Machine Learning: Chenhao Tan
University of Colorado Boulder

LECTURE 1

Slides adapted from Jordan Boyd-Graber, Thorsten Joachims
Basic Information

- Course location and time: ECCS 1B12, 17:00-18:15 (MW)
- Instructor: Chenhao Tan
- Course assistants: Zhenguuo Chen, Tyler Scott
- Graders: Zhenguuo Chen, Sean Harrison
Outline of today

- An overview of machine learning
- Syllabus
- Administrivia
- Pop-up quiz
Outline

An overview of machine learning
  Motivating examples
  What is machine learning?
  Why do we want machines to learn?
  How does machine learning work?

Syllabus

Administrivia
Machine learning is everywhere!
AlphaGo
Autonomous driving

Three lidar systems

A forward facing camera

Radar sensors

Self-driving sensors
Movie recommendation
Social networks
Which one will be retweeted more?

Food trucks are the epitome of small independently owned LOCAL businesses! Help keep them going! Sign the petition bit.ly/P6GYCq

I know at some point you’ve have been saved from hunger by our rolling food trucks friends. Let’s help support them! bit.ly/P6GYCq
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An overview of machine learning

Motivating examples

Finance

Dow Jones Composite Average (^DJA) - DJI

4,372.78  $20.68 (0.47%)  1:48 PM EDT

Enter name(s) or symbol(s) | GET CHART |COMPARE | EVENTS | TECHNICAL INDICATORS | CHART SETTINGS | RESET

Aug 29, 2012 2:59 PM - 3:04 PM EDT: DJA 4416.03

Volume: 571,700

FROM: Aug 29 2012  TO: Sep 4 2012 -0.57%
Health/Diagnosis

http://www.newyorker.com/magazine/2017/04/03/ai-versus-md
Machine learning is everywhere!

- smart city
- entertainment
- social
- finance
- medical
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Email me to introduce yourself, one of your core values, and a machine learning application that you care about.
What is machine learning?

One definition (Mitchell): A computer program is said to learn from

- experience $E$ with respect to some class of
- tasks $T$ and
- performance measure $P$,

if its performance at tasks in $T$, as measured by $P$, improves with experience $E$. 
Let us apply this to classic tasks in machine learning!
ImageNet/Object recognition

- $T$: identifying objects in an image
- $E$: tons of images with annotated objects
- $P$: how often the objects are identified correctly
An overview of machine learning | What is machine learning?

Sentiment analysis

Hutzler #571 Banana Slicer
The only banana slicer you will ever need.

Gourmac's easy-to-use Banana Slicer provides a quick solution to slice a banana uniformly each and every time. Simply press the slicer on a peeled banana and the work is done. Safe, fun and easy for children to use. Kids just love eating bananas with this as their favorite kitchen tool. The Banana Slicer may also be used as a quick way to add healthy bananas to breakfast cereal or to make uniform slices for a fruit salad or ice cream dessert.

Top critical review
See all 2,023 critical reviews

15,029 people found this helpful
🌟🌟🌟🌟🌟 Angle is wrong

By Jim Anderson on August 1, 2012

I tried the banana slicer and found it unacceptable. As shown in the picture, the slicer is curved from left to right. All of my bananas are bent the other way.
Sentiment analysis

An overview of machine learning  |  What is machine learning?

- **T**: deciding whether a review is positive or negative
- **E**: reviews with ratings
- **P**: how often the sentiment is predicted correctly

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Movie recommendation

- $T$: recommend movies
- $E$: movie watching history and movie ratings
Movie recommendation

- $T$: recommend movies
- $E$: movie watching history and movie ratings
- $P$: future rating of users? user active time on website? user subscription periods?
Why do we want machines to learn?

- Intellectually satisfying!
- Helping us solve problems.
Why do we want machines to learn?

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Automate tasks that we know how to perform

Explore tasks that we don’t know how to perform
Why do we want machines to learn?

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Automate tasks that we know how to perform
- Object recognition
- Driving

Explore tasks that we don’t know how to perform
- Movie recommendation
- Newsfeed ranking
- Predict message popularity
- Playing Go
- Finance
- Health/diagnosis
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  - Predict message popularity

What about these?
- Playing Go
- Finance
- Health/diagnosis
An overview of machine learning

How does machine learning work?

How does machine learning work as of today?

The focus of this course!

1. Collect or happen upon data (\(X\), experience in the previous definition).
2. Analyze it to find patterns.
3. Use those patterns to perform some task (\(T\)).
An overview of machine learning

How does machine learning work?

This course

We will study algorithms that find and exploit patterns in data.

- These algorithms draw on ideas from statistics and computer science.
- Applications include
  - natural science (e.g., genomics, neuroscience)
  - web technology (e.g., Google, NetFlix)
  - finance (e.g., stock prediction)
  - policy (e.g., predicting what intervention X will do)
  - and many others
This course

**We will study algorithms that find and exploit patterns in data.**

- **Goal:** fluency in thinking about modern machine learning problems.
- **We will learn about a suite of tools in modern data analysis.**
  - When to use them
  - The assumptions they make about data
  - Their capabilities, and their limitations
  - Theoretical guarantees
- **We will learn a language and process for solving data analysis problems.** On completing the course, you will be able to learn about a new tool, apply it to data, and understand the meaning of the result.
Supervised vs. unsupervised methods

- **Supervised methods** find patterns in **fully observed** data and then try to predict something from **partially observed** data.

- For example, in sentiment analysis, after learning something from annotated reviews, we want to take new reviews and automatically identify sentiments.
Supervised vs. unsupervised methods

- **Unsupervised methods** find hidden structure in data, structure that we can never formally observe.
- For example, modeling topics from a collection of scientific papers; evaluation is usually more difficult.
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Syllabus

Administrivia
Preliminary schedule

- Supervised learning
- Learning theory
- Unsupervised learning
- Others
  - Hidden Markov Models (structured prediction)
  - Online learning
  - Reinforcement learning
  - Machine learning and society, interpretability

https://chenhaot.com/courses/csci5622/2017fa/syllabus.html, there is a quiz about syllabus in homework 1.
Prerequisites

- Programming language: Python
- Math background:
  - probability
  - linear algebra
  - calculus
  - information theory
  - optimization
Course text books

- We will provide reading materials, mostly from the book.
- Slightly different focus: same concepts, use book as starting point.
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- We will provide reading materials, mostly from the book.
- Slightly different focus: same concepts, use book as starting point
- Learnability will be from suggested book

Foundations of Machine Learning

Mehryar Mohri,
Afsheen Rostamizadeh,
and Ameet Talwalkar
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Syllabus

Administrivia
Contact information

- Course webpage: https://chenhaot.com/courses/csci5622/2017fa/home.html
- Piazza: https://piazza.com/colorado/fall2017/csci5622/home
Grading policy

- Homeworks: No late submissions (40%)
- Midterm: in class (15%)
- Final project (40%)
- Participation (5%)
Final project

- Project brainstorming: Aug 28 – starting from the first day, getting yourself in ML mode
- Group formation due: Oct 4
- Final project proposal due: Oct 17
- Final project peer feedback due: Oct 25
- Midpoint spotlight: Nov 15
- Midpoint peer feedback due: Nov 27
- Final project poster session: Dec 13
- Final project report due: Dec 15
Feedback

- Private emails
- Periodic survey