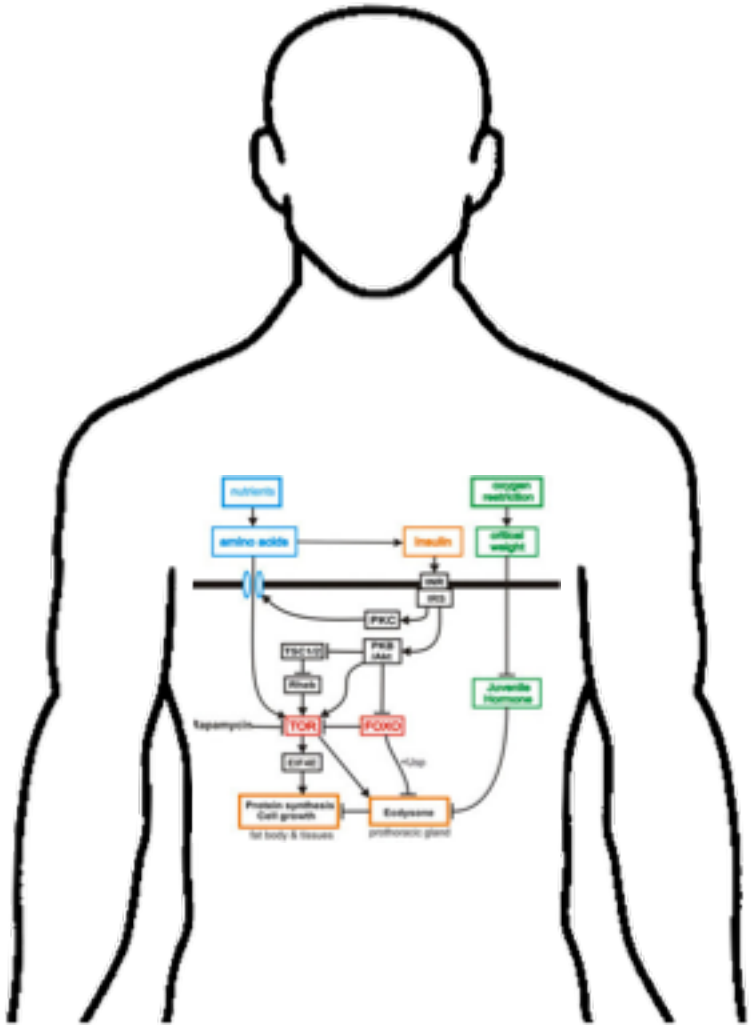
Solving World Problems

Learning One Example at a Time

Problem: Signaling Networks



To treat/cure disease, we need to understand the chains of protein interactions that determine how cells process signals from their environment

Problem: Robotic Interaction

To safely operate in distant/dangerous terrain, we need robotic teammates that can autonomously perceive, understand, interact with, and manipulate their environment

Problem: Winning on the Merits

To enact the best policies, we need to understand what makes for a strong argument

Solving World Problems

The common link in solving these and many other complex problems is the potential for using **Machine Learning**, which exploits…

- Big Data: examples from the world
- Cloud Computation: cheap, fast processing
- Algorithms: automatically uncovering value

Machine Learning

1. What is it?
   – Why you should care!
2. How does it work?
   – Learn your first ML technique!

http://ai.berkeley.edu

What is Machine Learning?

Computer programs that can improve performance with experience

But Wait…

Why Learn?

Many complex tasks are hard to describe, but easy to learn from experience

Why Now?

Data sources and powerful computing are increasingly cheap and plentiful

Natural Language Processing (NLP)

Modern NLP algorithms are typically based on statistical ML

Applications

- Summarization
- Machine Translation
- Speech Processing
- Sentiment Analysis

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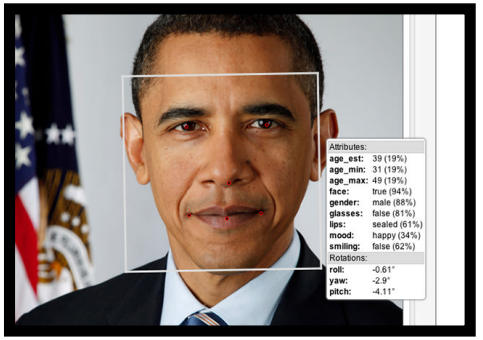
Computer Vision

Methods for acquiring, processing, analyzing, and understanding images



Applications

- Image search
- Facial recognition
- Object tracking
- Image restoration

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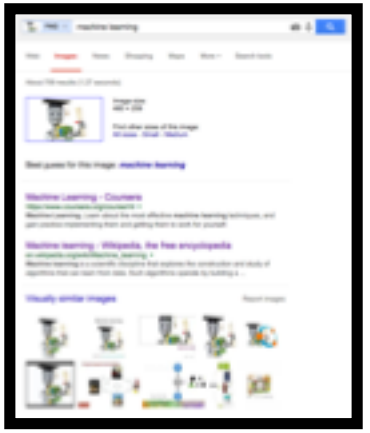
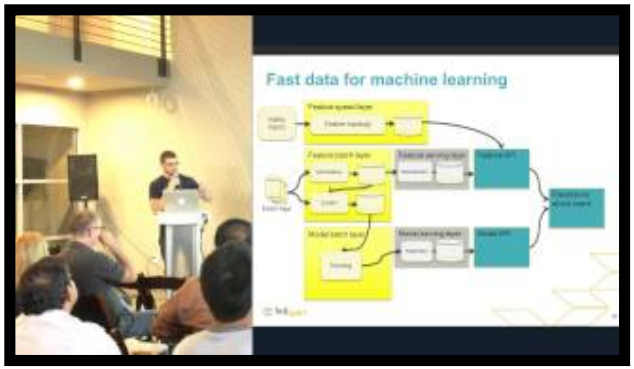
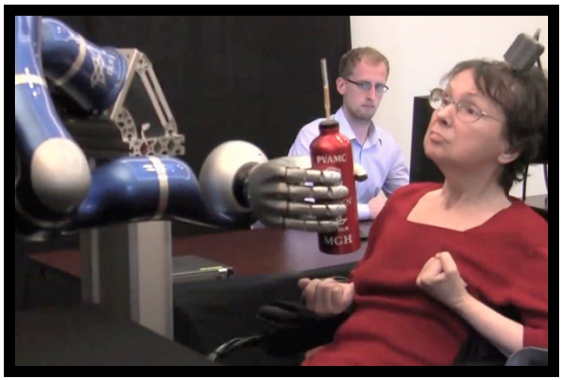


Games, Robotics, Medicine, Ads, …





Jobs!

Position	Salary
Data Scientist Machine Learning Engineer	$120,931
Software Engineer	$104,463

The New York Times

TECHNOLOGY

A.I. Researchers Are Making More Than $1 Million, Even at a Nonprofit

By CADE METZ APRIL 19, 2018

Tech Giants Are Paying Huge Salaries for Scarce A.I. Talent

Nearly all big tech compa
intelligence project, and t
experts millions of dollar

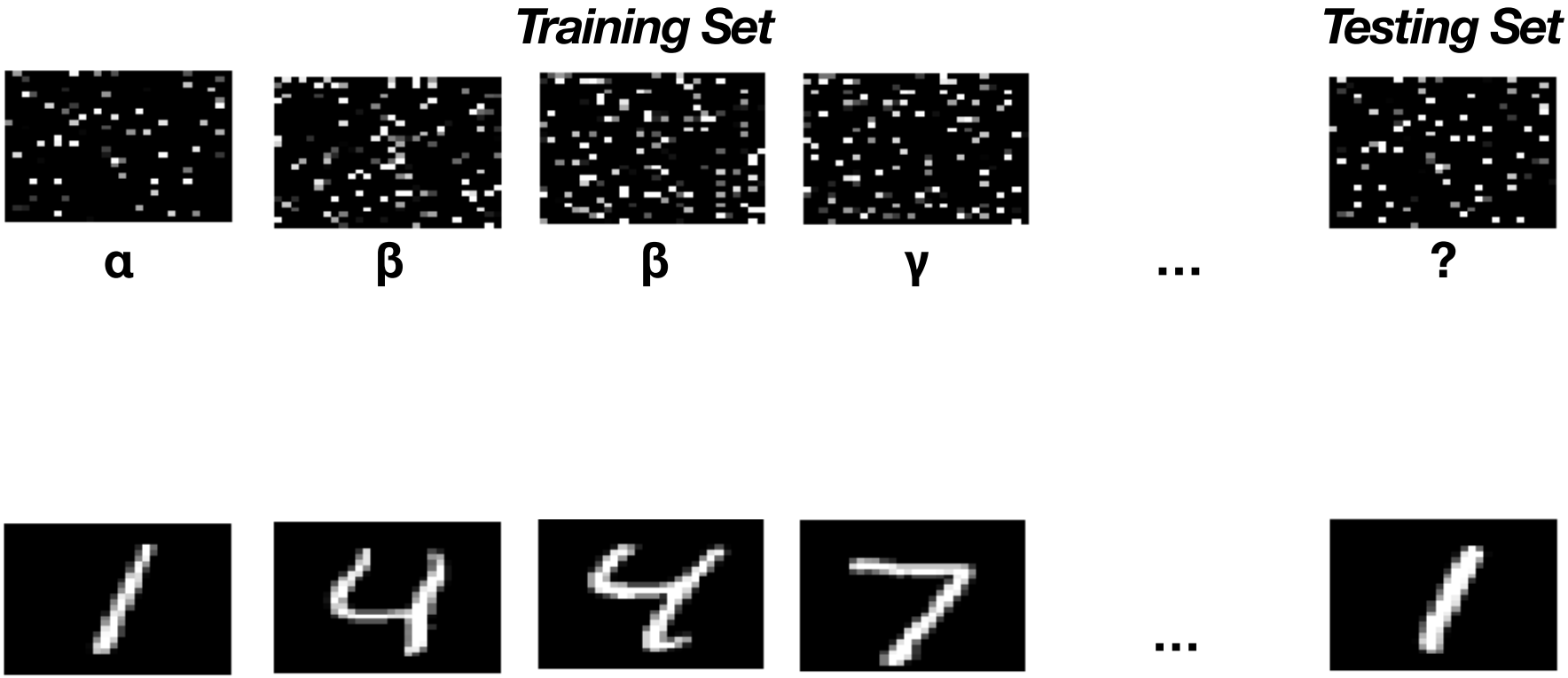
By CADE METZ

Typical A.I. specialists, including both Ph.D.s fresh out of school and people with less education and just a few years of experience, can be paid from $300,000 to $500,000 a year or more in salary and company stock, according to nine people who work for major tech companies or have entertained job offers from them. All of them requested anonymity because they did not want to damage their professional prospects.

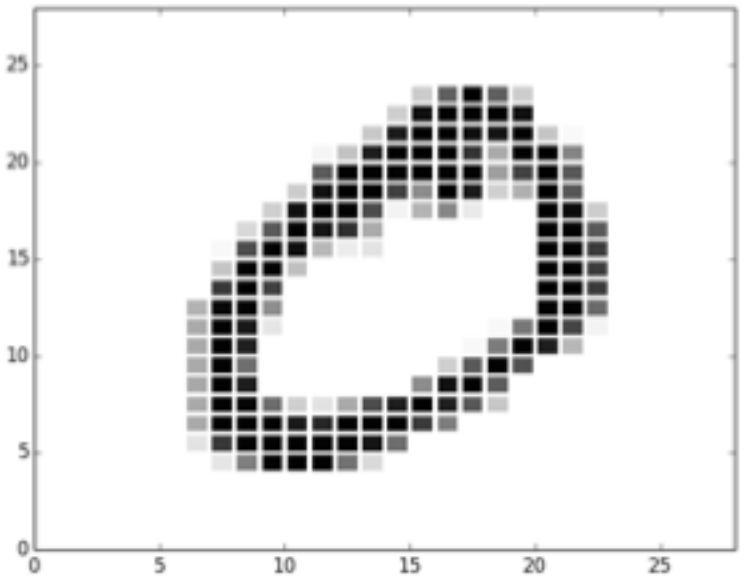
"Software Is Eating the World, but AI Is Going to Eat Software"
- Jensen Huang (CEO, NVIDIA)

*glassdoor.com, USA National Avg as of April 20, 2018

What does Machine Learning Do?



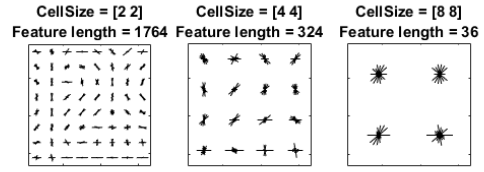
ML Terminology



example, instance
Unit of input

Composed of ***features***
(or ***attributes***)

- In this case, we could represent each digit via raw pixels: 28x28=784-pixel ***vector*** of greyscale values [0-255]
  - ***Dimensionality***: number of features per instance (|vector|)
- But other ***data representations*** are possible, and might be advantageous



- In general, the problem of ***feature selection*** is challenging

Your First ML Technique: **kNN**

Training

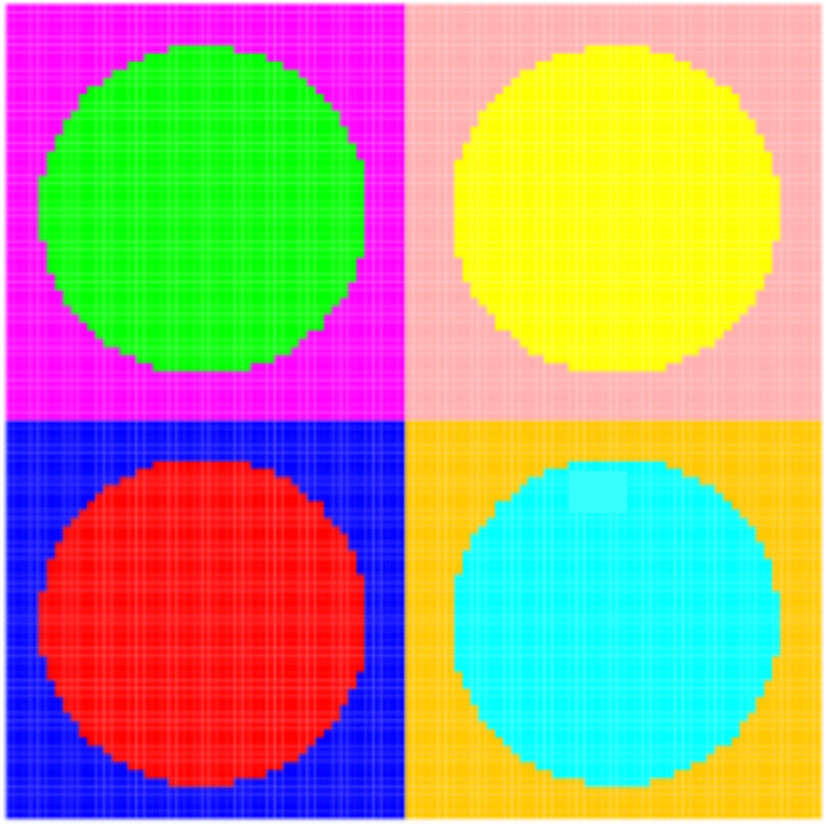
- Store all examples

Testing

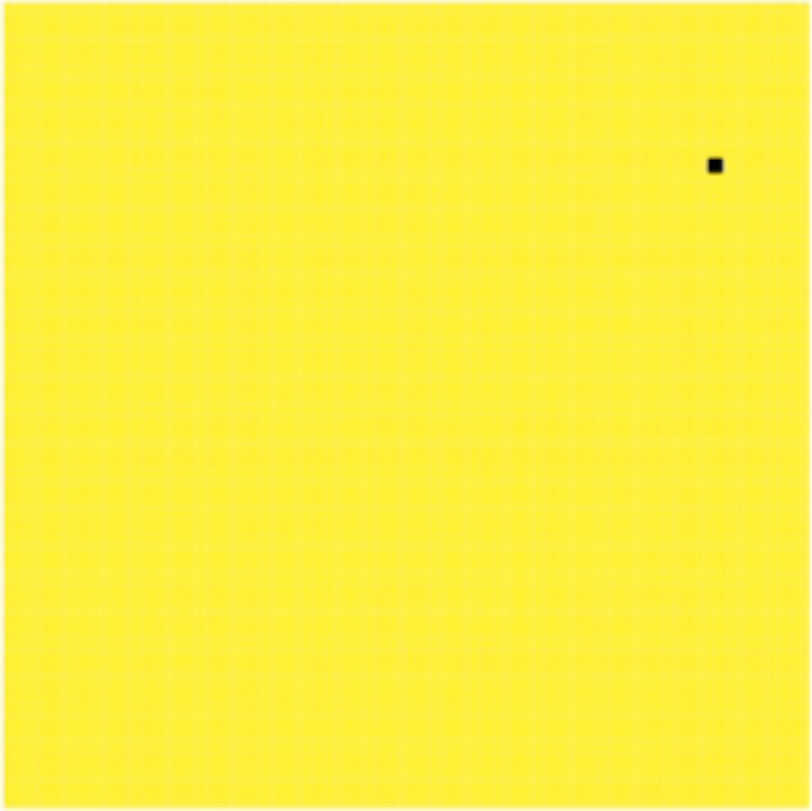
- Find the *k* nearest neighbors to input
- Vote on output

2D Multiclass Classification

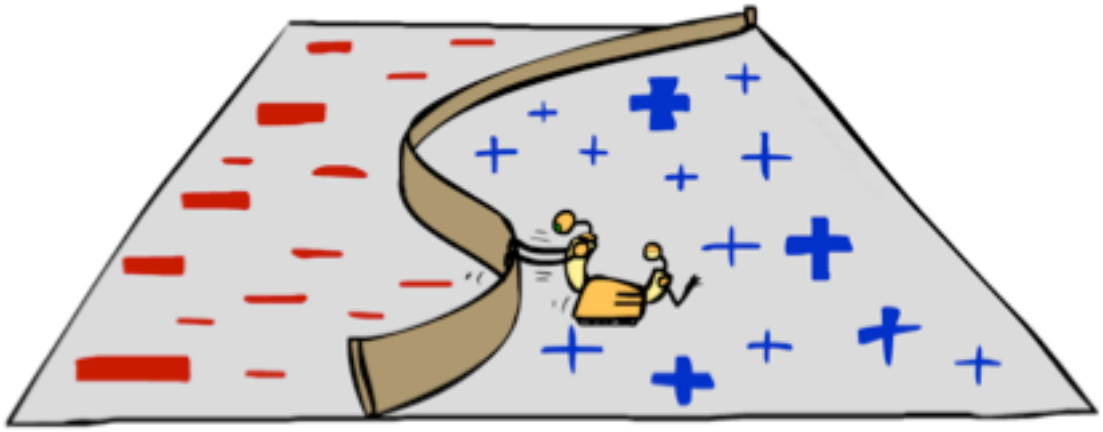
Boundary Tree

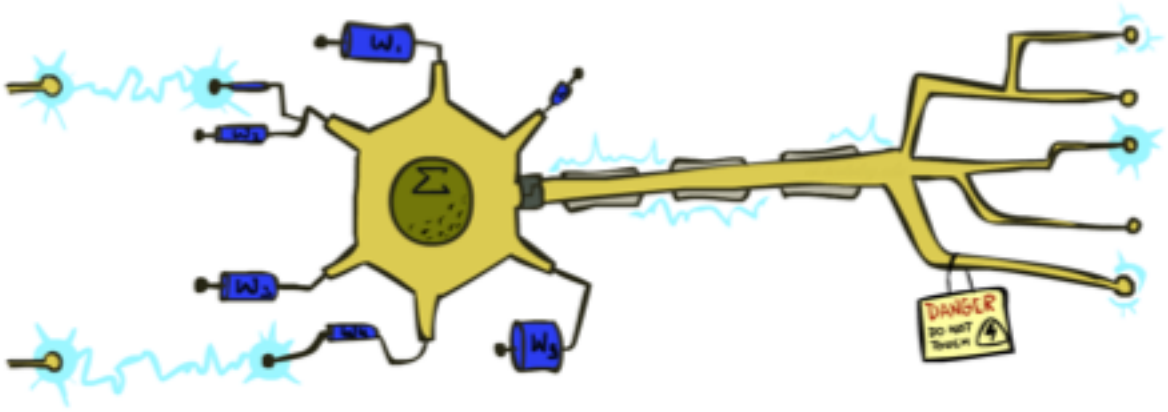


1-NN via Linear Scan



Many Approaches





Lots of Math 🙀

$$\text{SSE} = Y^\intercal Y - 2Y^\intercal XB + B^\intercal X^\intercal XB$$

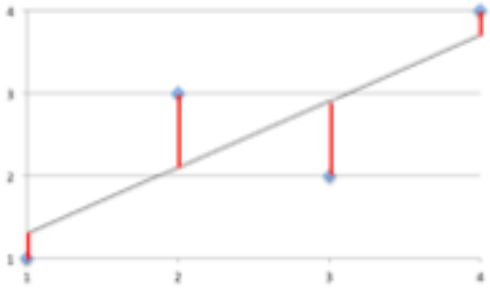
$$\frac{\partial \text{SSE}}{\partial B} = -2X^\intercal Y + 2X^\intercal XB$$

$$0 = -2X^\intercal Y + 2X^\intercal XB$$

$$-2X^\intercal XB = -2X^\intercal Y$$

$$X^\intercal XB = X^\intercal Y$$

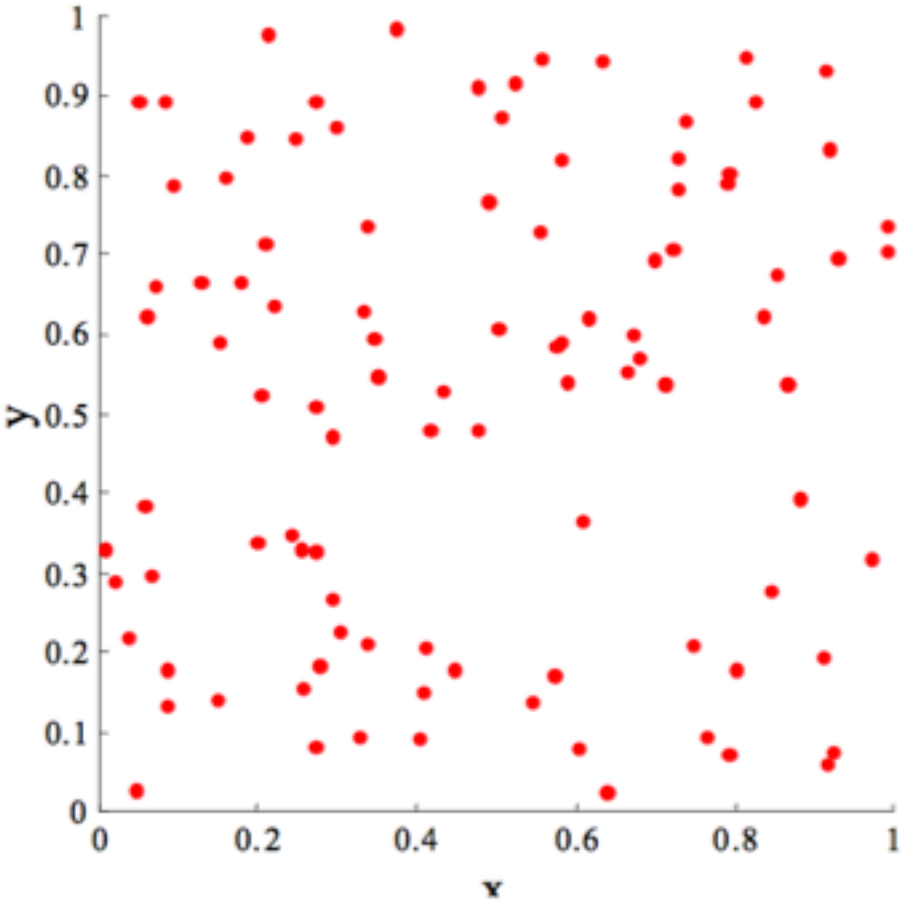
$$B = (X^\intercal X)^{-1} X^\intercal Y$$



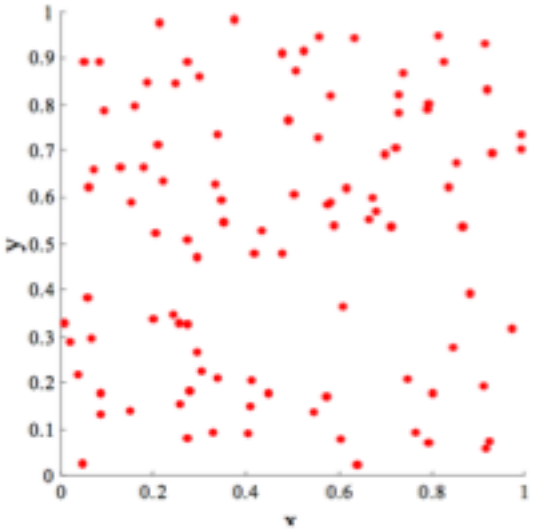
One (of many) Challenges

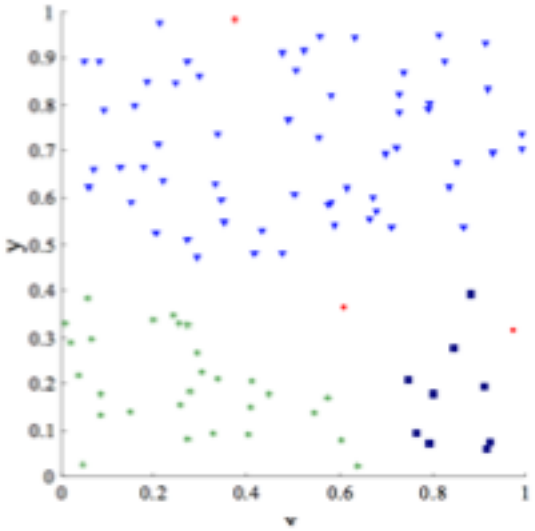
https://xkcd.com/1838/

What Makes for a "Good" Answer?



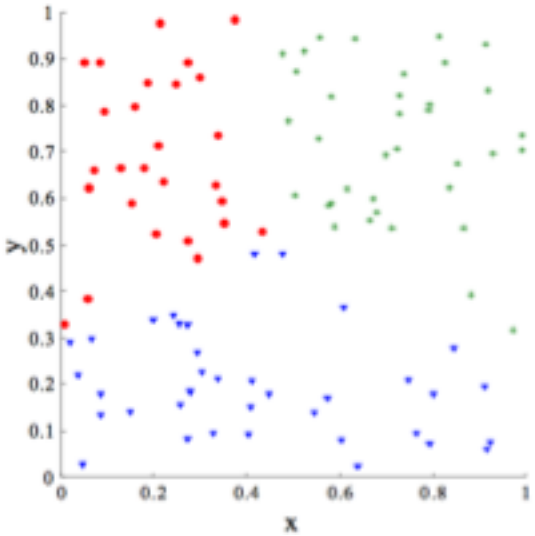
Did I Learn *Well*?

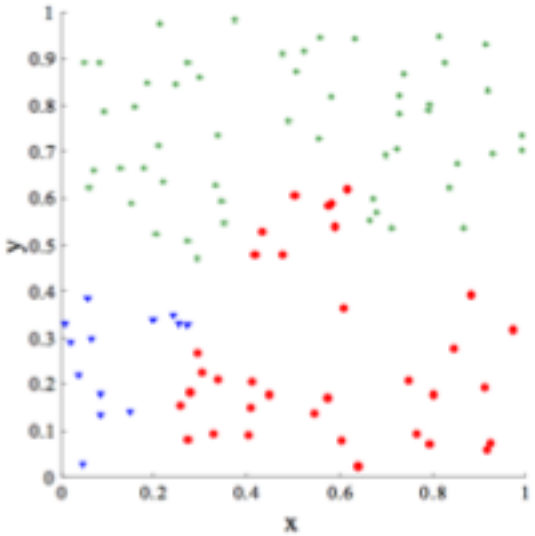




DBSCAN

K-means

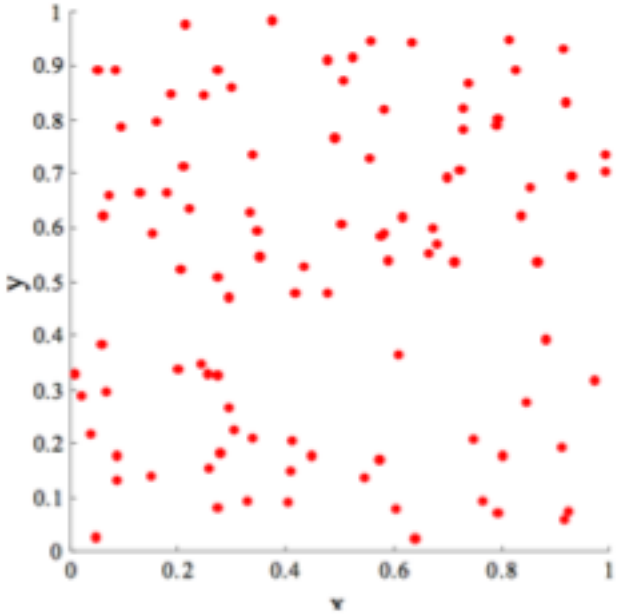




Complete Link

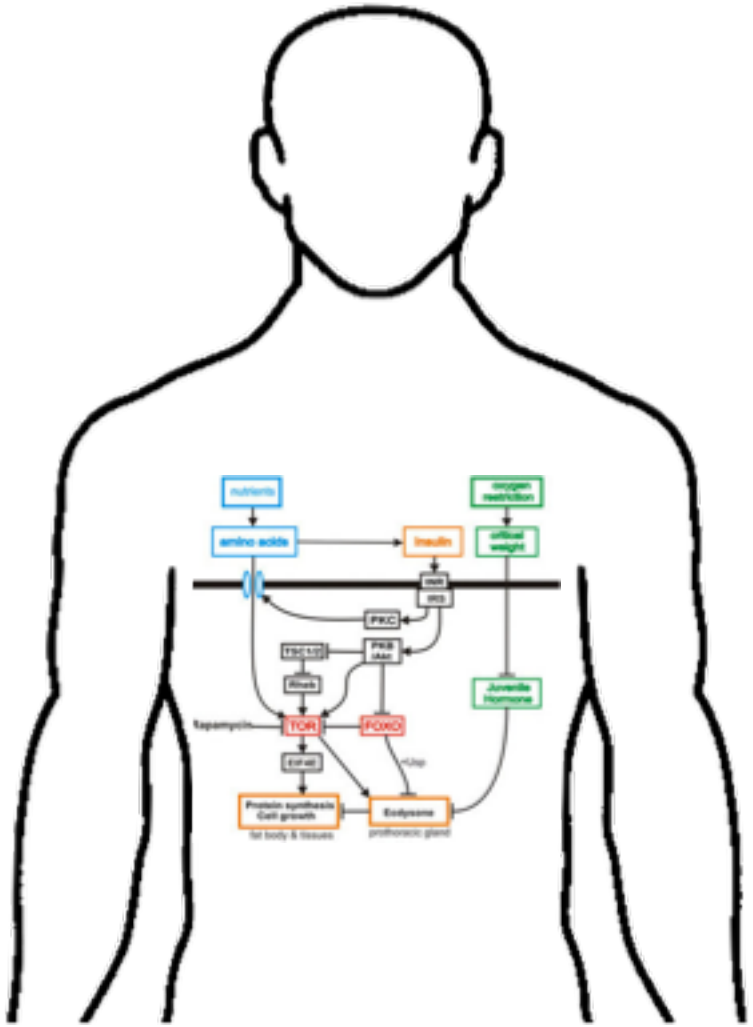
Did I Learn *Safely & Ethically*?

Random Points



- 👵🏽👴🏽 vs 👶🏿
- 🚌 vs 🚲 vs 🚶🏾‍♀️

Learning Signaling Networks



- Using NLP to aggregate and analyze scientific findings
- Given data, learn network structure

Learning Robotic Interaction

- Large-scale robotic grasp training
- Inter-planetary!

Learning to Win on the Merits

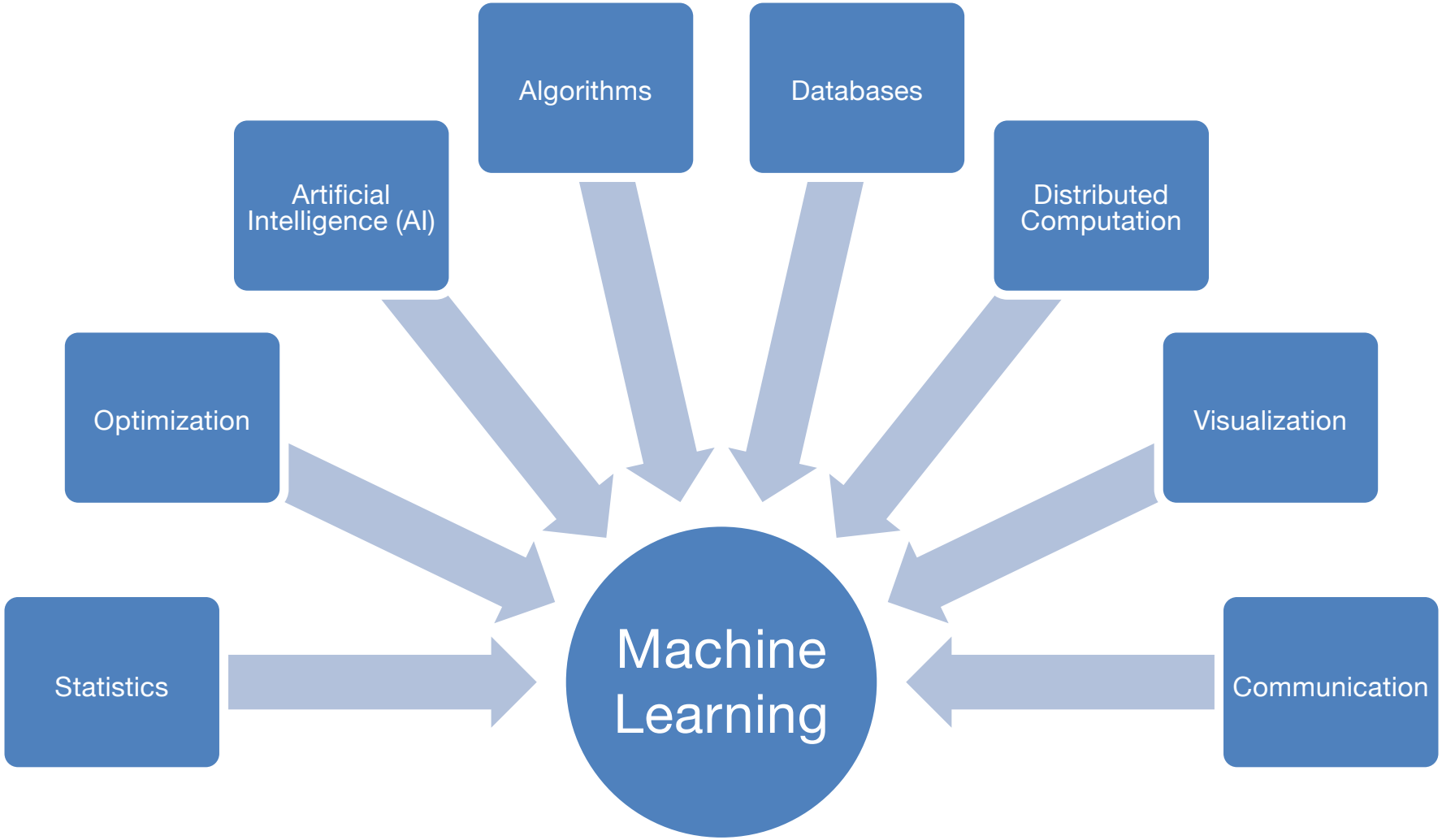
- Understanding content/style vs strength
- Making new arguments from past experience and data

Opportunities for (Machine) Learning

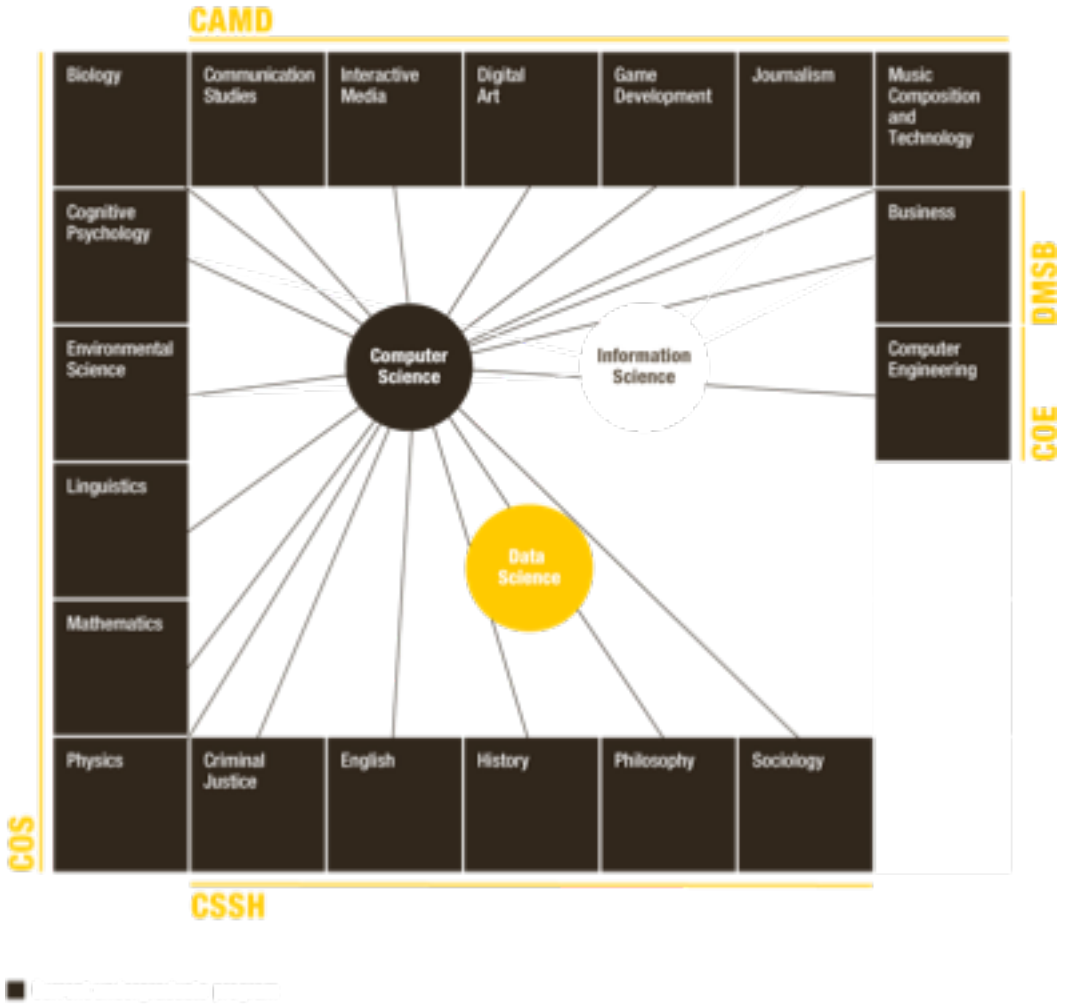
1. Courses
2. Research
3. Applications

http://ai.berkeley.edu

Fusing Disciplines



CS/ML @ Northeastern



Some Offerings…

- Artificial Intelligence
- Supervised Machine Learning and Learning Theory
- Unsupervised Machine Learning and Data Mining
- Natural Language Processing
- Advanced Machine Learning
- Information Presentation and Visualization
- Robotic Science and Systems
- Pattern Recognition and Computer Vision

…

What Problem Will **YOU** Learn to Solve?

Thank You :)

Questions?