Classification:

A machine learning perspective

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Machine Learning Specialization

University of Washington

Part of a specialization

This course is a part of the Machine Learning Specialization

What is the course about?

What is classification?

From features to predictions

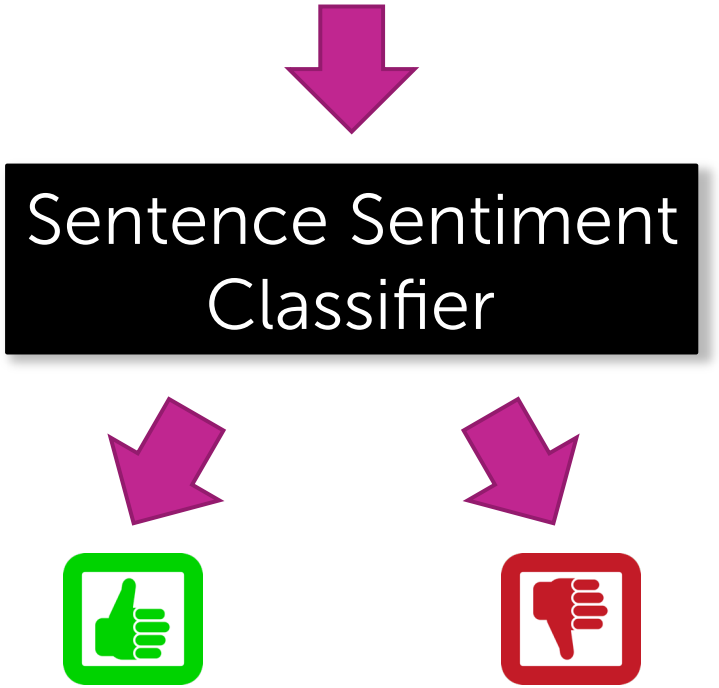
Input x:
features derived from data

Learn x→y relationship

Predict y:
categorical "output", class or label

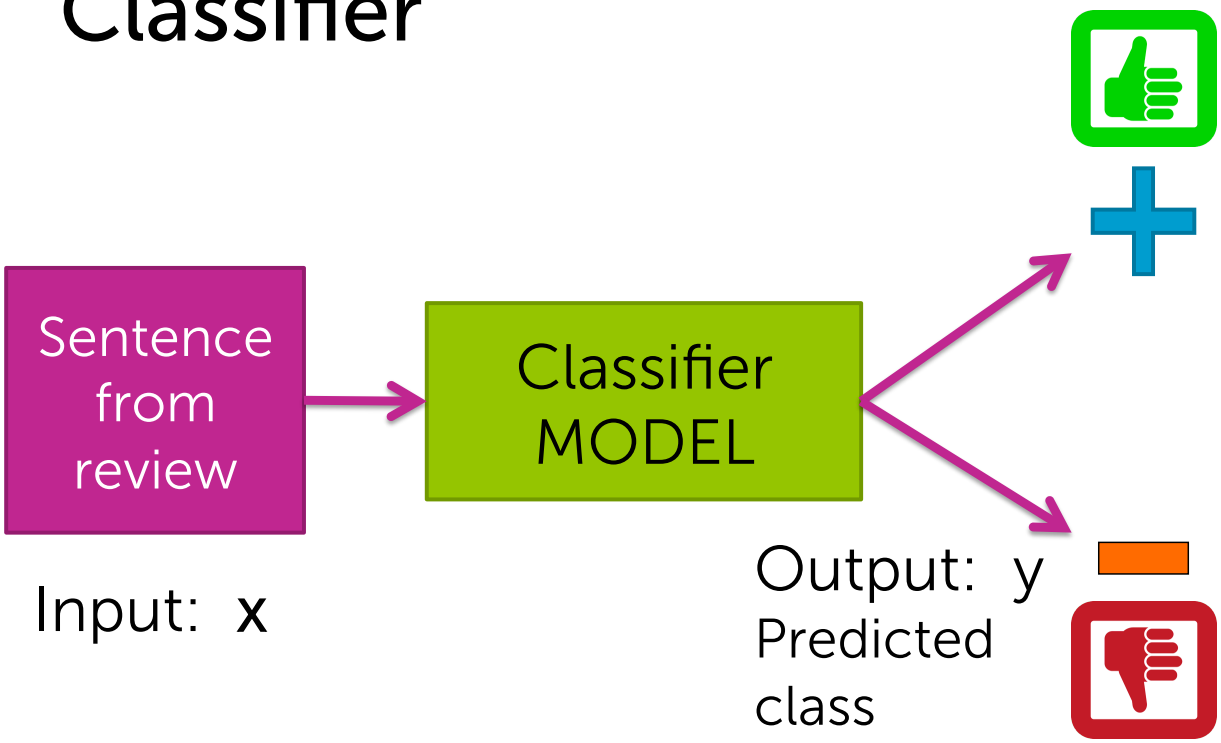
Sentiment classifier

Input **x**: Easily best sushi in Seattle.



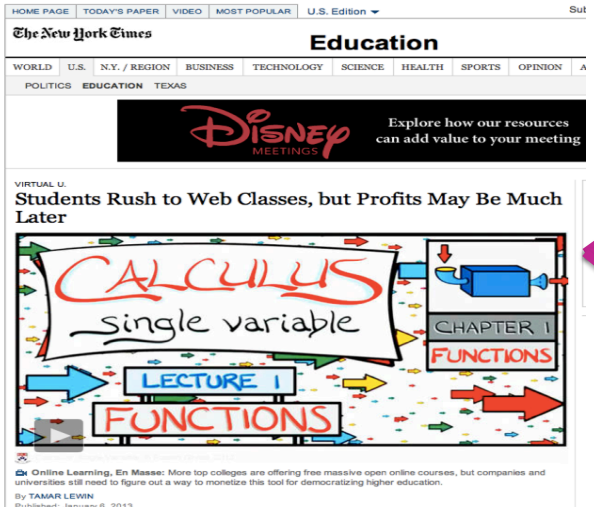
Output: y
Sentiment

Classifier



Example multiclass classifier

Output y has more than 2 categories



Education

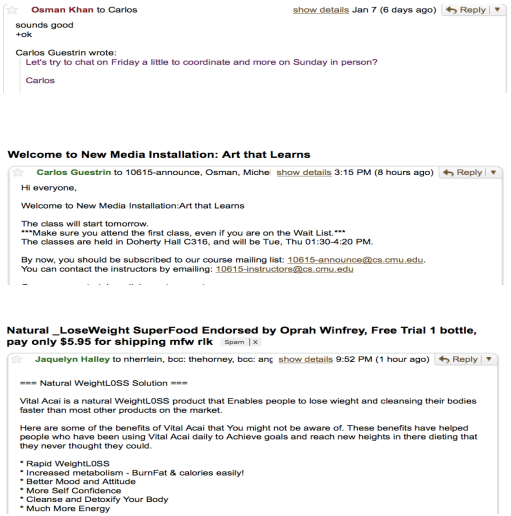
Finance

Technology

Input: **x**
Webpage

Output: y

Spam filtering



Input: **x**

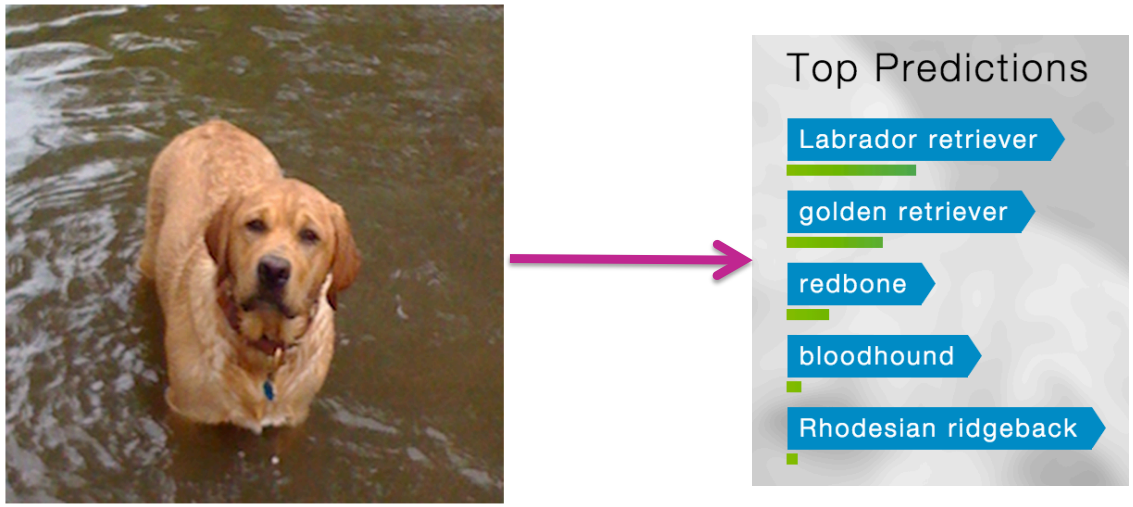
Text of email, sender, IP,...

Not spam

Spam

Output: **y**

Image classification

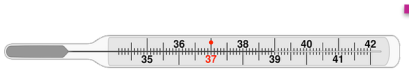


Input: **x**
Image pixels

Output: **y**
Predicted object

Personalized medical diagnosis

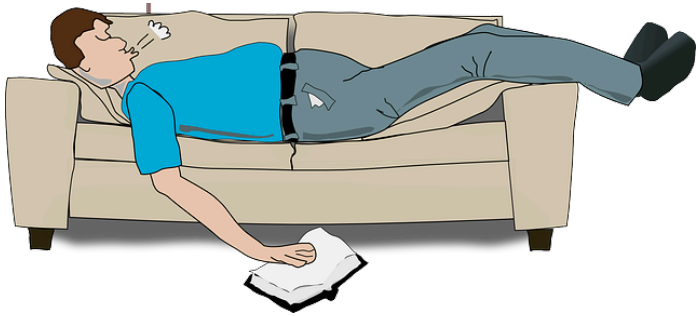
Input: x



Output: y

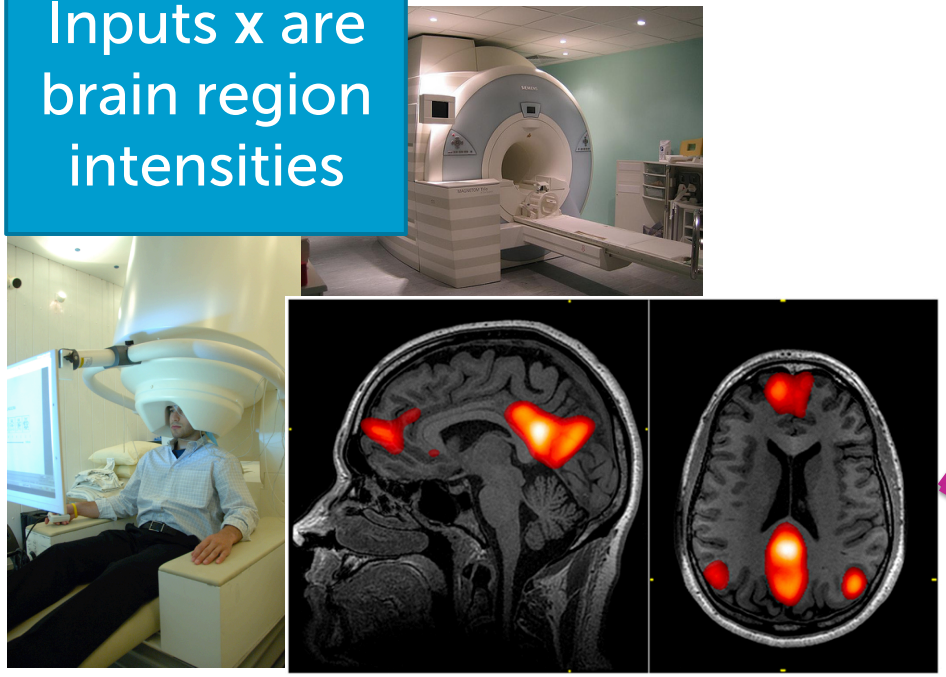
Disease Classifier MODEL

- Healthy
- Cold
- Flu
- Pneumonia
- …



Reading your mind

Inputs x are brain region intensities



Output y

"Hammer"

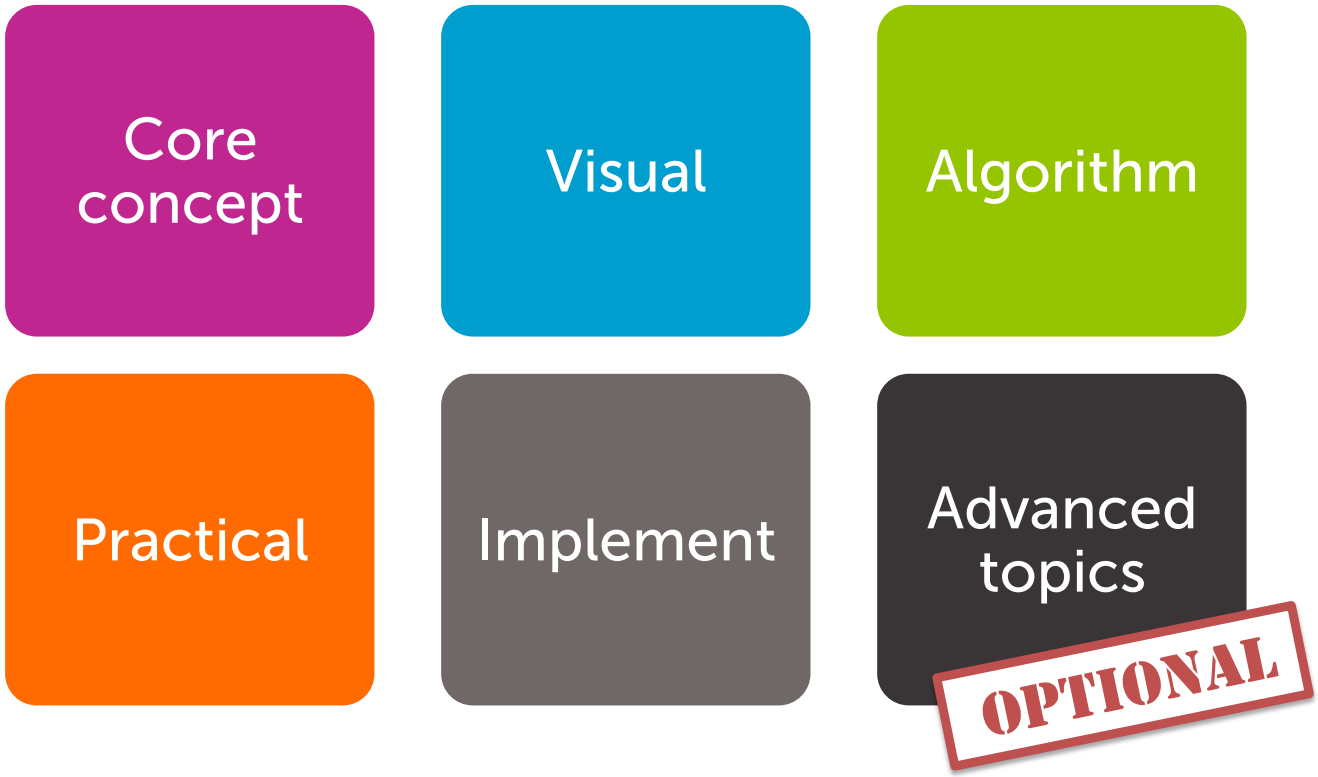
"House"

Impact of classification

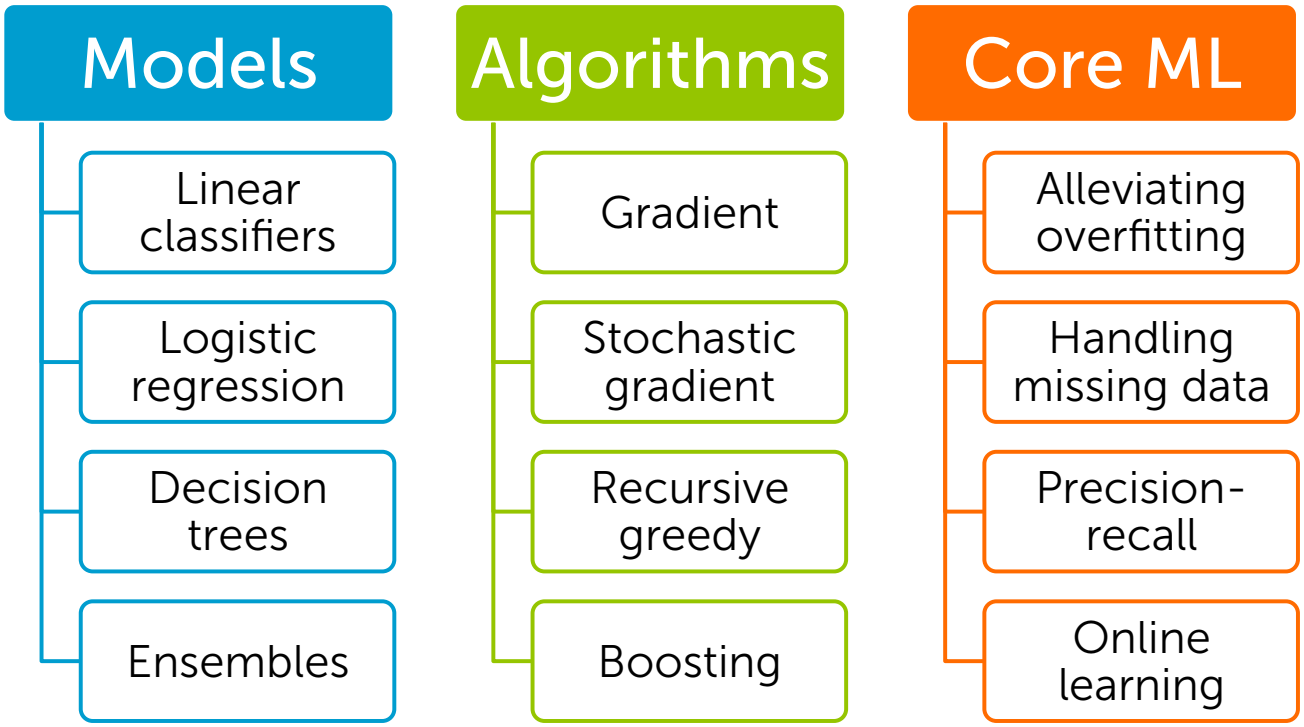
Impact of classification

Course overview

Course philosophy: **Always use case studies** & …

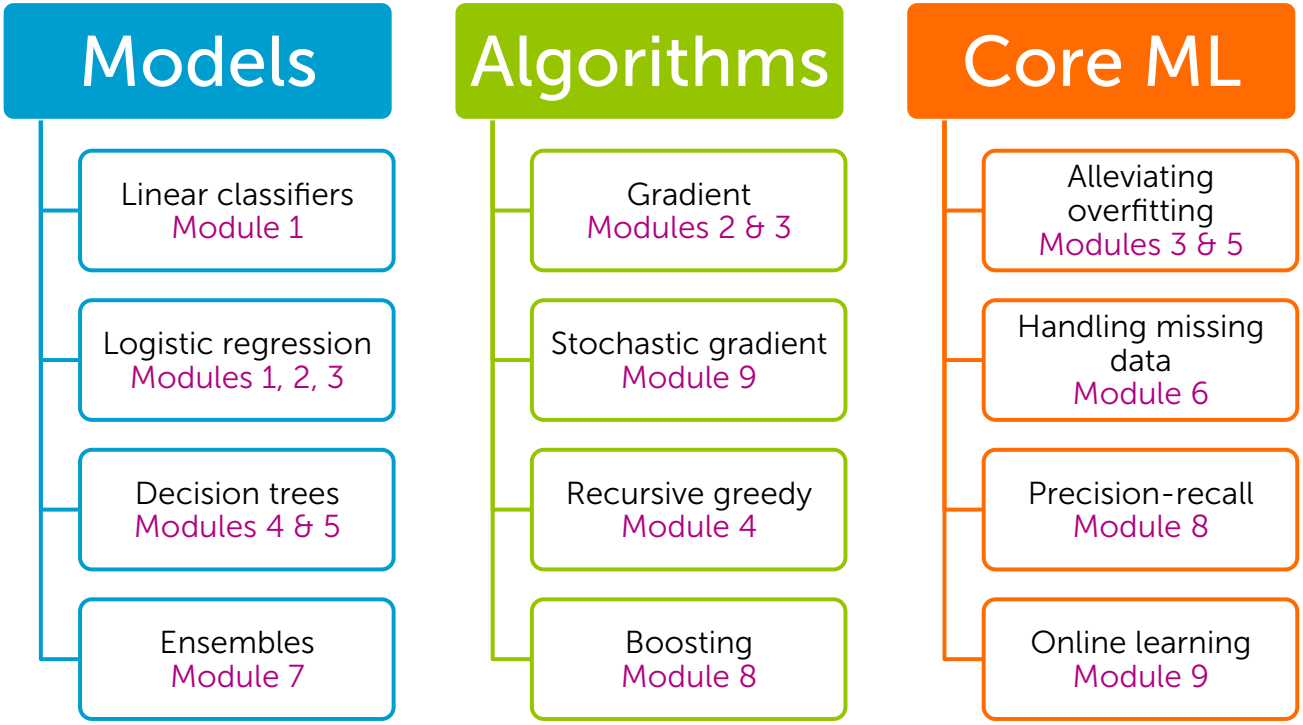


Overview of content



Course outline

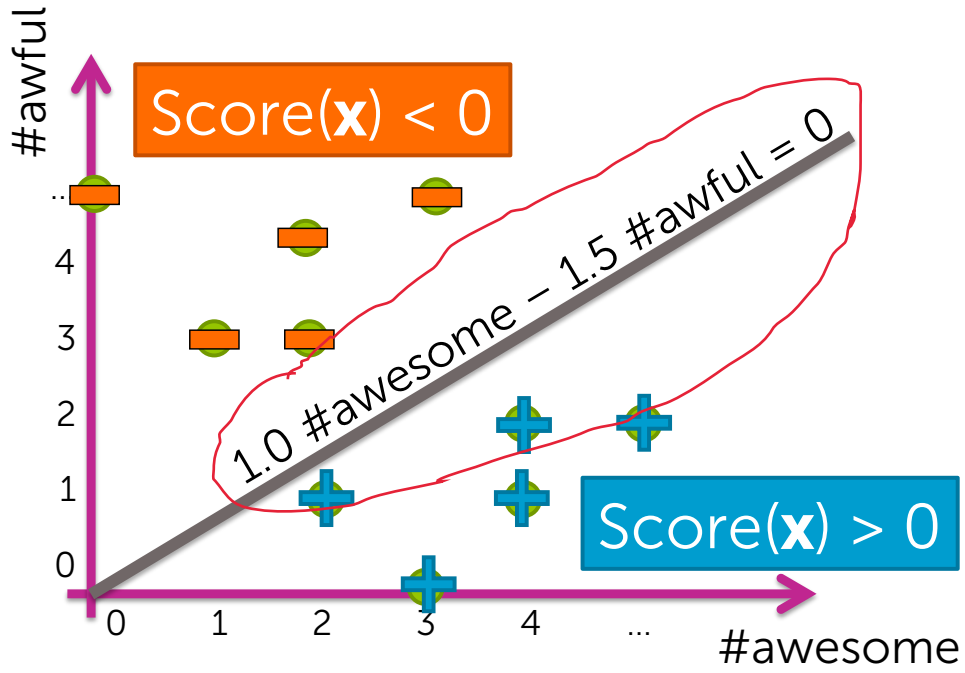
Overview of modules



Module 1: Linear classifiers

Word	Coefficient
#awesome	1.0
#awful	-1.5

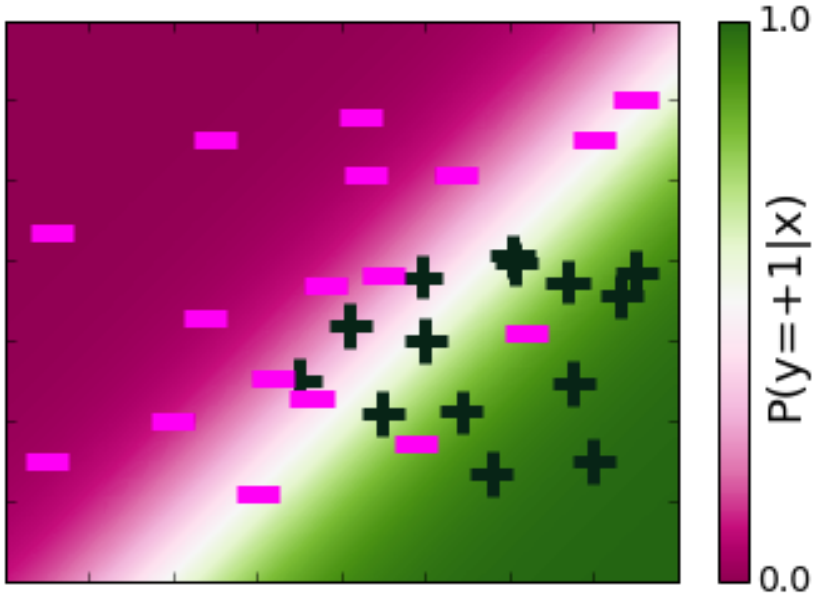
Score(x) = 1.0 #awesome – 1.5 #awful



Module 1: Logistic regression represents probabilities

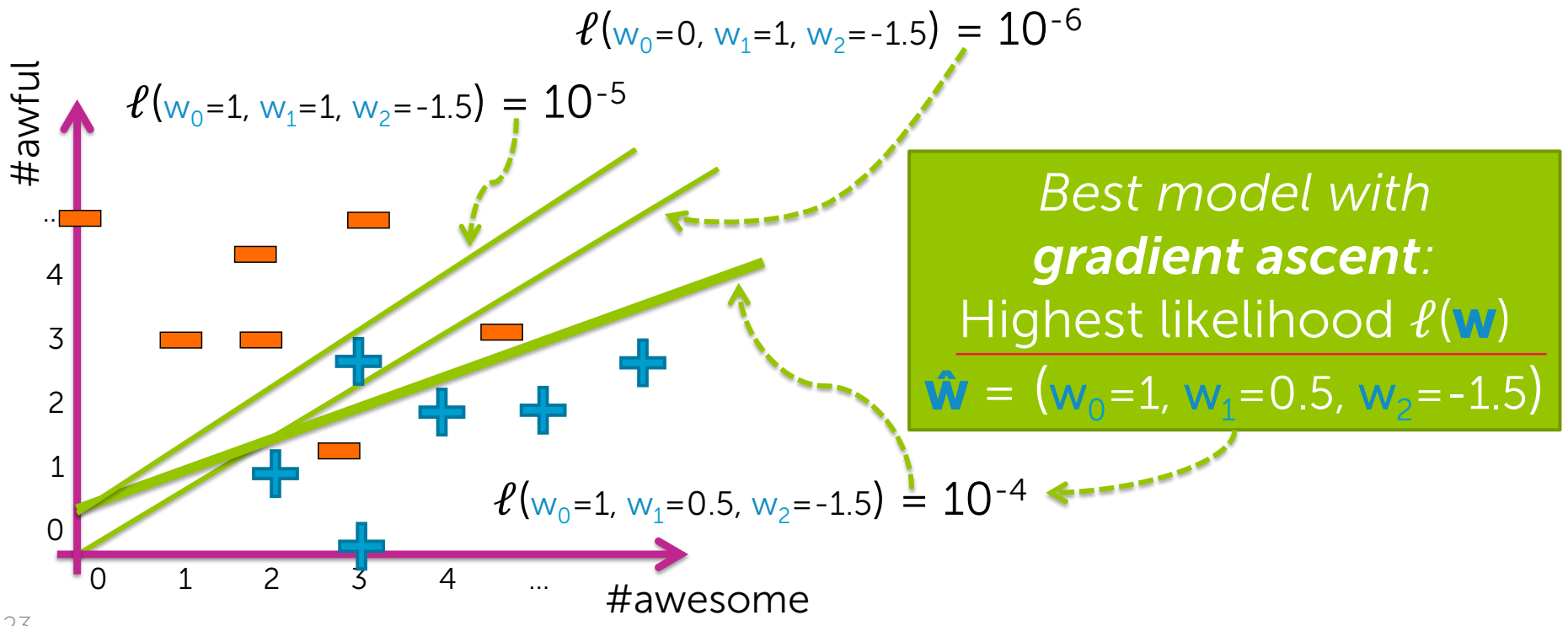
$$\hat{P}(y=+1|\mathbf{x},\hat{\mathbf{w}}) = \frac{1}{1 + e^{-\hat{\mathbf{w}}^T h(\mathbf{x})}}$$

probability

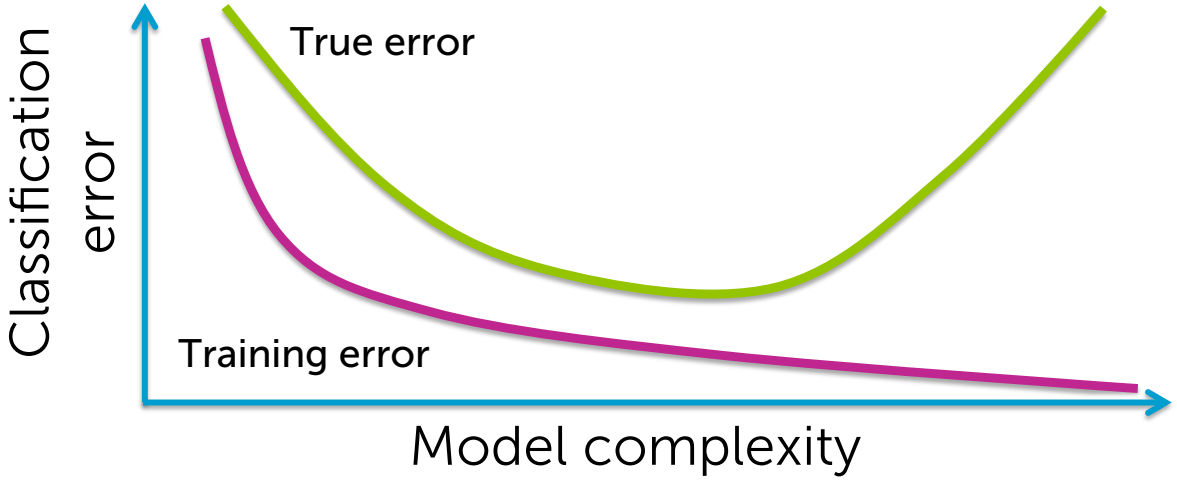


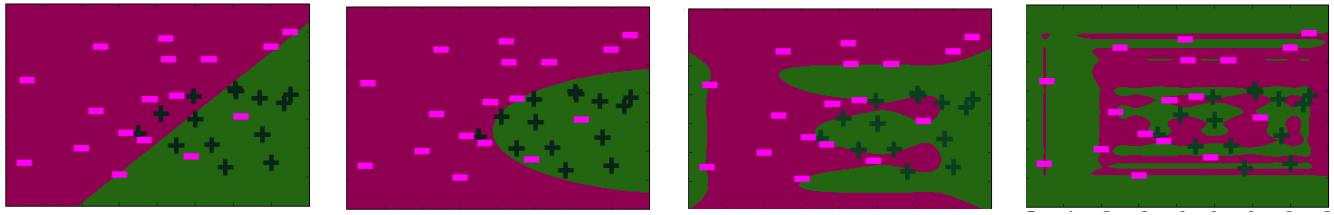
Module 2: Learning "best" classifier

Maximize likelihood over all possible w_0, w_1, w_2



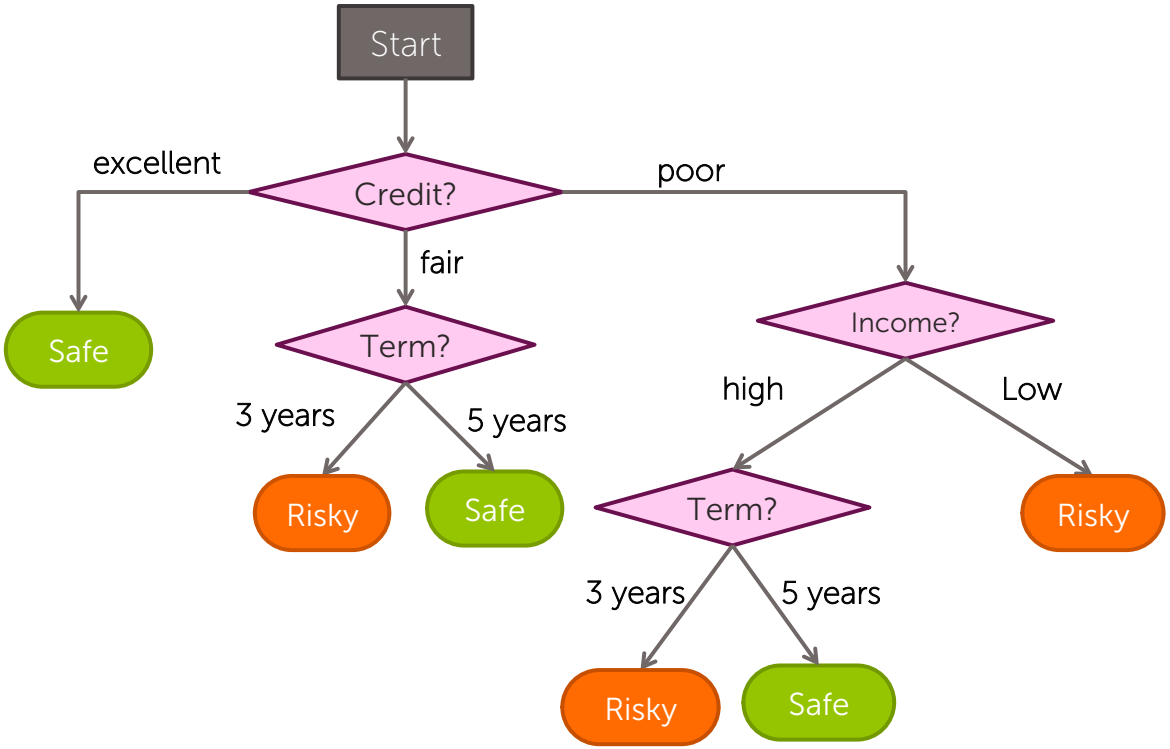
Module 3: Overfitting & regularization





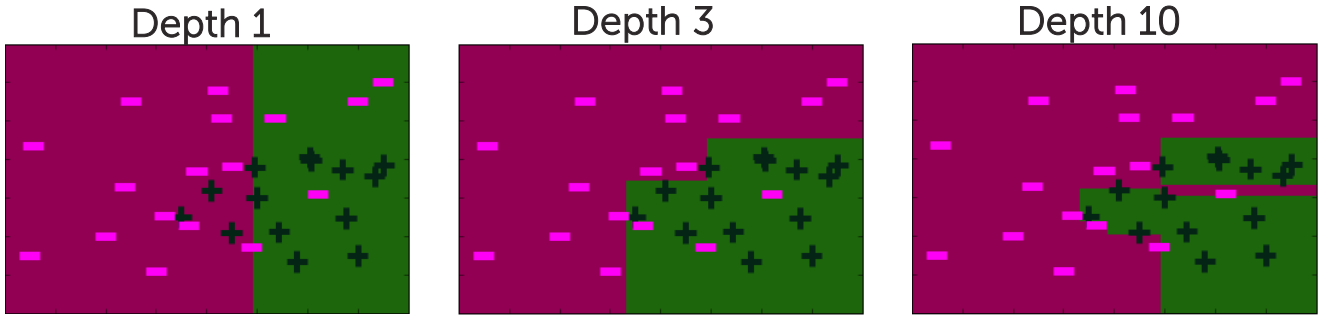
Use regularization penalty to mitigate overfitting $\ell(\mathbf{w}) - \lambda||\mathbf{w}||_2^2$

Module 4: Decision trees

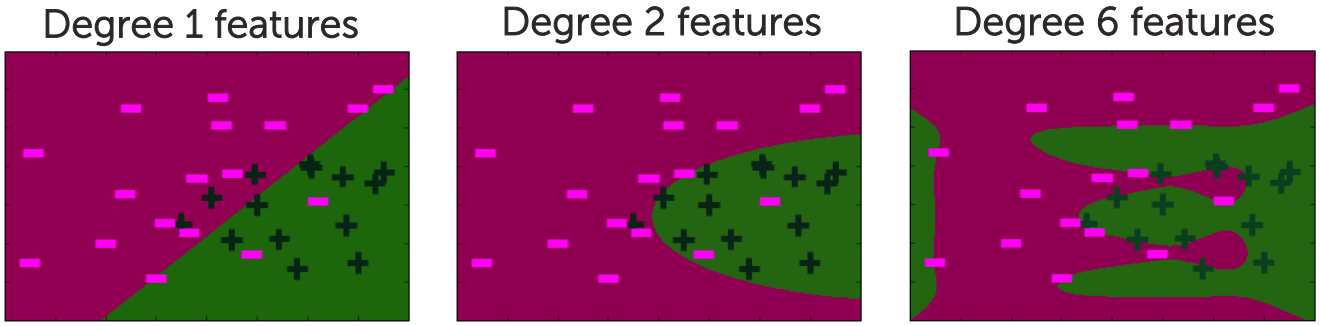


Module 5: Overfitting in decision trees

Decision Tree

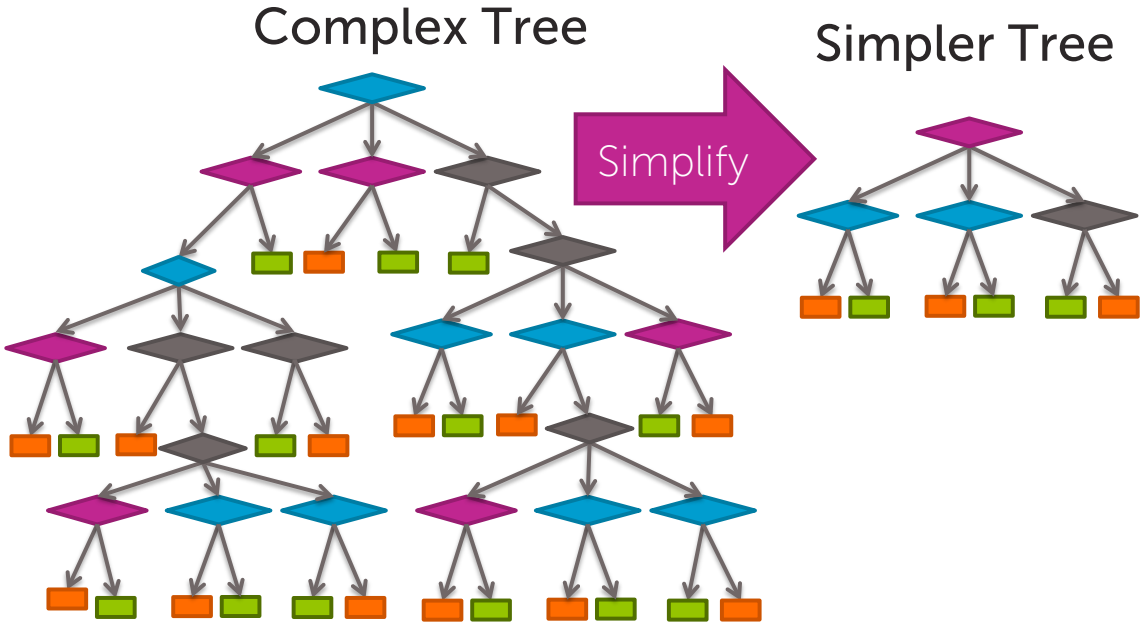


Logistic Regression



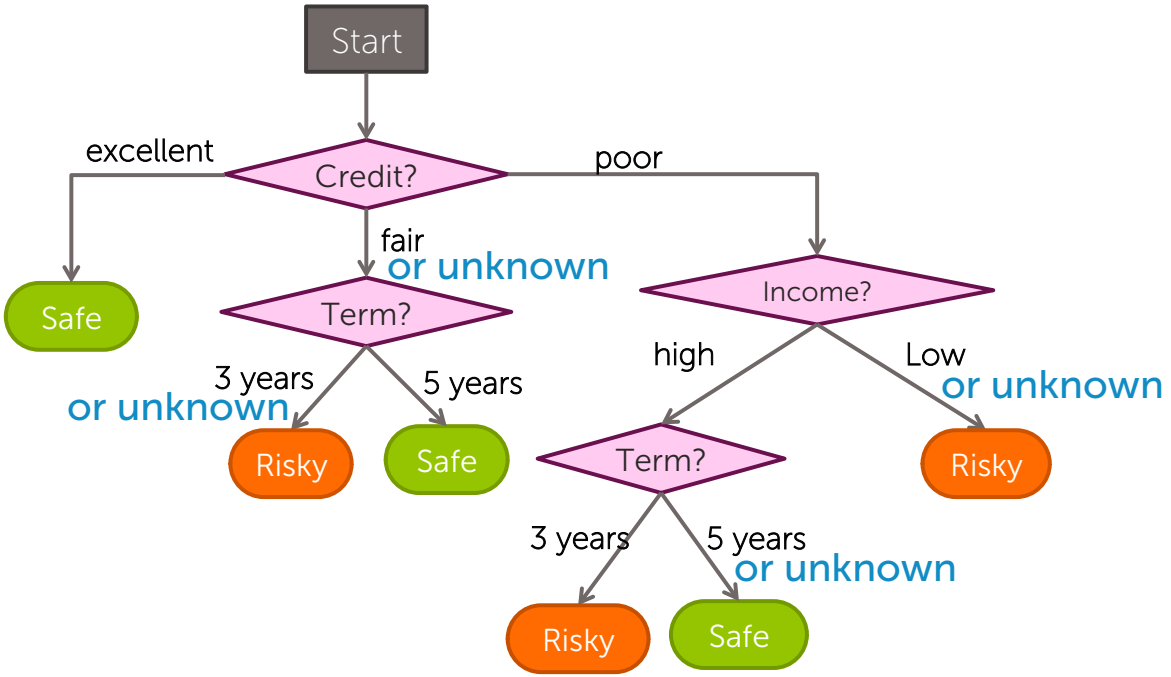
Module 5: Alleviate overfitting by learning simpler trees

Occam's Razor: *"Among competing hypotheses, the one with fewest assumptions should be selected", William of Occam, 13th Century*



Module 6: Handling missing data

Credit	Term	Income	y
excellent	3 yrs	high	safe
fair	?	low	risky
fair	3 yrs	high	safe
poor	5 yrs	high	risky
excellent	3 yrs	low	risky
fair	5 yrs	high	safe
poor	?	high	risky
poor	5 yrs	low	safe
fair	?	high	safe



Module 7: Boosting question

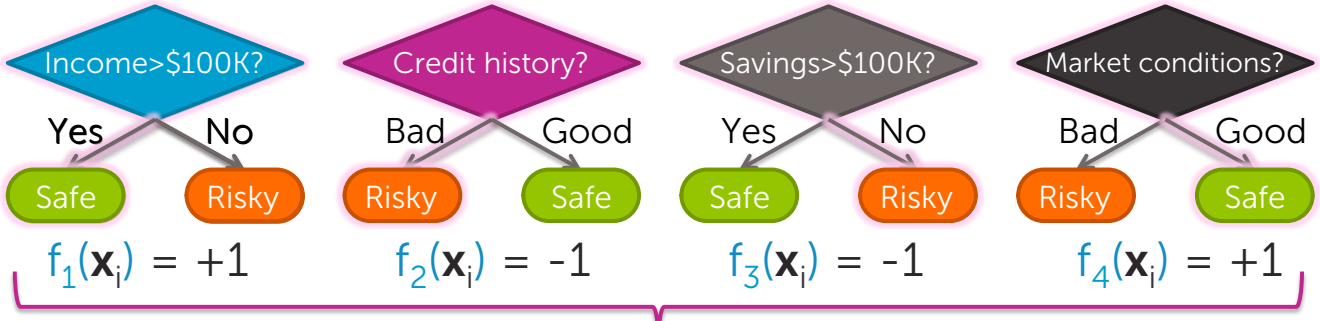
"Can a set of weak learners be combined to create a stronger learner?" *Kearns and Valiant (1988)*

Yes! *Schapire (1990)*

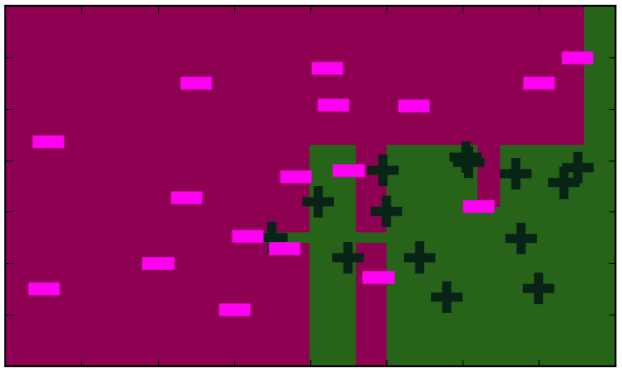
Boosting

Amazing impact: • simple approach • widely used in industry • wins most Kaggle competitions

Module 7: Boosting using AdaBoost



Ensemble: Combine votes from many simple classifiers to learn complex classifiers



Module 8: Precision-recall

Goal: increase # guests by 30%

Reviews

Need an automated, "authentic" marketing campaign

Great quotes

"Easily best sushi in Seattle."

Spokespeople

Accuracy not most important metric

PRECISION
Did I (mistakenly) show a negative sentence???

RECALL
Did I not show a (great) positive sentence???

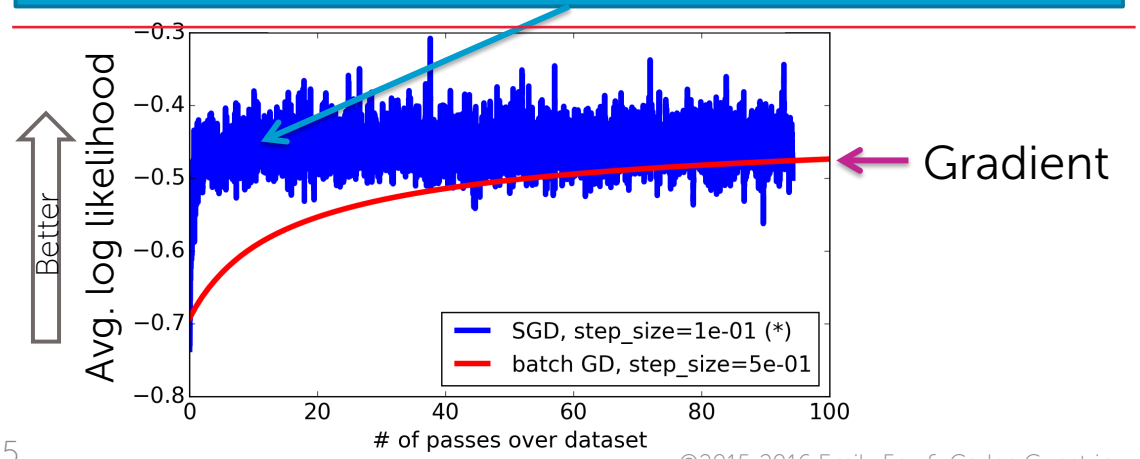
Module 9: Scaling to huge datasets & online learning

4.8B webpages

500M Tweets/day

5B views/day

Stochastic gradient: tiny modification to gradient, a lot faster, but annoying in practice



Assumed background

Courses 1 & 2 in this ML Specialization

- Course 1: Foundations
  - Overview of ML case studies
  - Black-box view of ML tasks
  - Programming & data manipulation skills

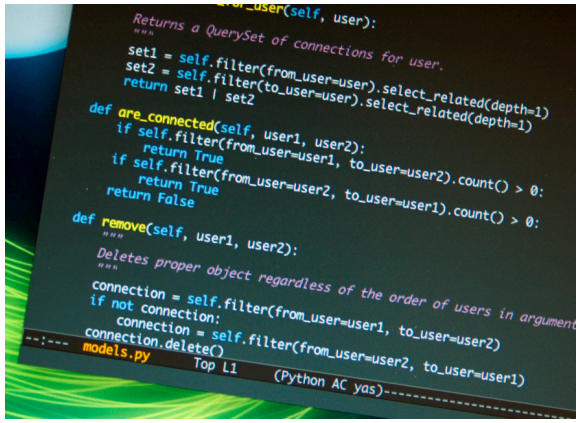
- Course 2: Regression
  - Data representation (input, output, features)
  - Linear regression model
  - Basic ML concepts:
    - ML algorithm
    - Gradient descent
    - Overfitting
    - Validation set and cross-validation
    - Bias-variance tradeoff
    - Regularization

Math background

- Basic calculus
  - Concept of derivatives
- Basic vectors
- Basic functions
  - Exponentiation e^x
  - Logarithm

Programming experience

- Basic Python used
  - Can pick up along the way if knowledge of other language



Reliance on GraphLab Create

- SFrames will be used, though not required
  - open source project of Dato (creators of GraphLab Create)
  - can use pandas and numpy instead
- Assignments will:
  1. Use GraphLab Create to explore high-level concepts
  2. Ask you to implement *all* algorithms without GraphLab Create

- Net result:
  - learn how to code methods in Python

Computing needs

- Basic 64-bit desktop or laptop
- Access to internet
- Ability to:
  - Install and run Python (and GraphLab Create)
  - Store a few GB of data

Let’s get started!