CPSC 340: Machine Learning and Data Mining

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University of British Columbia, Fall 2017

www.cs.ubc.ca/~schmidtm/Courses/340-F17

Some images from this lecture are taken from Google Image Search.

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.

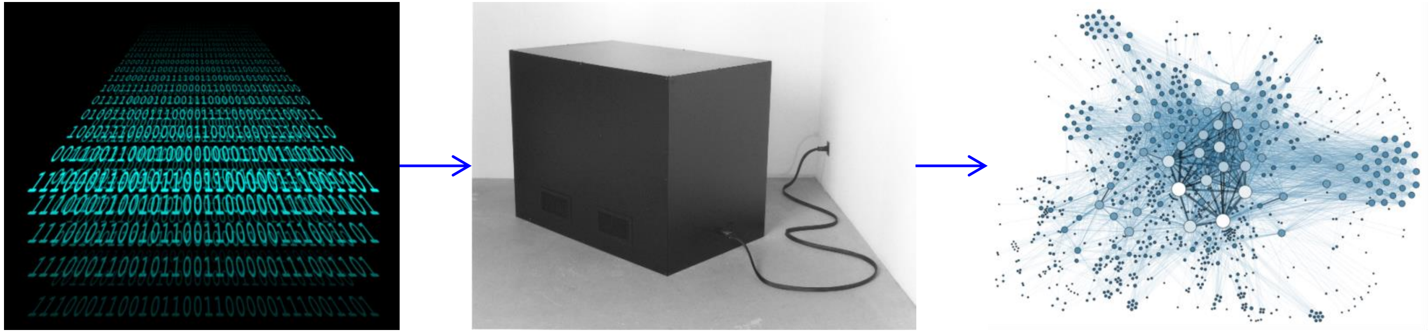
What can I help you with?

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

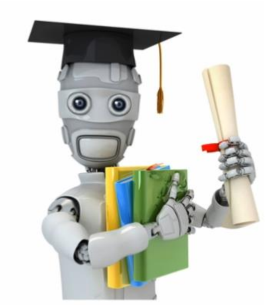
- Automatically extract useful knowledge from large datasets.



- Usually, to help with human decision making.

Machine Learning

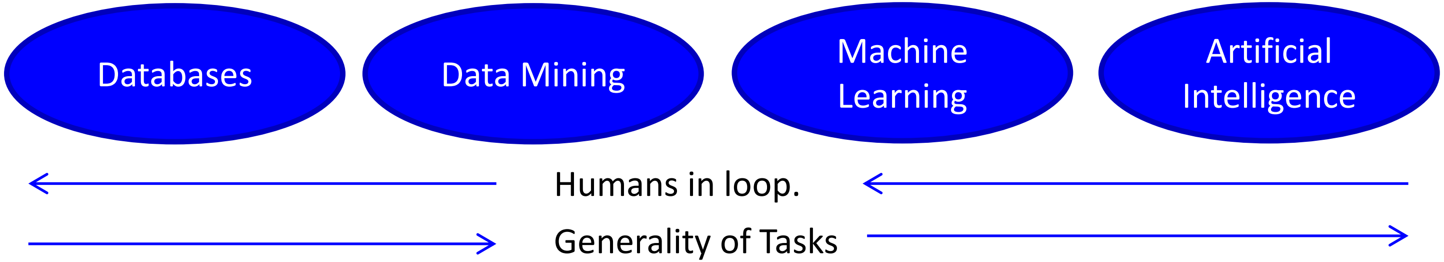
- Using computer to automatically detect patterns in data and use these to make predictions or decisions.



- 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.



Databases

Data Mining

Machine Learning

Artificial Intelligence

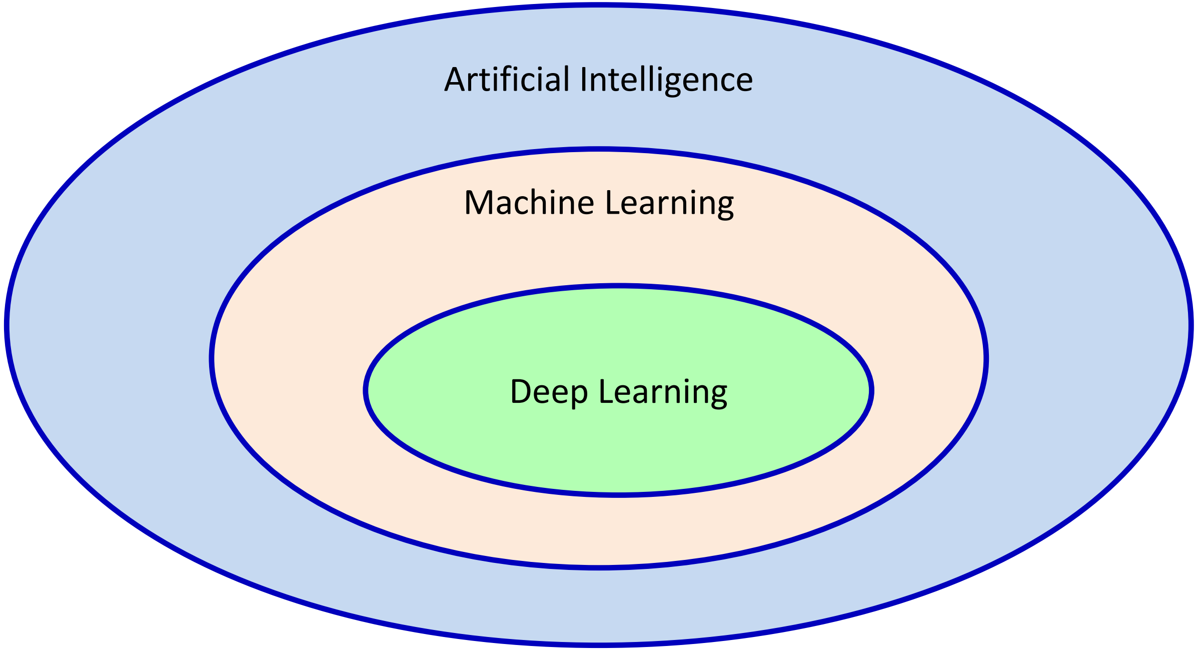
Humans in loop.

Generality of Tasks

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

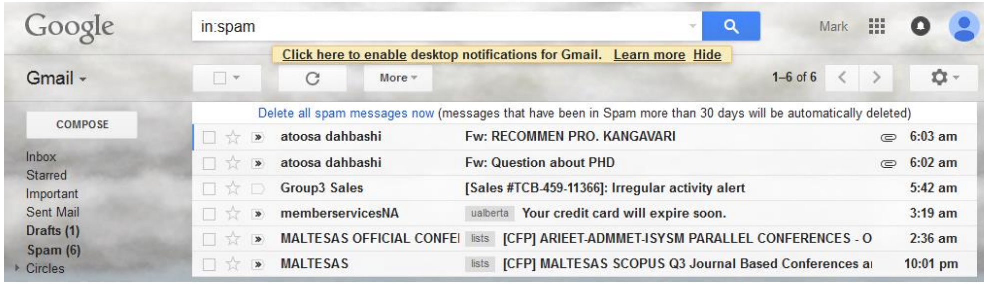
Deep Learning vs. Machine Learning vs. AI

- 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:
- Product recommendation:



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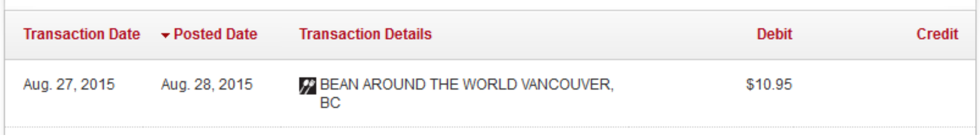

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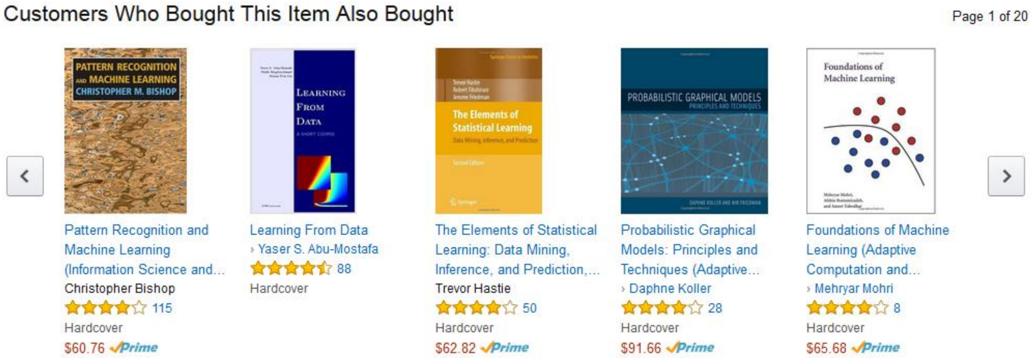
PATTERN RECOGNITION AND MACHINE LEARNING
CHRISTOPHER M. BISHOP
LEARNING FROM DATA
The Elements of Statistical Learning
PROBABILISTIC GRAPHICAL MODELS
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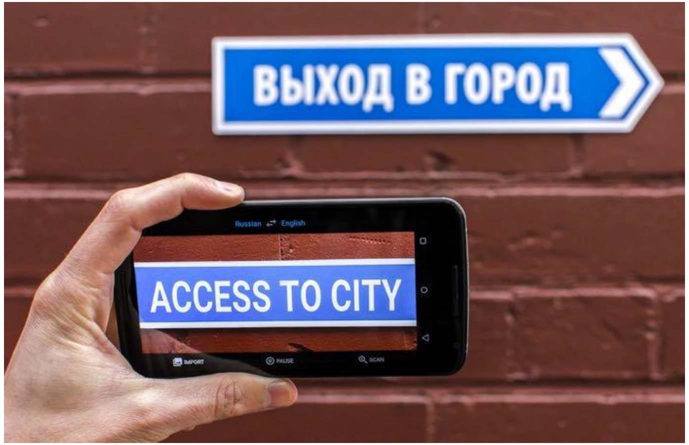
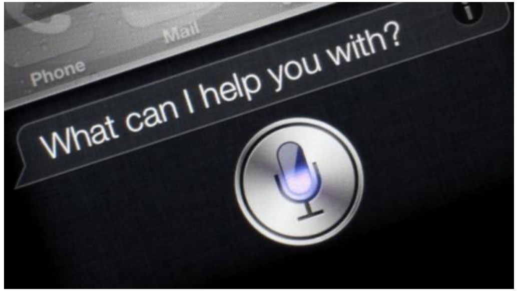
Applications

- Motion capture:

- Optical character recognition and machine translation:

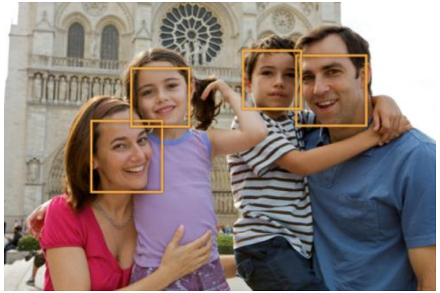


- Speech recognition:

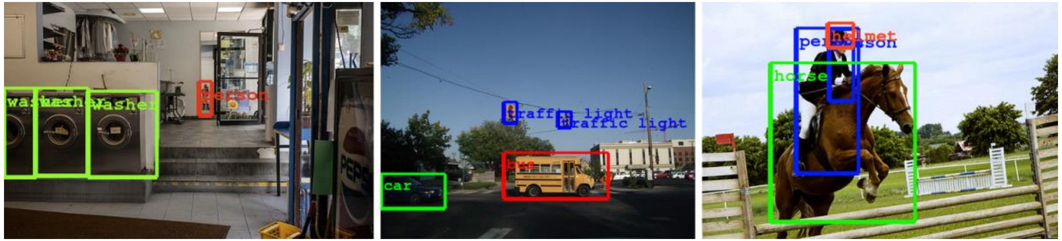


Applications

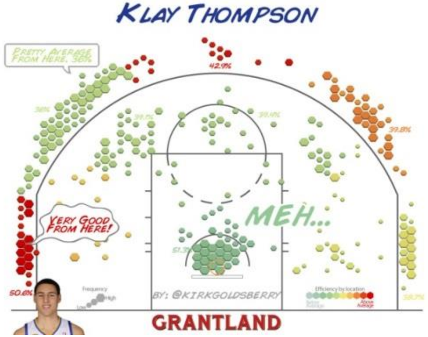
- Face detection:



- Object detection:

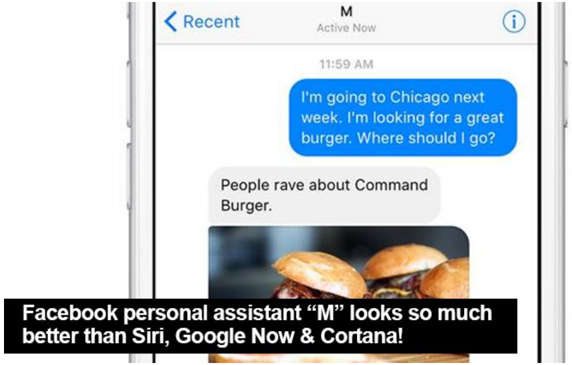


- Sports analytics:



Applications

- Personal Assistants:



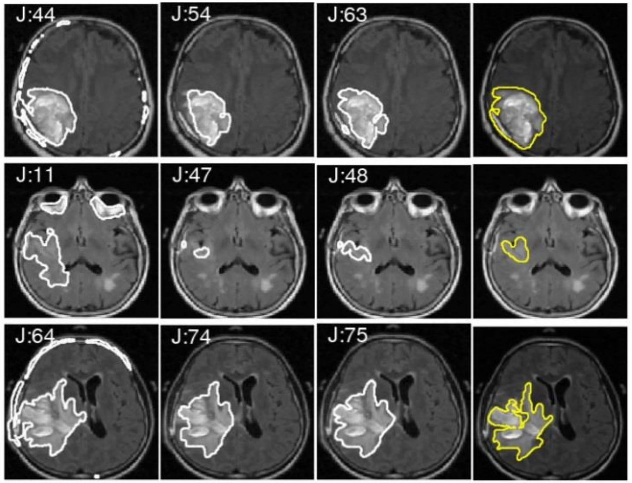
11:59 AM

I'm going to Chicago next week. I'm looking for a great burger. Where should I go?

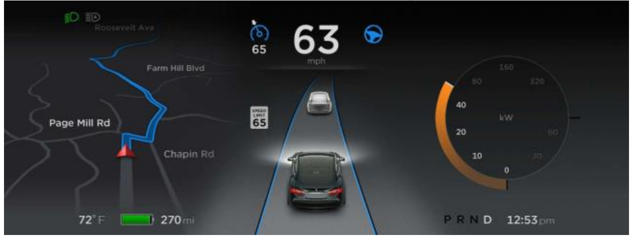
People rave about Command Burger.

Facebook personal assistant “M” looks so much better than Siri, Google Now & Cortana!

- Medical imaging:

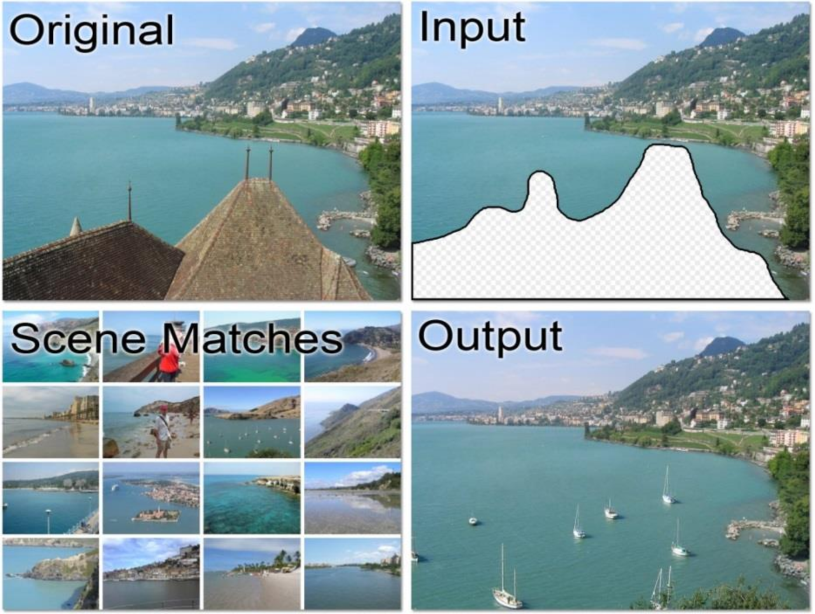


- Self-driving cars:



Applications

- Scene completion:



- Image annotation:

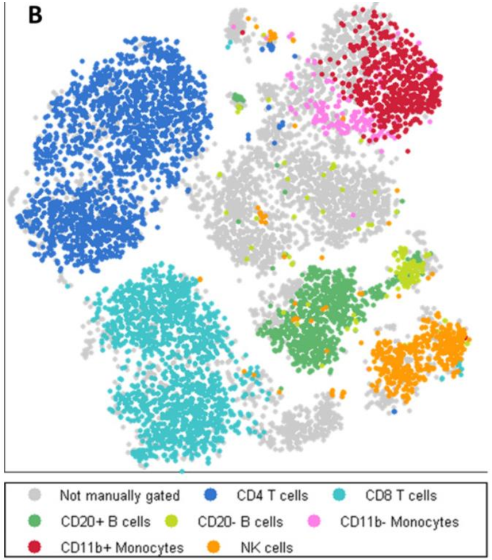
a cat is sitting on a toilet seat
logprob: -7.79

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

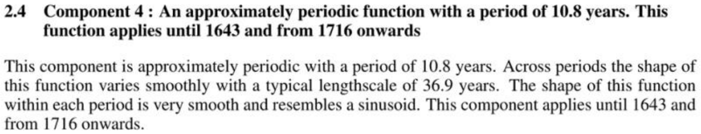
a group of people sitting at a table with wine glasses
logprob: -6.71

Applications

- Discovering new cancer subtypes:

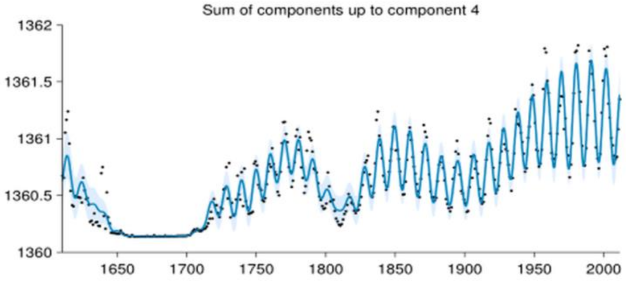


- Automated Statistician:



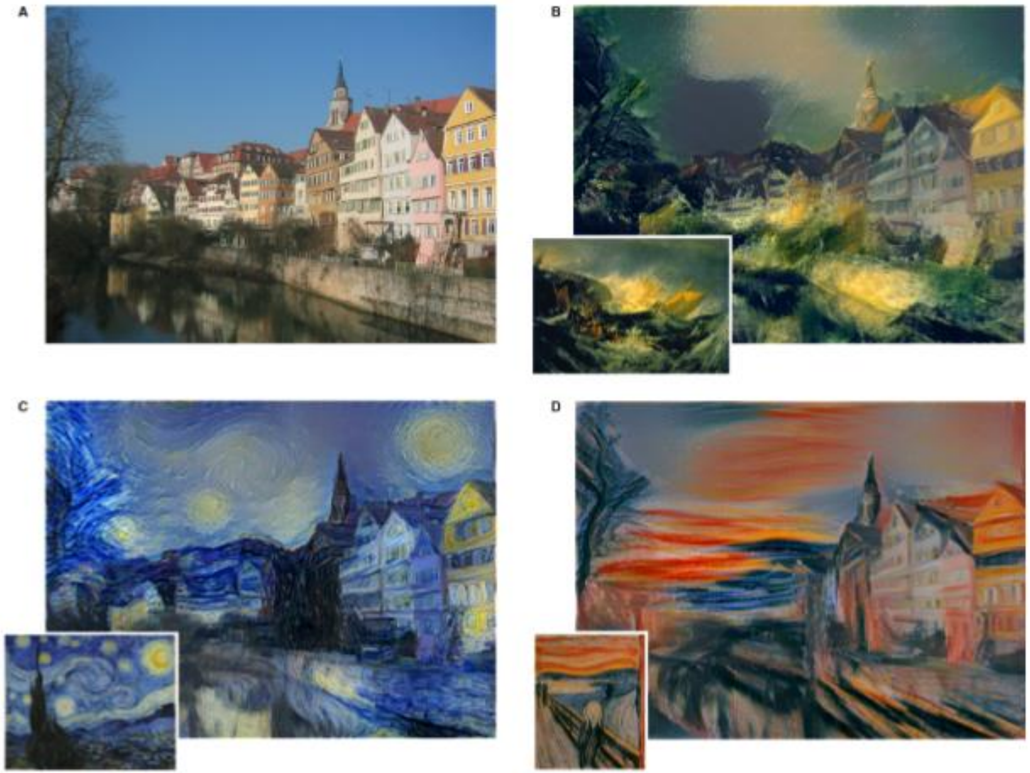
2.4 Component 4 : An approximately periodic function with a period of 10.8 years. This function applies until 1643 and from 1716 onwards

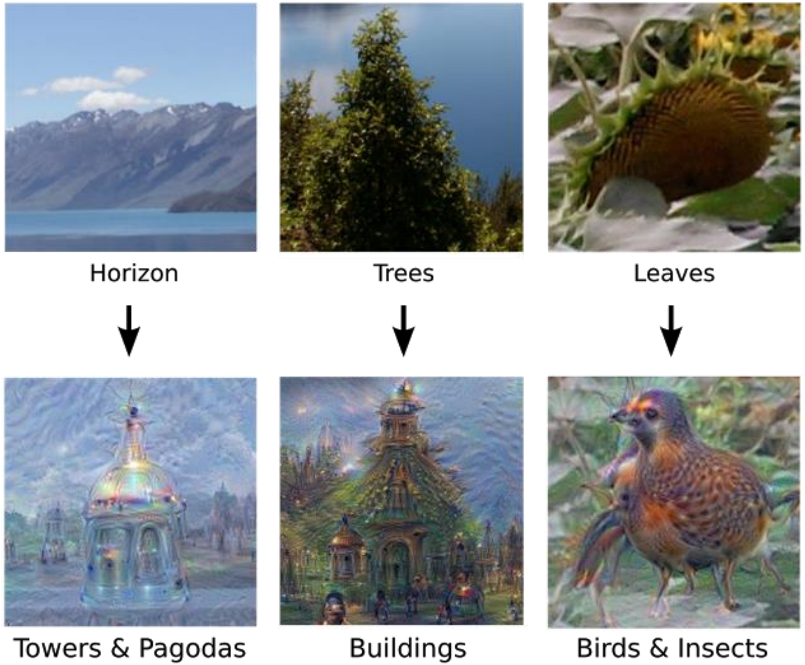
This component is approximately periodic with a period of 10.8 years. Across periods the shape of this function varies smoothly with a typical lengthscale of 36.9 years. The shape of this function within each period is very smooth and resembles a sinusoid. This component applies until 1643 and from 1716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



Applications

- Mimicking artistic styles and inceptionism:



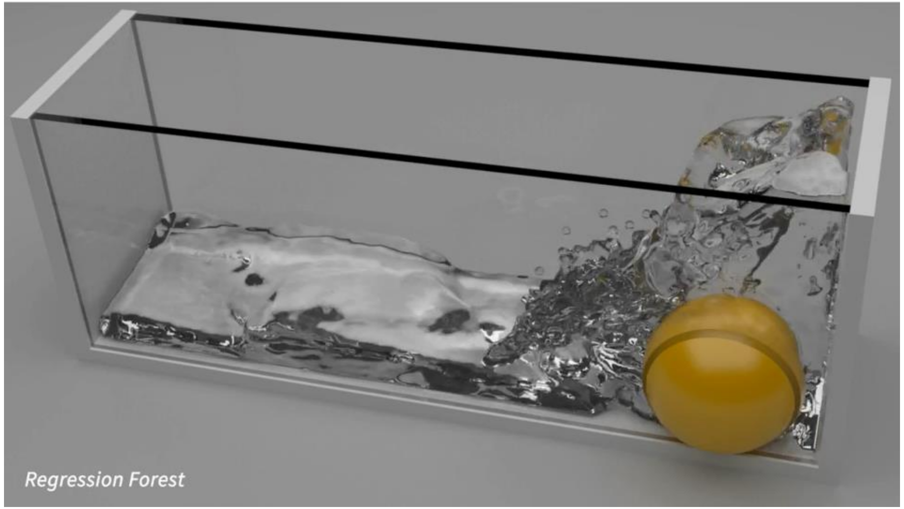


Applications

- “Deep dream”:

Applications

- Fast physics-based animation:



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

Applications

- Beating human Go masters:

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

- 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".

- 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.
  - A bubble in ML investments.

(pause)

Reasons NOT to take this class

- For many people, this course is a LOT of work.
  - Some people spend tens of hours per assignment.
- Compared to typical CS classes, there is a lot more math:
  - Requires linear algebra, probability, and multivariate calculus (at once).
  - "I think the prerequisites for this course should require that students have obtained at least 75% (or around there) in the required math courses. As someone who who did not excel at math, I felt severely under prepared and struggled immensely in this course, especially seeing that I have taken CPSC courses in the past with similar math requirements, but were not nearly as math heavy as CPSC340."

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- Compared to typical CS classes, there is a lot more math:
  - Requires linear algebra, probability, and multivariate calculus (at once).
- Compared to non-CS classes, there is a lot more programming:
  - This is not a class about running other people's software packages.
  - You are going to make/modify implementations of methods.
- Instructor: this is only my third undergrad course.
- We'll use the Julia language: Mike Gelbart uses Python.
- Take this course to learn, not to get a certain grade.

CPSC 340 vs. CPSC 540

- There is also a graduate ML course, CPSC 540:
  - More advanced material.
  - More focus on theory/implementation, less focus on applications.
  - More prerequisites and higher workload.

- For almost all students, CPSC 340 is the right class to take:
  - CPSC 340 focuses on the most widely-used methods in practice.
    - It covers much more material than standard ML classes like Coursera.
  - CPSC 540 focuses on less widely-used methods and research topics.
    - It is intended as a continuation of CPSC 340.
    - You'll miss important topics if you skip CPSC 340.

Essential Links

- Please bookmark the course homepage:
  - www.cs.ubc.ca/~schmidtm/Courses/340-F17
  - Contains lecture slides, assignments, optional readings, additional notes.

- You should sign up for Piazza:
  - www.piazza.com/ubc.ca/winterterm12017/cpsc340/home.
  - Can be used to ask questions about lectures/assignments/exams.
  - May occasionally be used for course announcements.

- Use Piazza instead of e-mail for questions:
  - I can take a long time to respond e-mails.

Textbooks

- No required textbook.

- I’ll post relevant sections out of these books as optional readings:
  - Artificial Intelligence: A Modern Approach (Rusell & Norvig).
  - Introduction to Data Mining (Tan et al.).
  - The Elements of Statistical Learning (Hastie et al.).
  - Mining Massive Datasets (Leskovec et al.)
  - Machine Learning: A Probabilistic Perspective (Murphy).

- Most of these are on reserve in the ICICS reading room.
- List of related courses on the webpage, or you can use Google.

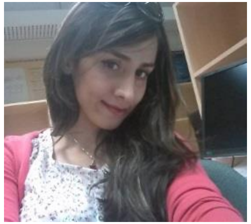
TA Cheat Sheet

- Clement Fung

- Hashemi Hooman
- Siyuan He
- Tanner Johnson
- Angad Kalra

- Xin Bei She
- Sharan Vaswani

- Nasim Zolaktaf



- Zainab Zolaktaf

Assignments and Working in Teams

- There will be 6 Assignments worth 30% of final grade:
  - Usually a combination of math and programming.
  - Submitted as a zip file using the Handin program.
    - You will need to setup a CS account to use this.

- Assignment 0 is on the webpage, and is due next Friday.

- Assignment 0 must be done individually.
- Assignments 1-5 can be done in pairs.
  - There is no commitment to keep the same pairs between assignments.

Late “Class” Policy for Assignments

- Assignments will be due at midnight “anytime on Earth” (ATE).

- If you can’t make it, you can use “late classes”:
  - For example, if assignment is due on a Friday:
    - Handing it in Friday is 0 late classes.
    - Handing it in Monday is 1 late class.
    - Handing it in Wednesday is 2 late classes.

  - You will get a mark of 0 on an assignment if you:
    - Use more than 2 late classes on the assignment.
    - Exceed 4 late classes across all assignments.
    - Submit the solutions to an assignment from a previous term.

- We’ll try to put grades on Connect within 1 week of due date.

Programming Language: Julia

- 3 most-used languages in these areas: Python, Matlab, and R.

- We will be using Julia which is similar to Matlab.
  - Except it’s free and is way faster than Python/Matlab/R.

- No, you cannot use Python/Matlab/R/etc.
  - Assignments have prepared code that we won’t translate to 3 languages.
  - TAs shouldn’t have to know 3 languages to grade.

Waiting List and Auditing

- Right now only CS students register directly.
- 181/195 seats are filled, but the room supports 250 students.

- We’re going to start registering people from the waiting list.
  - Being on the waiting list is the only way to get registered:
    - https://www.cs.ubc.ca/students/undergrad/courses/waitlists
  - You might be registered without being notified, be sure to check!
    - They might also ask to submit a prereq form, let me know if you have issues.

- Because the room is full, we may not have seats for auditors.
  - If there is space, I’ll describe (light) auditing requirements then.

Getting Help

- Many students find the assignments long and difficult.
- But there are many sources of help:
  - TA office hours and instructor office hours (see webpage for times).
    - Starting in the second week of class.
  - Piazza.
  - Weekly tutorials.
    - Starting in second week of class.
    - Will go through provided code, review background material, review big concepts, and/or do exercises.
    - Tutorials are optional be you must be registered in a tutorial section to stay enrolled.
  - Other students (ask your neighbor for their e-mail).
  - The web (almost all topics are covered in many places).

Midterm and Final

- In-class midterm worth 20% (tentatively scheduled for October 20) and a (cumulative) final worth 50% (some time on/before December 22)
  - Closed-book.
  - One doubled-sided ‘cheat sheet’ for midterm.
  - Two doubled-sided pages for final.
  - No need to pass the final to pass the course (but recommended).

- There will be two types of questions:
  - ‘Technical’ questions requiring things like pseudo-code or derivations.
    - Similar to assignment questions, only be related topics covered in assignments.
  - ‘Conceptual’ questions testing understanding of key concepts.
    - All lecture slide material except “bonus slides” is fair game here.

Lectures

- All slides will be posted online (before lecture, and final version after).

- Please ask questions: you probably have similar questions to others.
  - I may deflect to the next lecture or Piazza for certain questions.

- Be warned that the course we will move fast and cover a lot of topics:
  - Big ideas will be covered slowly and carefully.
  - But a bunch of other topics won’t be covered in a lot of detail.

- Isn’t it wrong to have only have shallow knowledge?
  - In this field, it’s better to know many methods than to know 5 in detail.
    - This is called the “no free lunch” theorem: different problems need different solutions.

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.

Code of Conduct

- Do not post offensive or disrespectful content on Piazza.
- If you have a problem or complaint, let me know (maybe we can fix it).
- Do not distribute any course materials without permission.
- Do not record lectures without permission.
- Acknowledge all sources, including webpages and other students.
- Think about how/when to ask for help:
  - Don’t ask for help after being stuck for 10 seconds. Make a reasonable effort to solve your problem (check instructions, Piazza, and Google).
  - But don’t wait until the 10th hour of debugging before asking for help.
- There will be no post-course grade changes based on grade thresholds:
  - 49% will not be rounded to 50%, and 71% will not be rounded to 72%.

Course Outline

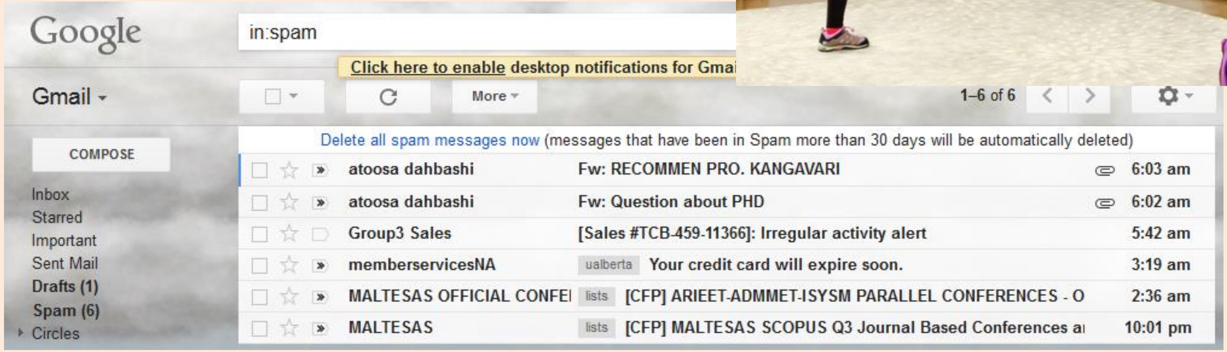
- Next class discusses data “exploratory data analysis”.

- 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.

(pause)

Supervised Learning

- Classification:
  - Given an object, assign it to predefined ‘classes’.
- Examples:
  - Spam filtering.
  - Body part recognition.



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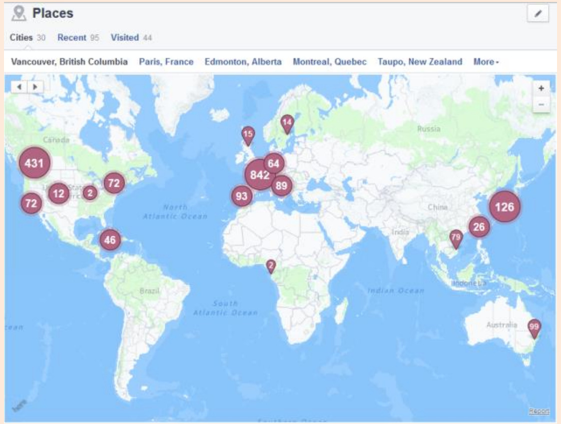
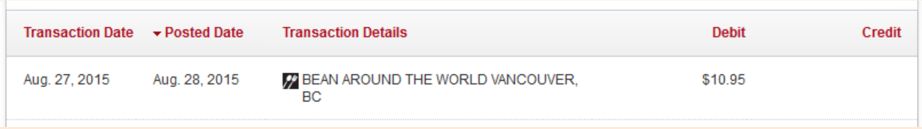
MALTESAS	lists [CFP] MALTESAS SCOPUS Q3 Journal Based Conferences ai	10:01 pm

Unsupervised Learning

- Clustering:
  - Find groups of `similar’ items in data.
- Examples:
  - Are there subtypes of tumors?
  - Are there high-crime hotspots?
- Outlier detection:
  - Finding data that doesn’t belong.
- Association rules:
  - Finding items frequently ‘bought together’.





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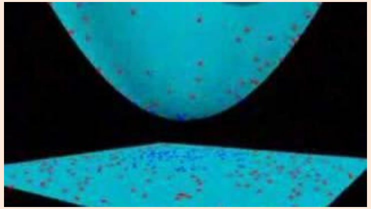
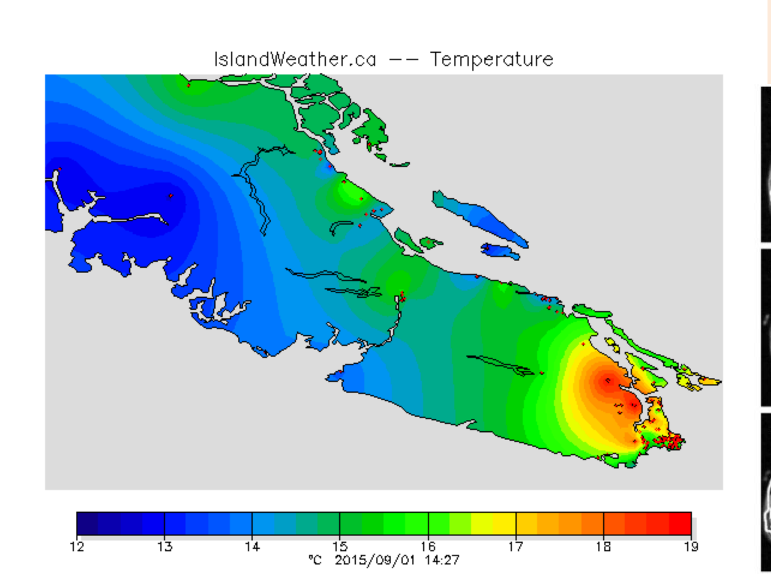
MARKET BASKET ANALYSIS

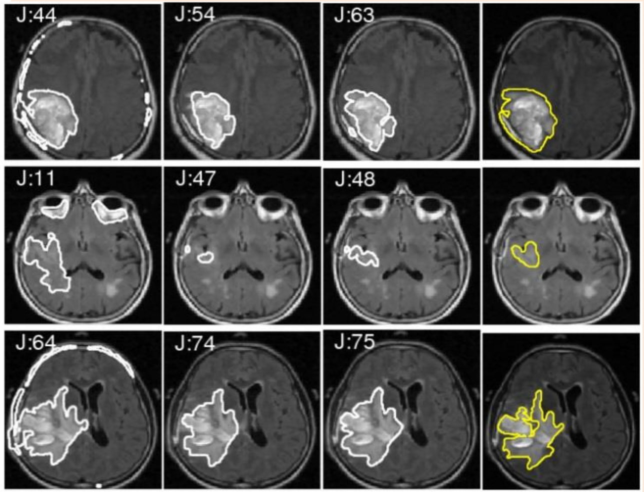
98% of people who purchased items A and B also purchased item C

Linear Prediction

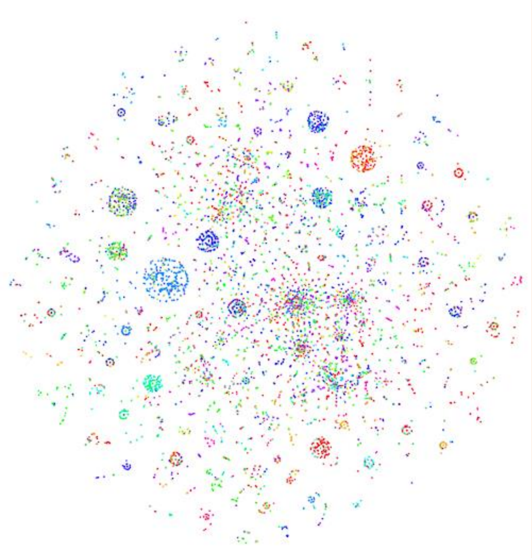


- Regression:
  - Predicting continuous-valued outputs.
- Working with very high-dimensional data.

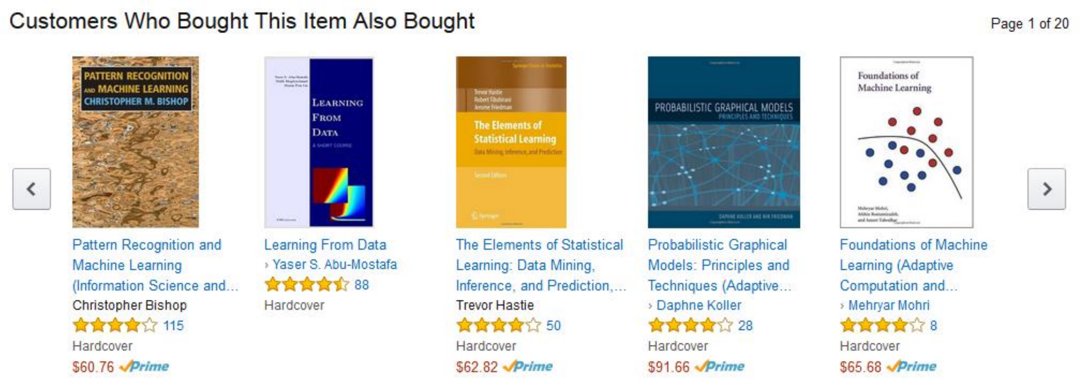




Latent-Factor Models



- Principal component analysis and friends:
  - Low-dimensional representations.
  - Decomposing objects into “parts”.
  - Visualizing high-dimensional data.
- Collaborative filtering:
  - Predicting user ratings of items.



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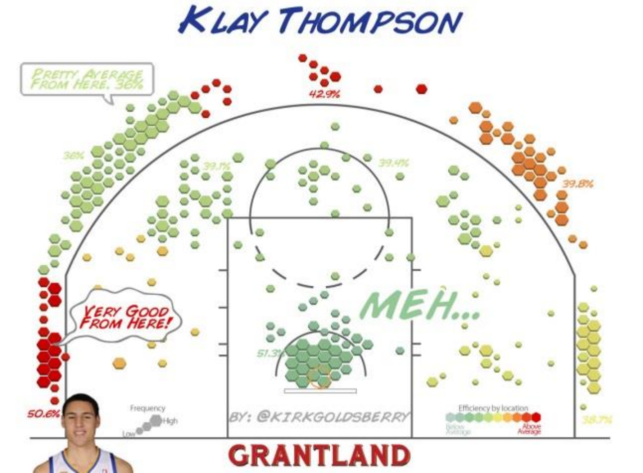
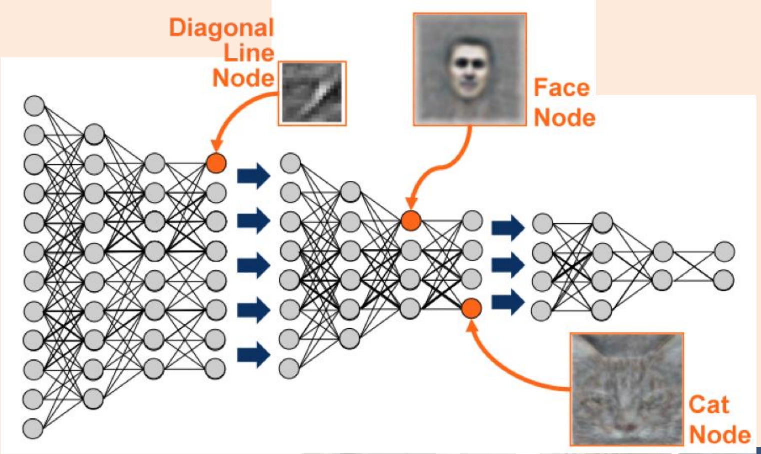
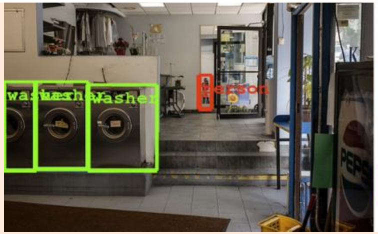
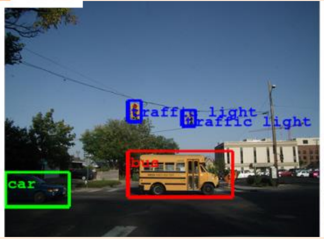


Deep Learning

- Neural networks: Brain-inspired ML when you have a lot of data/computation but don't know what is relevant.







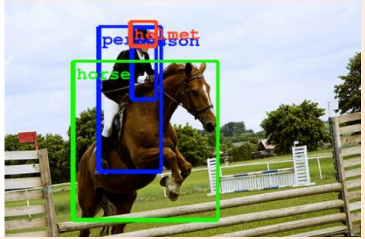
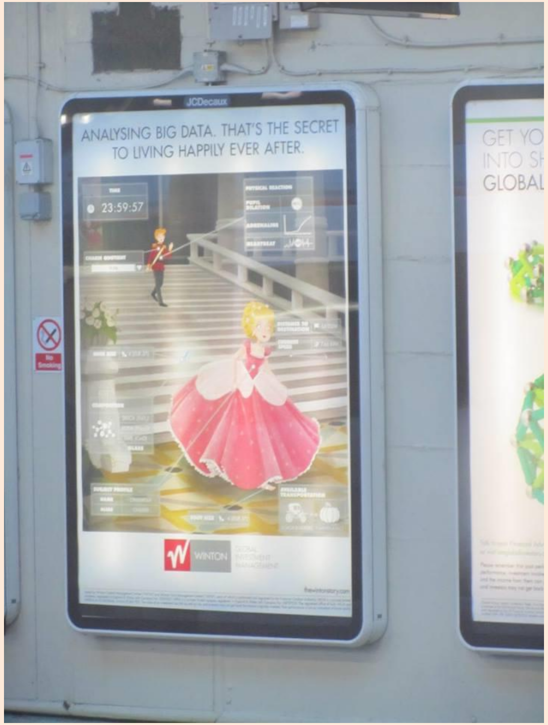


Photo I took in the UK on the way home from the “Optimization and Big Data” workshop:


JCDecaux
ANALYSING BIG DATA. THAT'S THE SECRET TO LIVING HAPPILY EVER AFTER.
23:59:57
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