CPSC 340: Machine Learning and Data Mining

Mark Schmidt University of British Columbia Fall 2015

Outline

1) Intro to Machine Learning and Data Mining:

- Big data phenomenon and types of data.
- Definitions of data mining and machine learning.
- Applications and impact.

Course Administrivia
 Course Overview

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:
 - News articles and blog posts.
 - YouTube, Facebook, and WWW.
 - Credit cards transactions and Amazon purchases.
 - 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?
 <u>Too much data</u> 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:
 - Don't have a human expert.
 - Humans can't explain patterns.
 - Problem is too complicated.

Data Mining vs. Machine Learning

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



 Both similar to statistics, but less emphasis on 'correct' models and more on computation.

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Transaction Date - Posted Date

Aug. 28, 2015

Aug. 27, 2015

• Motion capture:

• Machine translation:

• Speech recognition:





• Face detection:

• Object detection:





• Sports analytics:

KLAY THOMPSON



• Personal Assistants:

• Medical imaging:

• Self-driving cars:







• 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

• Inceptionism, mimicking art styles:



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

- But, you should not use these methods blindly:
 - The future may not be like the past.
 - Associations do not imply causality.

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- 1) Intro to Machine Learning and Data Mining:
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Location, Dates, Webpage

- Course homepage:
 - www.cs.ubc.ca/~schmidtm/Courses/340-F15
- Office hours:
 - Thursdays in ICCS 146 from 3-4.
 - Or by appointment.
- Tutorials:
 - Mondays in DMP 201 from 11-12, 2-3, and 4-5.
 - Only on weeks when assignments are due.
- Teaching Assistants:
 - Issam Laradji.
 - Sharan Vaswani.
 - Tian Qi (Ricky) Chen.
 - Yan Zhao.



CPSC 540 and Auditting 340

- There is also a graduate ML course, CPSC 540:
 Higher workload.
 - More advanced material.
 - More implementation/theory, fewer applications.
- Auditing CPSC 340 or 540, an excellent option:
 - Pass/fail on transcript rather than grade.
 - Do 2 assignments or write a 2-page report on one technique from or attend > 90% of classes.
 - But please do this officially:
 - http://students.ubc.ca/enrolment/courses/academicplanning/audit

Textbooks

- No required textbook.
- Some books that cover related material:
 - Artificial Intelligence: A Modern Approach (Rusell & Norvig).
 - The Elements of Statistical Learning (Hastie et al.).
 - Machine Learning: A Probabilistic Perspective (Murphy).
 - Pattern Recognition and Machine Learning (Bishop).
 - All of Statistics (Wasserman).
 - Introduction to Data Mining (Tan et al.).
- There is a list of related courses on the webpage.
- You can also use Google.

Assignments

- 6 Assignments worth 25% of final grade:
 - Written portion and Matlab programming.
 - Due at the start of Friday class:
 - September 18 (Friday of next week), October 2, October 16, November 6, November 20, December 4.
 - You can have up to 3 total 'late classes':
 - Handing in an assignment on Monday counts as one.
 - Handing in on Wednesday counts as two.
 - After that, you will get a mark of 0 for late assignments.
 - Examples:
 - you can hand in A1, A4, and A5 one day late.
 - you can hand in A2 two days late and A4 one day late.
 - you can hand in A1 three days late, and all others on time.

Getting Help

- Tutorials on Mondays before assignments due.
- Piazza for assignment/course questions:
 piazza.com/ubc.ca/winterterm12015/cpsc340
- If you do not have access to Matlab:
 - Ask for a CS guest account.
 - Purchase Matlab through the bookstore or online.
 - Use the free alternative Octave.
- You can work in groups and use any source, but:
 - Hand in your own homework.
 - Acknowledge all sources, including other students.

Midterm and Final

- Midterm details:
 - 30% of final grade
 - In class October 30.
 - Closed book, two-page double-sided 'cheat sheet'.
- No 'tricks' or 'surprises':
 - Given a list of things you need to know how to do.
 - Mostly minor variants on assignment questions.
- If you miss the exam, see me with a doctor's note or other relevant documentation.
- Final will follow same format:
 - 45% of final grade.
 - Cumulative.

Lecture Style and Instructor Evaluation

- I feel that I learn/teach better when using the board.
 - Slows down the lecture.
 - Makes the lecture adaptive.
- This term: hybrid "writing on slides" approach.
- About recording:
 - Do not record without permission.
 - All class material will be available online.
- Topics/readings will be posted before each class.
- October 12, we'll do an unnofficial instructor evaluation:
 - Will let me adapt lecture/assignment style.

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Course Outline

- 1) Data preprocessing and exploration.
- 2) Frequency-based supervised learning.
- 3) Data clustering and association rules.
- 4) Linear prediction, regularization, and kernels.
- 5) Outlier detection, dimensionality reduction, and visualization.
- 6) Neural networks and deep learning.
- 7) Link analysis and collaborative filtering.
- 8) Sequences and time-series.

Data Preprocessing and Exploration,

- Types of data and data structures.
- Issues with data quality.
- Summary statistics.
- Data visualization.





Frequency-Based Supervised Learning

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



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Data Clustering and Association Rules

• Clustering:

- Find groups of `similar' items in data.

- Examples:
 - Are there subtypes of tumors?
 - Are there high-crime hotspots?
- Association rules:
 - Finding items frequently 'bought together'.











Linear Prediction, Regularization, and Kernels

• Regression:

Predicting continuous-valued outputs.



• Working with very high-dimensional data.





Outlier Detection, Dimensionality Reduction, and Visualization

- Outlier detection:
 - Finding data that doesn't belong.
- Dimensionality reduction:
 - Low-dimensional representations .
- Visualization:
 - Displaying
 high-dimensional
 relationships.



Neural Networks and Deep Learning

• ML when you have a lot of data/computation but don't know what is relevant.







Link Analysis and Collaborative Filtering

• Link analysis:

Customers Who Bought This Item Also Bought

- Evaluate relationships between nodes in graph.
- Collaborative filtering:
 - Predict user rating of items.









Pattern Recognition and Machine Learning (Information Science and... Christopher Bishop The science and the s



Learning From Data • Yaser S. Abu-Mostafa • • • • • • • • 88 Hardcover



The Elements of Statistical Learning: Data Mining, Inference, and Prediction,... Trevor Hastie Trevor Hastie 50 Hardcover \$62.82 *Prime*



Probabilistic Graphical Models: Principles and Techniques (Adaptive...) Daphne Koller) Daphne Koller 28 Hardcover \$91.66 //Prime

Sequences and Time Series

• How can we model trends over time?



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

