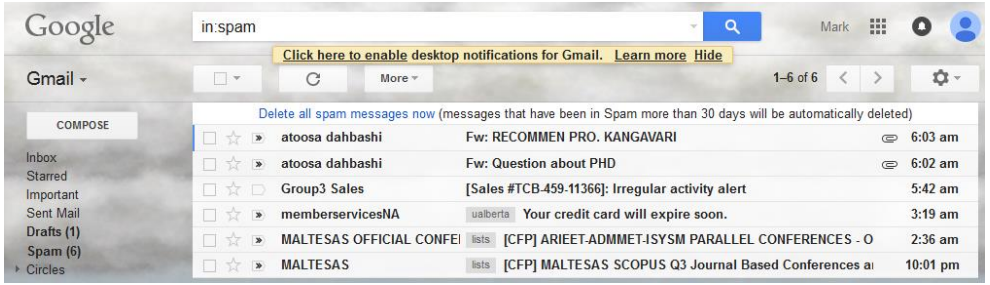
Deep Learning vs. Machine Learning vs. AI

- Traditional we've viewed ML as a subset of AI.
  - And "deep learning" as a subset of ML.

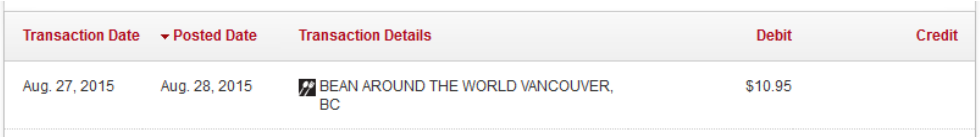


Applications

- Spam filtering:



- Credit card fraud detection:



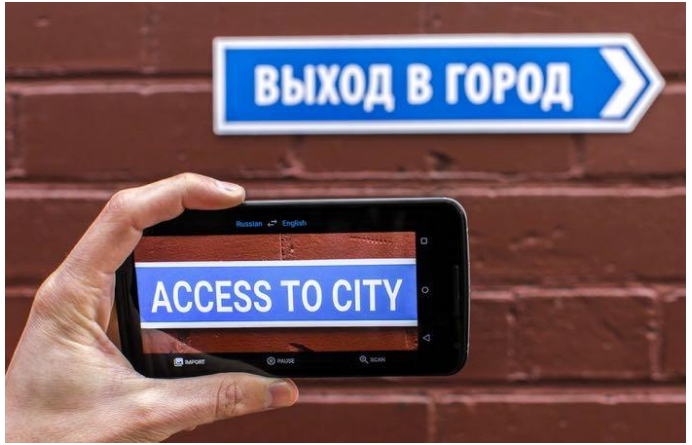
Transaction Date	Posted Date	Transaction Details	Debit	Credit
Aug. 27, 2015	Aug. 28, 2015	BEAN AROUND THE WORLD VANCOUVER, BC	$10.95	

- Product recommendation:

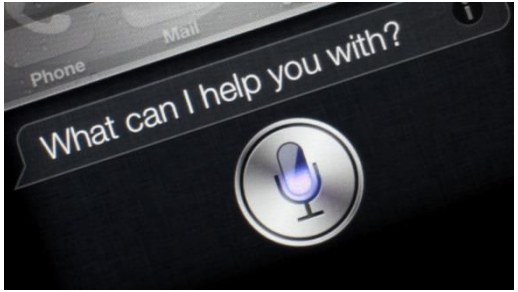
Applications

- Motion capture:

- Optical character recognition and machine translation:

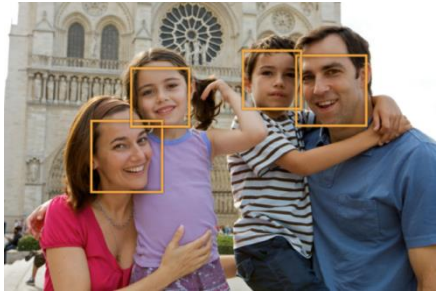


- Speech recognition:

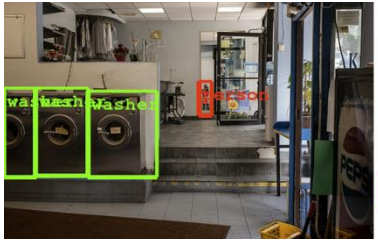


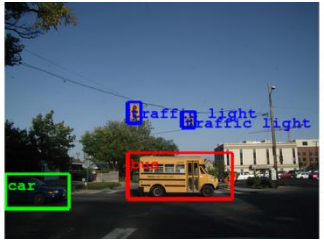
Applications

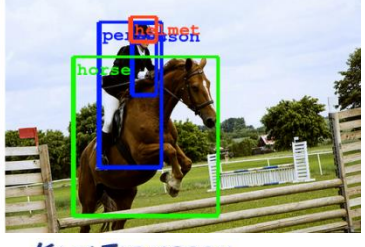
- Face detection:



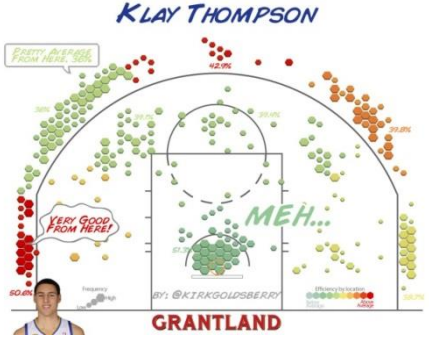
- Object detection:





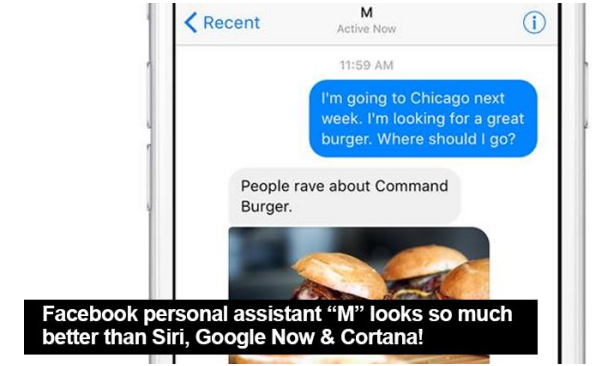


- Sports analytics:

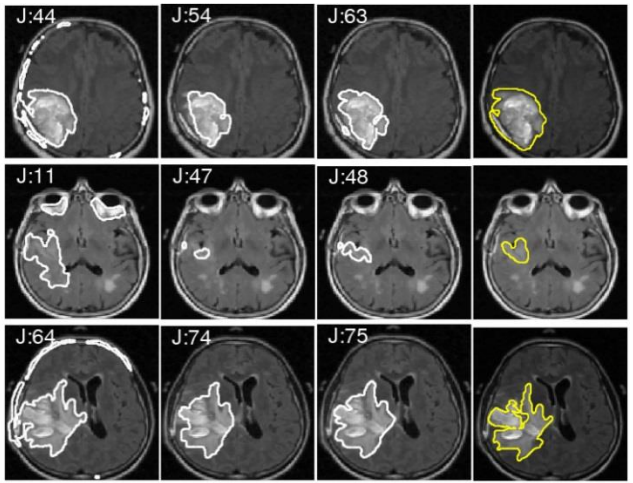


Applications

- Personal Assistants:



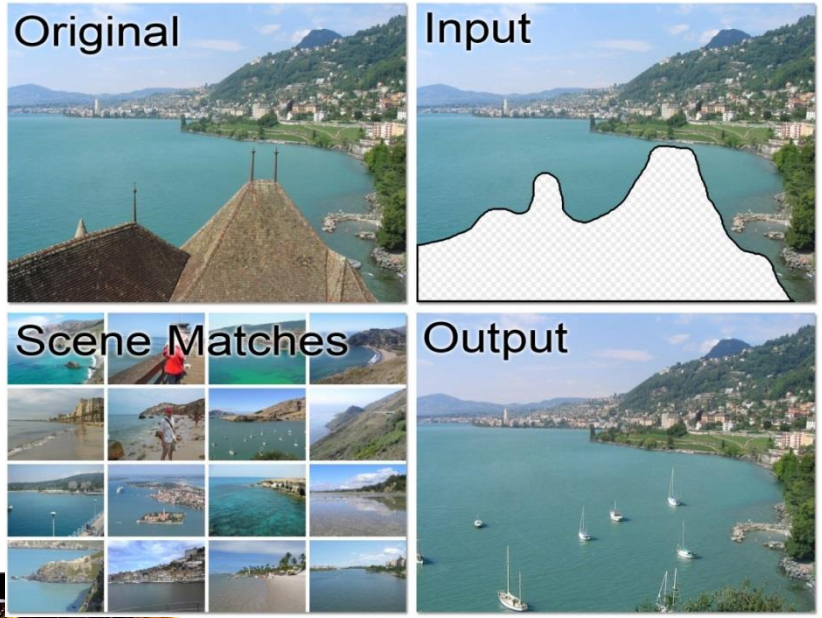
- Medical imaging:



- Self-driving cars:

Applications

- Scene completion:



- Image annotation:

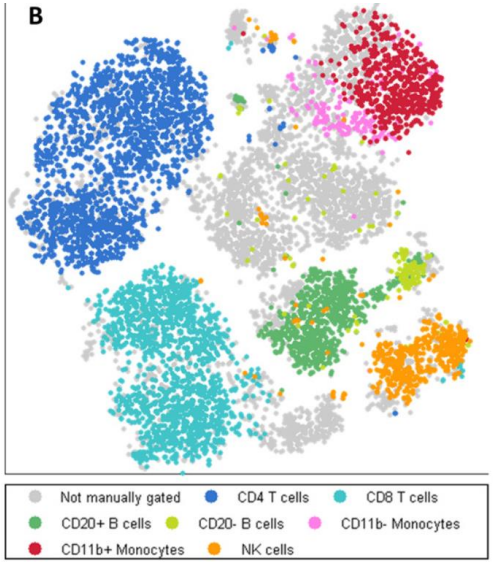

a cat is sitting on a toilet seat
logprob: -7.79


a display case filled with lots of different types of donuts
logprob: -7.78


a group of people sitting at a table with wine glasses
logprob: -6.71

Applications

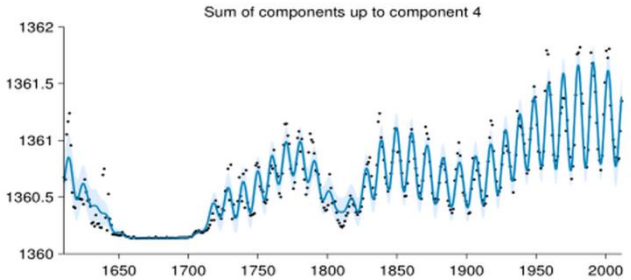
- Discovering new cancer subtypes:



- Automated Statistician:

2.4 Component 4 : An approximately periodic function with a period of 10.8 years. This function applies until 1643 and from 1716 onwards

This component is approximately periodic with a period of 10.8 years. Across periods the shape of this function varies smoothly with a typical lengthscale of 36.9 years. The shape of this function within each period is very smooth and resembles a sinusoid. This component applies until 1643 and from 1716 onwards.

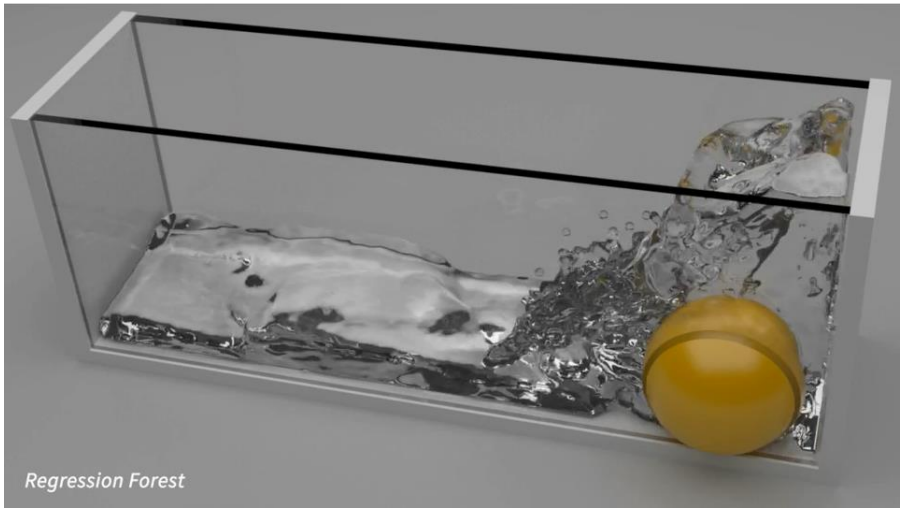


Applications

- Mimicking artistic styles:

Applications

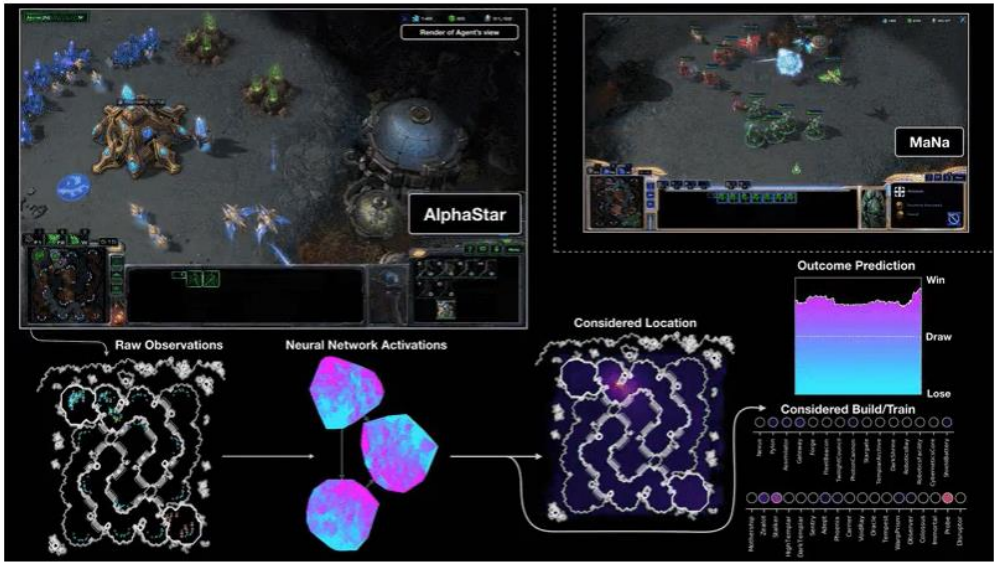
- Fast physics-based animation:



- Mimicking art style in video.
- Recent work on generating text/music/voice/poetry/dance.

Applications

- Beating humans in Go and Starcraft:



- Summary:
  - There is a lot you can do with a bit of statistics and a lot data/computation.

- We are in exciting times.
  - Major recent progress in fields like speech recognition and computer vision.
  - Things are changing a lot on the timescale of 3-5 years.
  - NeurIPS conference sold out in ~11 minutes last year.
  - A bubble in ML investments (most "AI" companies are just doing ML).

- But it is important to know the limitations of what you are doing.
  - "The combination of some data and an aching desire for an answer does not ensure that a reasonable answer can be extracted from a given body of data." – John Tukey
  - A huge number of people applying ML are just "overfitting".
    - Or don't understand the assumptions needed for them to work.
    - Their methods do not work when they are released "into the wild".

Bonus Slides

- I will include a lot of “bonus slides”.
  - May mention advanced variations of methods from lecture.
  - May overview big topics that we don’t have time for.
  - May go over technical details that would derail class.

- You are not expected to learn the material on these slides.
  - But they’re useful if you want to take 540 or work in this area.

- I’ll use this colour of background on bonus slides.

Course Outline

- Next class discusses “exploratory data analysis”.

- After that, the remaining lectures focus on five topics:
  1) Supervised Learning.
  2) Unsupervised learning.
  3) Linear prediction.
  4) Latent-factor models.
  5) Deep learning.

- “What is Machine Learning?” (overview of many class topics)

Photo I took in the UK on the way home from the “Optimization and Big Data” workshop: