Day 1: Introduction to Machine Learning

Summer STEM: Machine Learning

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June 15, 2019

Learning Objectives

- What is Machine Learning?
- What is Regression?
- What is Classification?
- Why is Machine Learning gaining so much importance?
- Where do I find data, how is it represented?
- How do we use Python to represent, manipulate, and visualize data?
- How do we use vectors and matrices to manipulate data?
- How do computers understand continuous data? How do we visualize it?
- How do we use random numbers in programming and modelling noise?

Outline

1 Teacher and Student Introductions

2 What is Machine Learning?

3 Course Outline

4 Dealing with Data

5 Vectors and Matrices

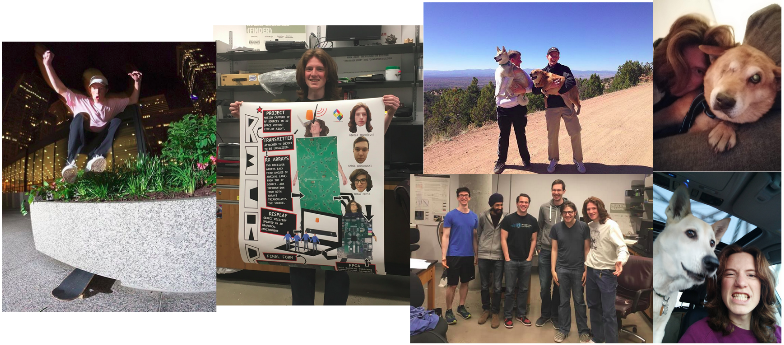
6 Mean and Variance

7 Lab: Plotting Functions

8 Artificial Intelligence and Machine Learning

9 Why the Hype?

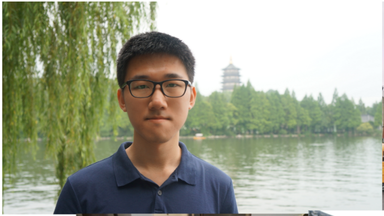
Nikola



Akshaj

Aishwarya

Jacky



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Tell the class about yourself

- Write down the following pieces of information on your notecard:
    - Name
    - Grade
    - Where are you from?
    - What do you want to get out of this class?
    - What time did you wake up this morning?
    - Where did you travel from?
    - What mode of transport did you take?
    - How long did it take you? use Google Maps if unsure
    - One rule you'd like to propose for the classroom
- Stand in front of the class and present what you've written down
- We'll visualize this data in python later today
    - Link to excel sheet here

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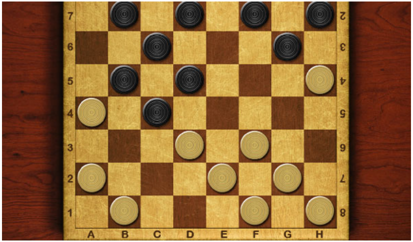
Definition

- Arthur Samuel (1959): Machine Learning is a field of study that gives computers the ability to learn without being explicitly programmed.



Another Example: Digit Recognition

- Challenges with expert approach
  - Simple expert rule breaks down in practice
  - Difficult to translate our knowledge into code
- Machine Learning approach
  - Learned systems do very well on image recognition problems
  - This is what you will learn in this course

```
def classify(image):
    ...
    nv = count_vert_lines(image)
    nh = count_horiz_lines(image)
    ...

    if (nv == 1) and (nh == 1):
        digit = 7
    ...

    return digit
```

Modern Definition

Tom Mitchell provides a more modern definition: “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.”
Example: playing checkers.

- E = the experience of playing many games of checkers
- T = the task of playing checkers.
- P = the probability that the program will win the next game.

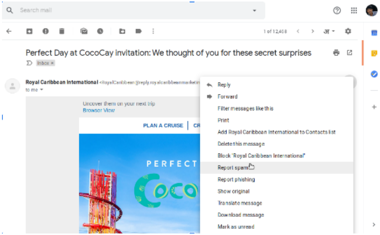
Question

Suppose your email program watches which emails you do or do not mark as spam, and based on that learns how to better filter spam. What is the task, experience and performance in this setting?

a) Classifying emails as spam or not spam

b) Watching you label emails spam or not spam

c) The number of emails correctly classified as spam or not spam

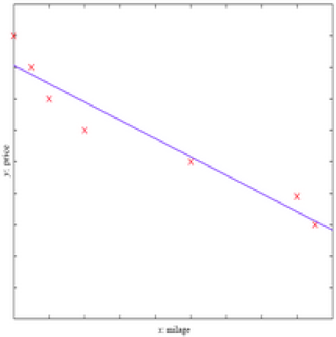


Types of Machine Learning Problems?

- There are many types of machine learning problems
  - Supervised Learning
  - Unsupervised learning
  - Reinforcement learning etc.
- In this class, we will go through two important classes of supervised learning
  - Regression
  - Classification

What is Regression?

- Target variable is continuous-valued
- Example
  - Predict y = price of a car
  - From x = mileage, size, horsepower
  - Can use multiple predictors
- Assume some form of mapping
  - Ex: Linear mapping: $y = \beta_0 + \beta_1 x$
  - Find parameter β_0, β_1 from data



What is Classification?

- Object classification from images
- Determine what objects are in an image
- Features
  - Pixels of the image
- Target
  - Classification label
- Learn a model / function from features to target
  - Use examples of labeled images

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Course Outline

- Day 1: Intro to ML
- Day 2: Linear Regression
- Day 3: Generalization Error
- Day 4: Linear Classification
- Day 5: Mini-Project Competition & Presentations
- Day 6: Neural Networks
- Day 7: Deep Learning & Convolutional Neural Networks
- Day 8: Applications of CNNs
- Day 9: Final Projects
- Day 10: Final Projects & Presentations

Course Format, Website, Resources

- Course Website: github.com/nikopj/SummerML
  - Contains lecture slides, code notebooks, and datasets
  - Slides posted after lecture, student code notebooks and datasets the morning of
- We're programming in Python via Google Colab
  - No installation required
- We'll give additional resources at the end of each day based on student interest

Github & Colab

- Github is an online service for sharing code repositories and collaborating on projects
- Google Colab runs Python code on a server or your local machine
  - Works just like Jupyter Notebook
  - Write separate code blocks and markdown blocks

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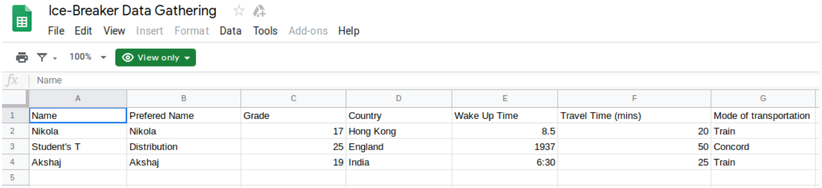
Looking at our "ice-breaker" data in spreadsheets

- Columns have labels in the first row
- Collected data (numbers, words) follow below
- Let's export it to a Comma-Separated Values (CSV) file and open it
- Demo on Github.



	A	B	C	D	E	F	G
1	Name	Prefered Name	Grade	Country	Wake Up Time	Travel Time (mins)	Mode of transportation
2	Nikola	Nikola	17	Hong Kong	8.5	20	Train
3	Student's T	Distribution	25	England	1937	50	Concord
4	Akshaj	Akshaj	19	India	6:30	25	Train
5							

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  - Ex: $|\mathbf{v}| = \sqrt{1 + 25 + 4 + 81} = \sqrt{111}$

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  - Ex: $aB = \begin{bmatrix} 0 & 8a \\ 7a & 11a \end{bmatrix}$, where a is a scalar

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4 Dealing with Data

5 Vectors and Matrices

6 Mean and Variance

7 Lab: Plotting Functions

8 Artificial Intelligence and Machine Learning

9 Why the Hype?

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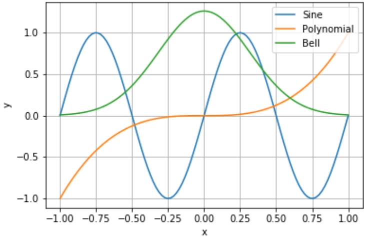

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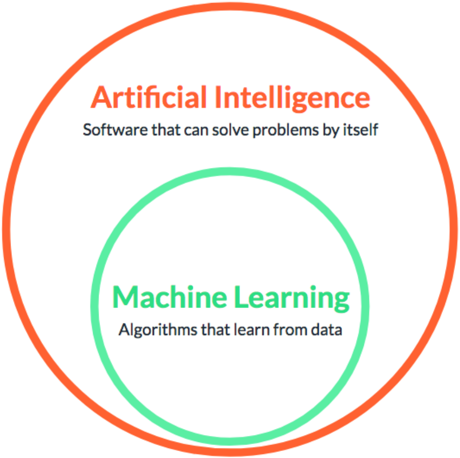
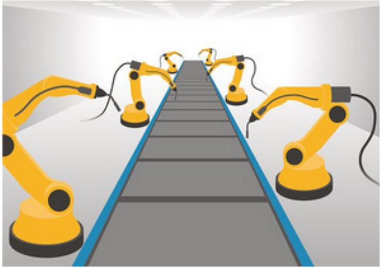
Artificial Intelligence

- Search
- Reasoning and Problem Solving
- Knowledge Representation
- Planning
- Learning
- Perception
- Natural Language Processing
- Motion and Manipulation
- Social and General Intelligence

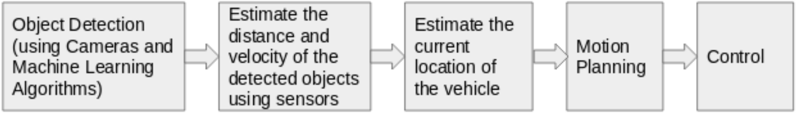
Machine Learning



Autonomous vs. Automated



Autonomous Example: Driver-less Cars



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Why is Machine Learning so Prevalent?

- Database mining
- Medical records
- Computational biology
- Engineering
- Recommender systems
- Understand human brain

Why Now?

- Big Data
  - Massive storage. Large data centers
  - Massive connectivity
  - Sources of data from internet and elsewhere
- Computational advances
  - Distributed machines, clusters
  - GPUs and hardware

Learning Objectives

- What is Machine Learning?
- What is Regression?
- What is Classification?
- Why is Machine Learning gaining so much importance?
- Where do I find data, how is it represented?
- How do we use Python to represent, manipulate, and visualize data?
- How do we use vectors and matrices to manipulate data?
- How do computers understand continuous data? How do we visualize it?
- How do we use random numbers in programming and modelling noise?

Thank You!

- Next Class: Linear Regression
- The real machine learning will begin!