18-461/661: Introduction to ML for Engineers

Course Overview

Spring 2020

ECE – Carnegie Mellon University

Registration

- Course is currently full and we can't increase class size
- Expect several students will drop the course
- Course will be offered again in Fall 2020

Direct all waitlist-related questions to Megan Oliver (Pittsburgh) or Brittany Walker (SV): mvoliver@andrew.cmu.edu and bmw2@andrew.cmu.edu

- If you're not registered, we encourage you to stay patient
- You are welcome to keep attending the lectures until the waitlists are sorted out

Instructors & TAs: One Class, Three Campuses!

- Gauri Joshi, Co-Instructor (Pittsburgh)
- Carlee Joe-Wong, Co-Instructor (SV)
- Moise Busogi, Co-Instructor (Kigali)

- Shreyas Chaudhari, TA (Pittsburgh)
- Ritwick Chaudhry, TA (Pittsburgh)
- Soham Deshmukh, TA (Pittsburgh)
- Jacob Hoffman, TA (Pittsburgh)
- Samarth Gupta, TA (Pittsburgh)
- Mike Weber, TA (SV)
- TJ Kim, TA (SV)
- Sweta Hari Kumar, TA (SV)

Credit & thanks to:

- Yuejie Chi and Virginia Smith, CMU
- Anit Sahu and Joao Saude, CMU
- Ameet Talwalkar, CMU
- Fei Sha, USC
- Emily Fox, UW

Outline

1. What is Machine Learning?
2. Course Goals
3. Course Logistics

What is Machine Learning?

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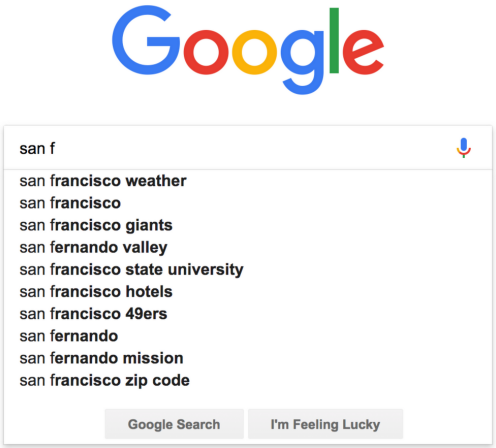

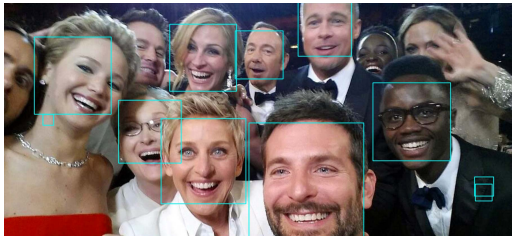

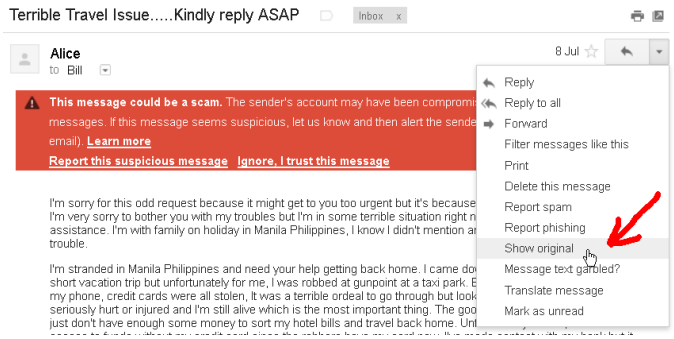

- **Machine learning is**: the study of methods that *improve their performance on some task with experience*

Machine Learning Pipeline

Examples

Task 1: Regression

How much should you sell your house for?

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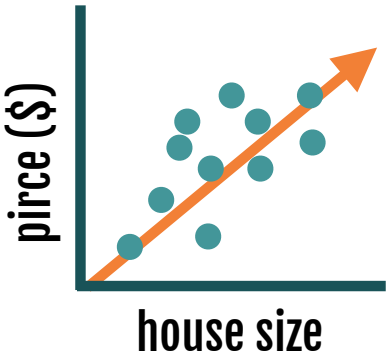

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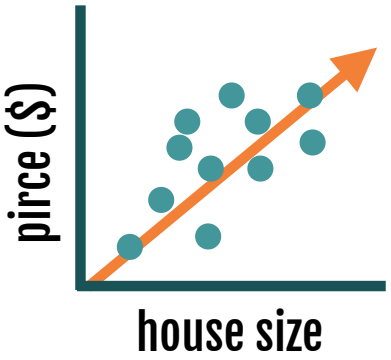

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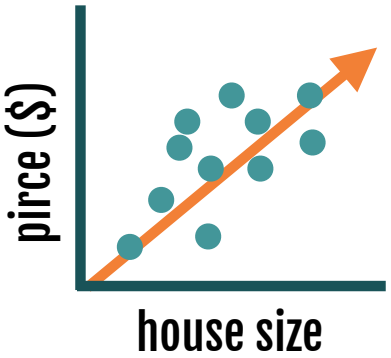

input: houses & features **learn**: $x \to y$ relationship **predict**: y (*continuous*)

Course Covers: Feature Scaling, Linear/Ridge Regression, Loss Function, SGD, Regularization, Cross Validation

Task 2: Classification

Cat or dog?

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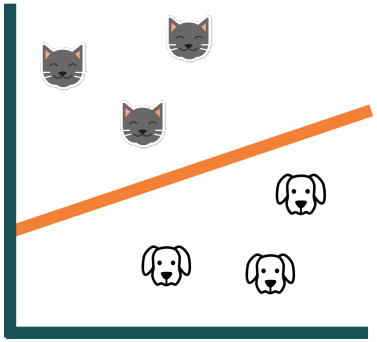

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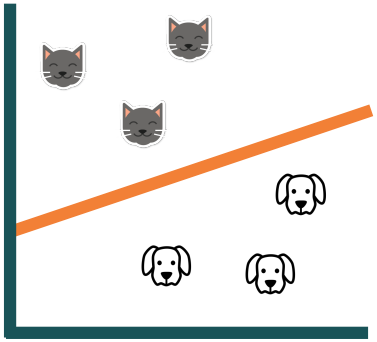

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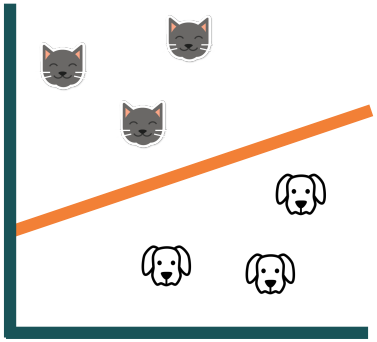

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Course Covers: Naive Bayes, Logistic Regression, SVMs, Neural Nets, Decision Trees, Boosting, Nearest Neighbors

Task 3: Clustering

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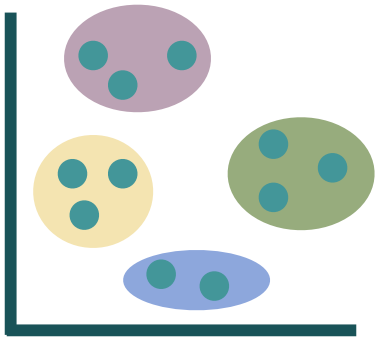

separate: $\{x\}$ into sets

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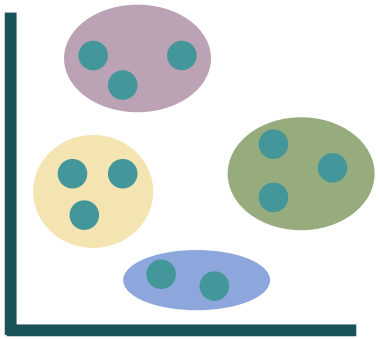

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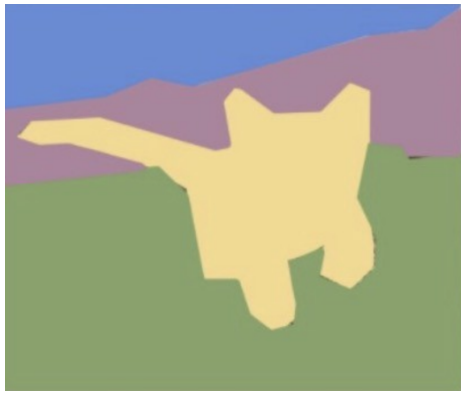

output: cluster labels $\{z\}$

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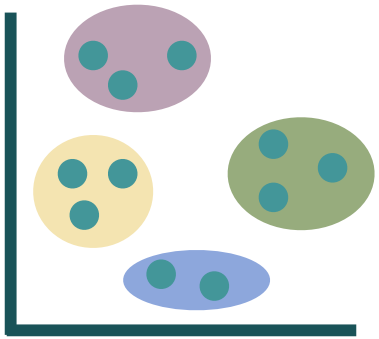

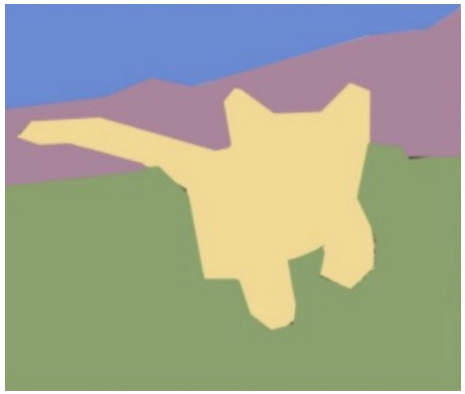

input: raw pixels $\{x\}$ **separate**: $\{x\}$ into sets **output**: cluster labels $\{z\}$

Course Covers: K-means, K-means++ clustering

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How to reduce size of dataset?

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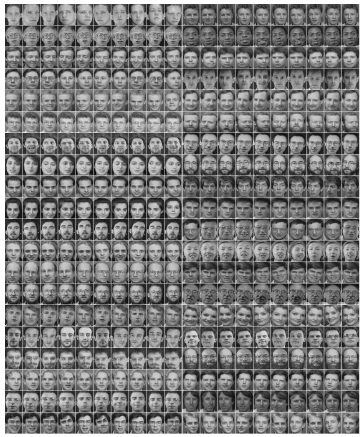

input: large dataset $\{x\}$

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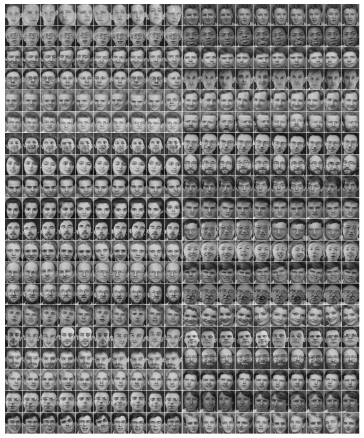

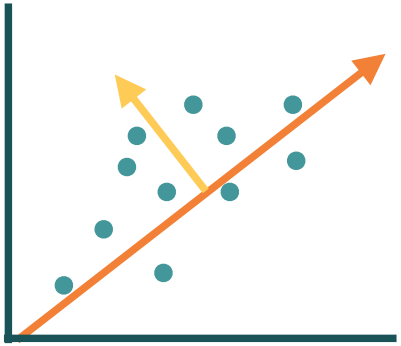

input: large dataset $\{x\}$ **find**: sources of variation

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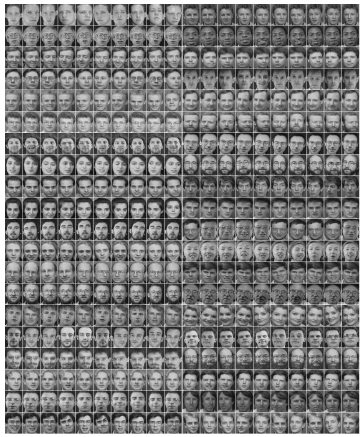

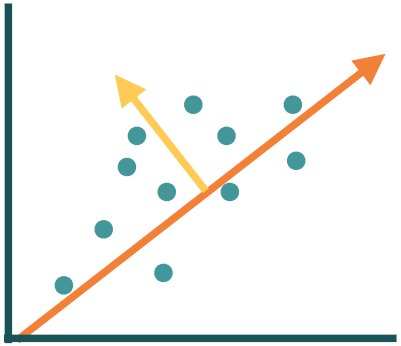

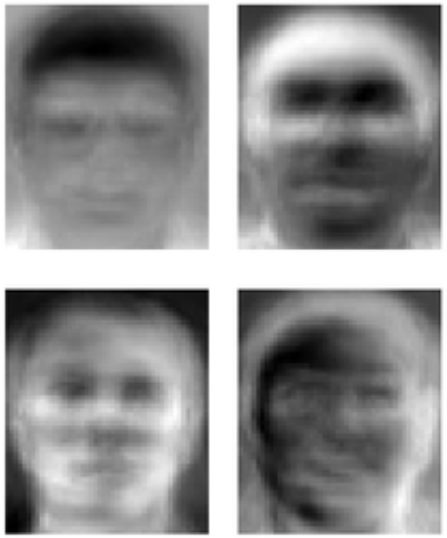

input: large dataset $\{x\}$ **find**: sources of variation **return**: representation $\{z\}$

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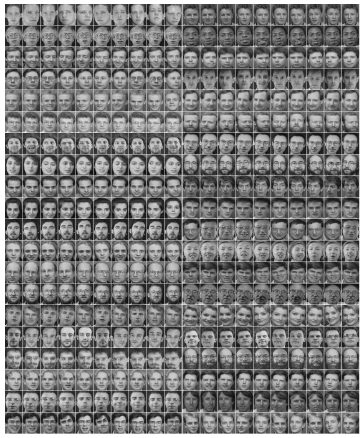

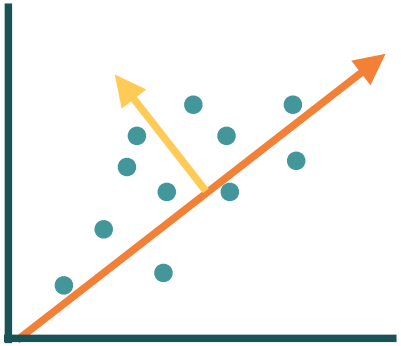

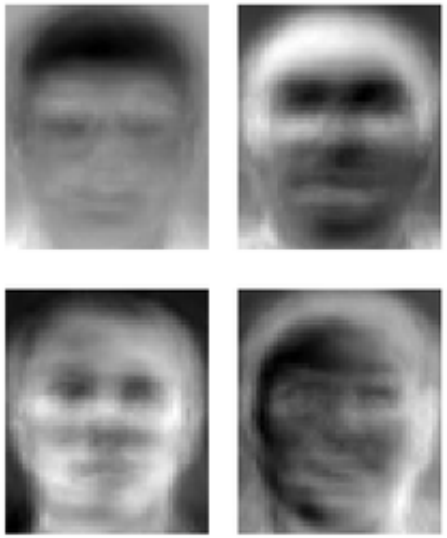

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Course Covers: Dimensionality Reduction, PCA

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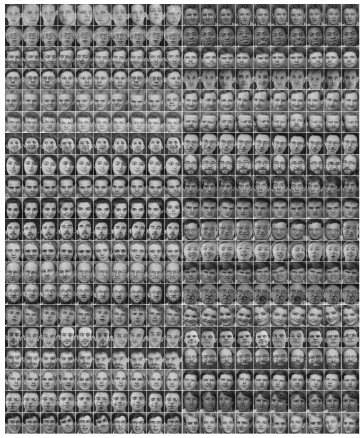

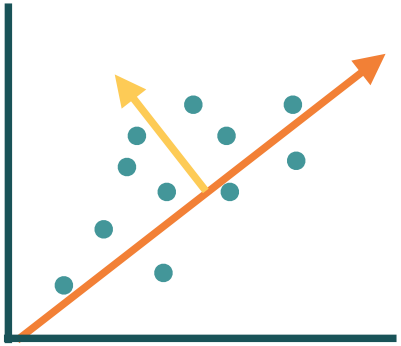

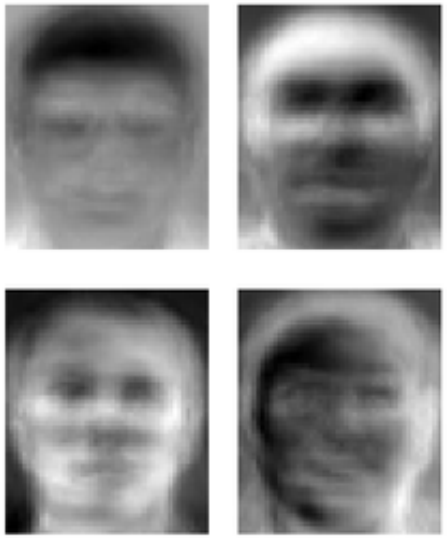

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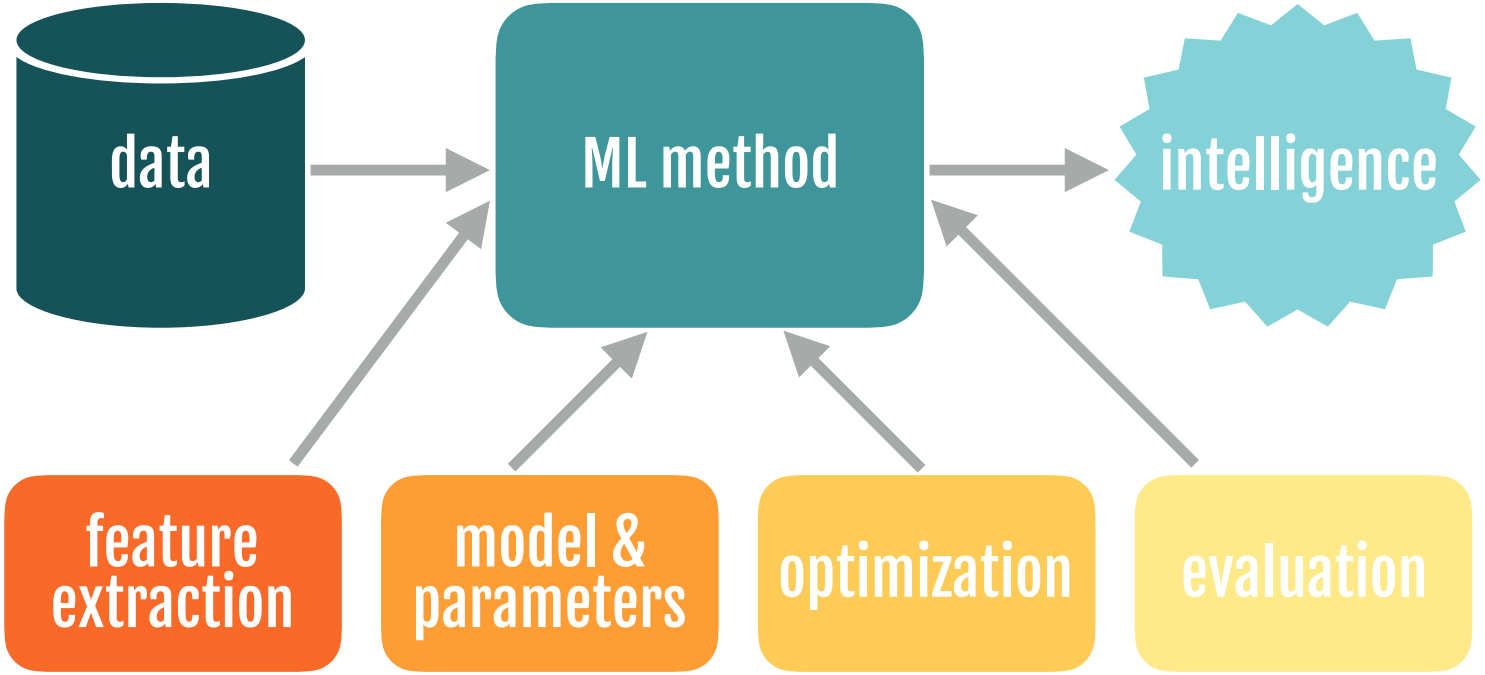
Course Goals

Goal of the Course



Equip you with the *tools* to *develop* and *deploy* machine learning for engineering applications

- Fundamental Understanding: Algorithms, Theoretical Analysis
- Applications: Implementation in Python, PyTorch

Key Topics

Models

- Linear regression
- Linear classification: logistic regression, SVM
- Nonlinear models: kernels, neural networks & deep learning, decision trees
- Nearest neighbors, clustering

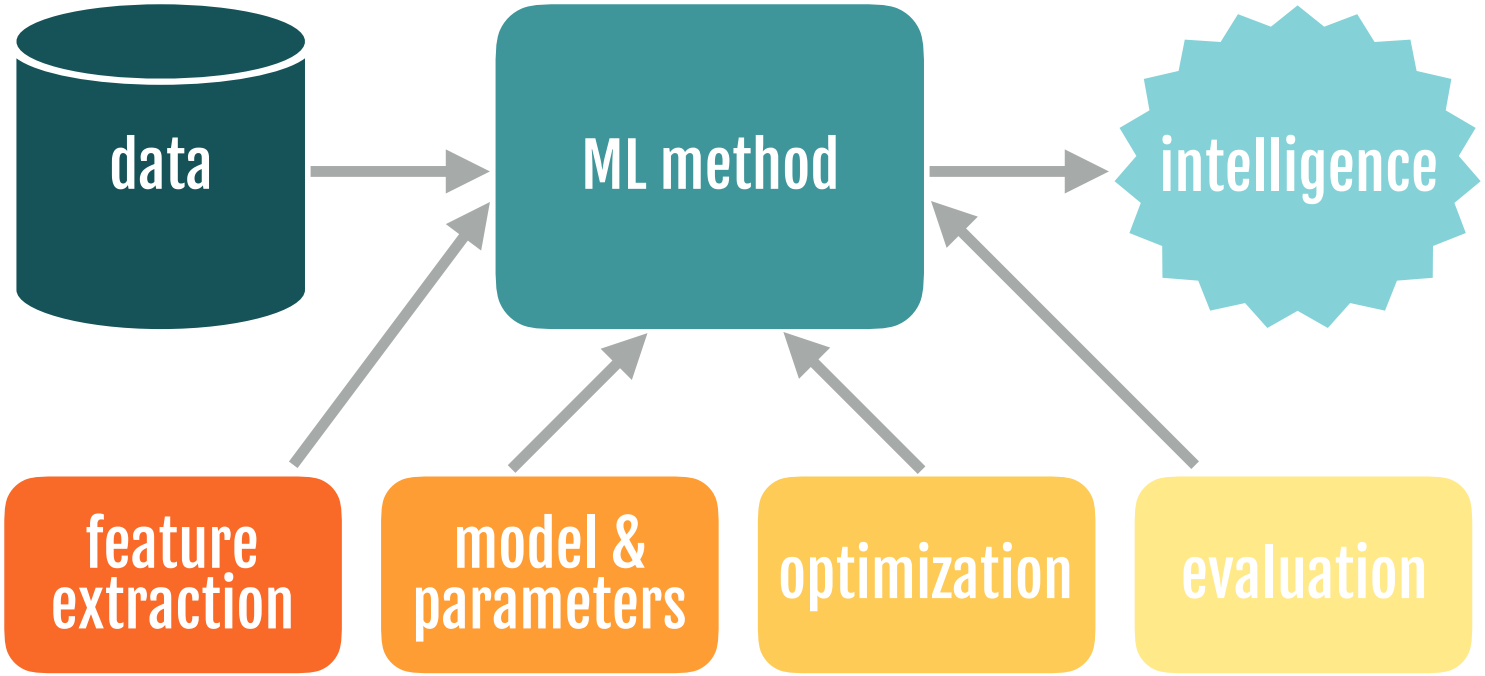
Methods

- Gradient descent
- Boosting
- k-means
- PCA

Concepts

- Point estimation, MLE, MAP
- Loss functions, bias-variance tradeoff, cross-validation
- Sparsity, overfitting, model selection
- Types of ML (supervised, unsupervised, reinforcement)

Similar Courses



- Most similar CMU Courses are 10-601 and 10-701
- This class is geared towards engineers and will include Python & PyTorch implementation of ML methods on real datasets

Course Logistics

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Office Hours

- Instructors' office hours will be held immediately after class
- TA Office Hours (starting next week) TBD on course website

Lectures and Office Hours

Lectures

- Gauri and Carlee will co-teach, switching after every 3-4 lectures
- Lectures will be broadcast to the remote campuses
- Recorded lectures will be uploaded to Canvas

Office Hours

- Gauri's office hours – right after class (4:20-5 pm) at Pitt CIC 4105
- Carlee's office hours – right after class (1:20- 2:30 pm) at SV
- Moise's office hours – right before class (8-9 pm) in Kigali D110
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Recitations

- There will be ~ 1 recitation every week (see schedule on the website):
  - Friday 10:30am-11:50am ET, BH 136A (Pittsburgh)
  - Friday 1:30pm-2:50pm PT, B23 118 (SV)
- Attending discussion sections is not mandatory
  - But it is strongly encouraged!
  - Discussion will go into greater detail, cover supplementary material, answer questions, and review before exams

Homeworks and Exams

- Homeworks (50%): Both math and programming problems
- Midterm Exam (20%): Linear and Logistic Regression, SVMs
- Final Exam (30%): Nearest Neighbors, Neural Networks, Decision Trees, Boosting, Clustering, PCA, plus pre-midterm topics

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Difference between 18-461 and 18-661

- The major programming HW will be easier for 18-461
- Grading Curve is separate (and easier) for 18-461

Logistics

- Course Website: `https://www.andrew.cmu.edu/course/18-661/`: Slides and Other Reading Materials
- Gradescope: Homework submission and grading
- Piazza: Course Discussions

We are working on getting you access to Gradescope and Piazza ASAP. More instructions to follow

Student Wellness

Take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and alcohol, getting enough sleep and taking some time to relax. This will help you achieve your goals and cope with stress.

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If you feel overwhelmed or want to talk to someone, please feel free to contact the following resources:

- Counseling and Psychological Services (CaPS) in Pittsburgh at 412-268-2922 or `http://www.cmu.edu/counseling/`.
- Director of Student Affairs in SV at 650-335-2846, Building 19, Room 1041 or student-services@sv.cmu.edu.

Quick Polls

- Undergrad / Masters / PhD?

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- ECE / Other Engineering / Computer Science / Other?

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- Registered / Waitlist / Hoping to Register / Other?

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TAs will discuss the math quiz during this Friday's recitations

Questions?

Math Quiz

Score won't affect grade

But is an indication of your preparedness for the course