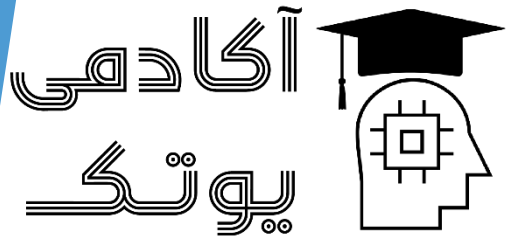


Machine Learning Course

Vahid Reza Khazaie

Course Outline

- Python Tutorial
- Machine Learning Applications
- Introduction to Machine Learning
- Getting Familiar with Data
- Supervised Learning
- Performance Evaluation and Tuning
- Ensemble Model
- Unsupervised Learning
- Introduction to Deep Learning

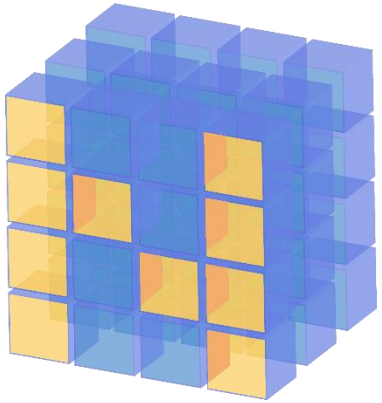
Introduction to Python

- Before diving into deep learning, it is necessary to get familiar with Python.

00_introduction_to_python.ipynb

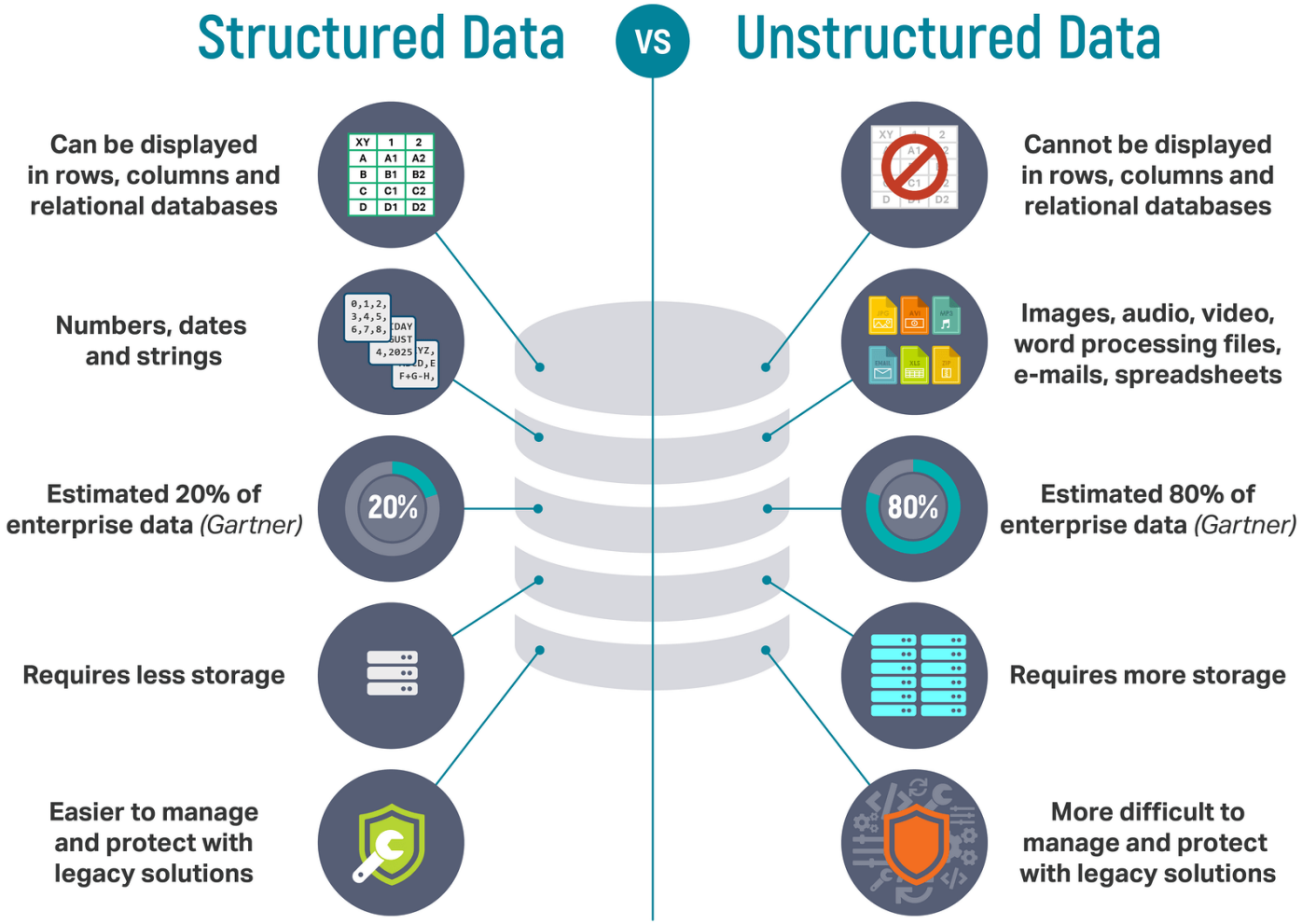
Introduction to NumPy

- NumPy is a library for the Python programming language, adding support for large, multi-dimensional arrays and matrices, along with a large collection of high-level mathematical functions to operate on these arrays. Wikipedia



00_introduction_to_numpy.ipynb

Data Types


Structured Data
VS
Unstructured Data
Can be displayed in rows, columns and relational databases
Cannot be displayed in rows, columns and relational databases
Numbers, dates and strings
Images, audio, video, word processing files, e-mails, spreadsheets
Estimated 20% of enterprise data (Gartner)
20%
80%
Estimated 80% of enterprise data (Gartner)
Requires less storage
Requires more storage
Easier to manage and protect with legacy solutions
More difficult to manage and protect with legacy solutions

Data Types

- Structured Data (Example): **Heart Disease UCI**

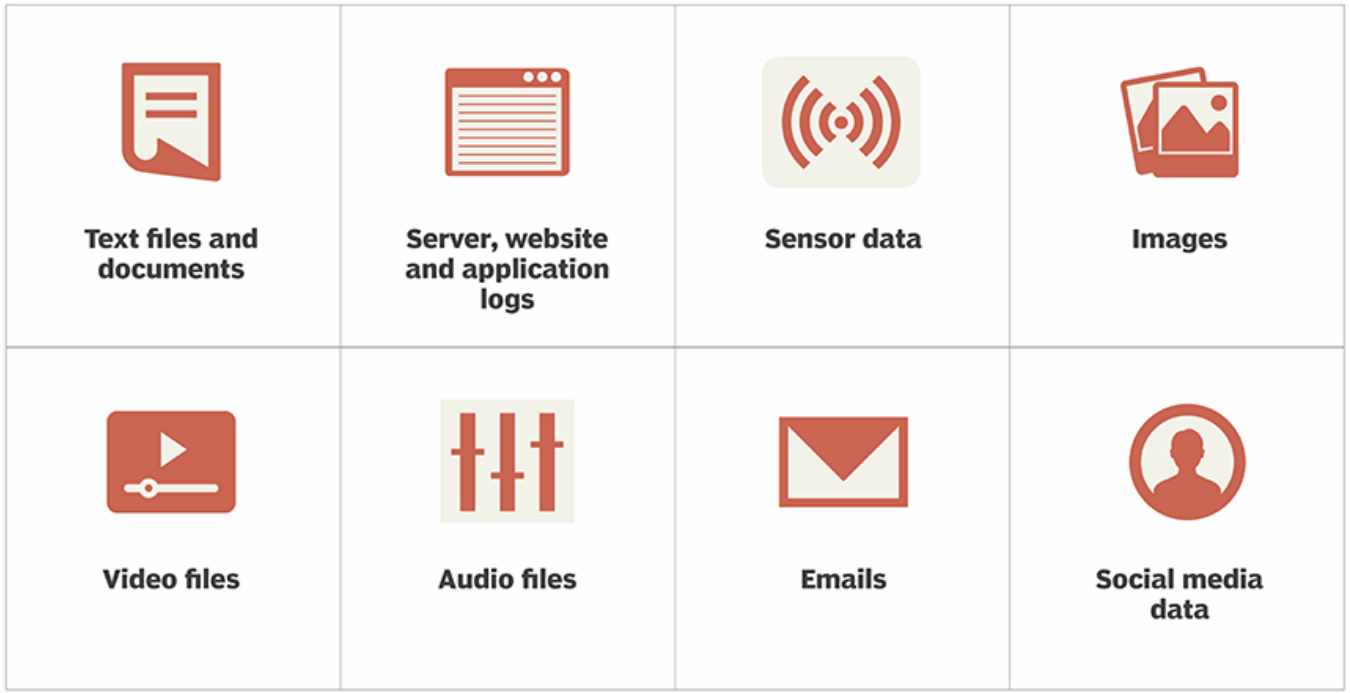
heart.csv (11.06 KB) — 14 of 14 columns — Views

	# age	# sex	# cp	# trestbps	# chol	# fbs	# restecg	# thalach	# exang	# oldpeak	# slope	# ca	#
1	63	1	3	145	233	1	0	150	0	2.3	0	0	
2	37	1	2	130	250	0	1	187	0	3.5	0	0	
3	41	0	1	130	204	0	0	172	0	1.4	2	0	
4	56	1	1	120	236	0	1	178	0	0.8	2	0	
5	57	0	0	120	354	0	1	163	1	0.6	2	0	
6	57	1	0	140	192	0	1	148	0	0.4	1	0	
7	56	0	1	140	294	0	0	153	0	1.3	1	0	
8	44	1	1	120	263	0	1	173	0	0	2	0	
9	52	1	2	172	199	1	1	162	0	0.5	2	0	
10	57	1	2	150	168	0	1	174	0	1.6	2	0	
11	54	1	0	140	239	0	1	160	0	1.2	2	0	
12	48	0	2	130	275	0	1	139	0	0.2	2	0	
13	49	1	1	130	266	0	1	171	0	0.6	2	0	
14	64	1	3	110	211	0	0	144	1	1.8	1	0	
15	58	0	3	150	283	1	0	162	0	1	2	0	
16	50	0	2	120	219	0	1	158	0	1.6	1	0	
17	58	0	2	120	340	0	1	172	0	0	2	0	

https://www.kaggle.com/ronitf/heart-disease-uci

Data Types

- Unstructured Data

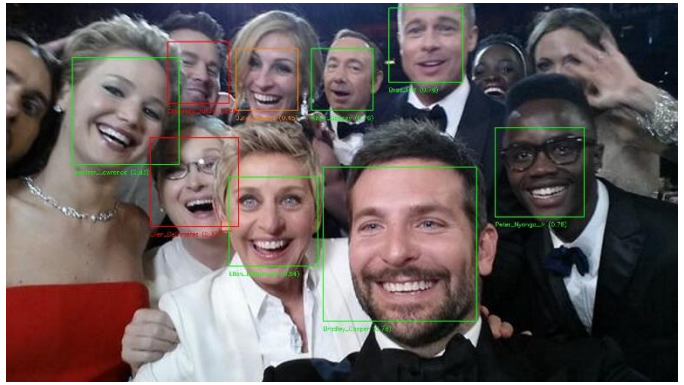


Machine Learning Applications

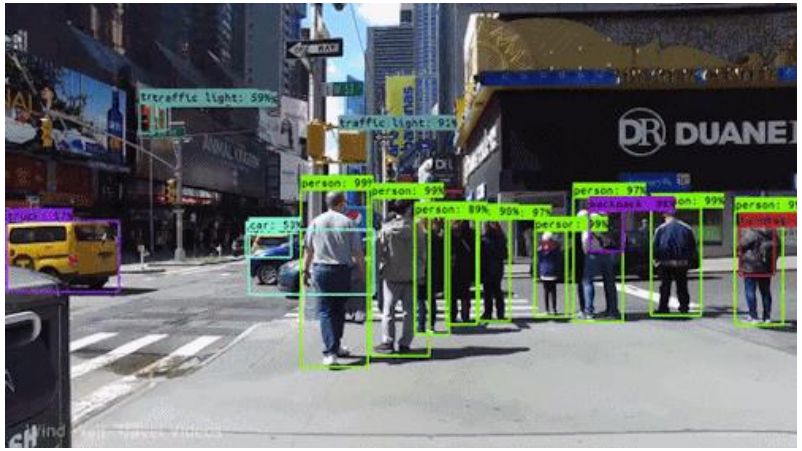
- Computer Vision:
  - is an interdisciplinary scientific field that deals with how computers can gain high-level understanding from digital images or videos. Wikipedia

Machine Learning Applications

- Computer Vision



Face Recognition Systems



Object Detection

Image Colorization

Machine Learning Applications

- Natural Language Processing:
  - Text Classification
  - Chatbots
  - Automatic Summarization
  - Sentiment Analysis
  - Machine Translation
  - Question Answering
  - Text Generation

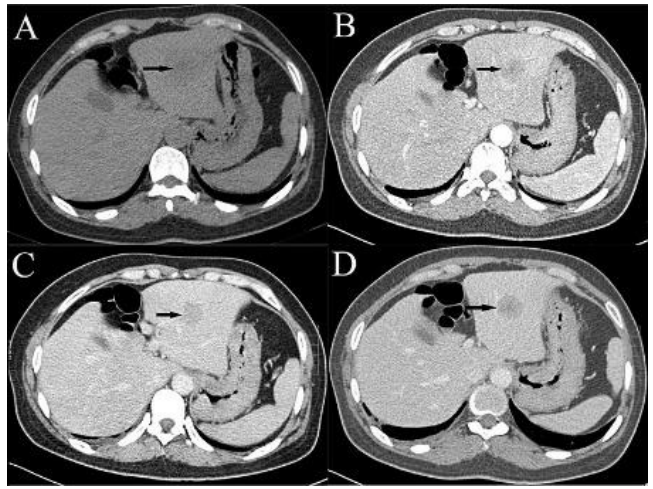
Machine Learning Applications

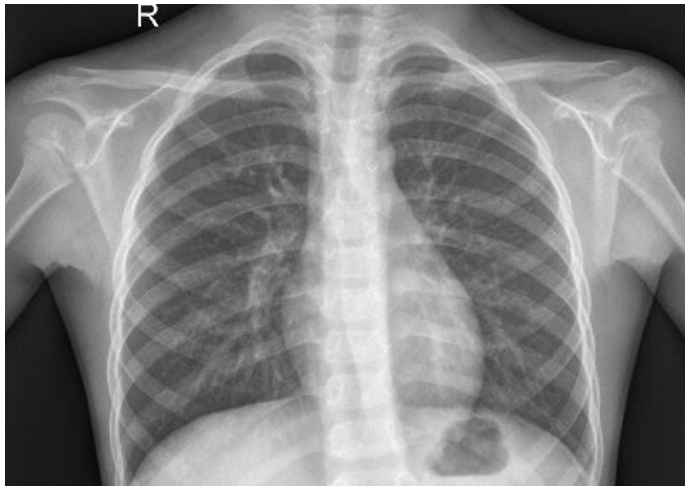
- Speech Processing:
  - Audio Classification
  - Automatic Music Tagging
  - Music Retrieval
  - Music Generation
  - Trigger Word Detection

A Practical Example

- COVID-19 Diagnosis

01_a_practical_example.ipynb





https://www.kaggle.com/andrewmvd/covid19-ct-scans

https://www.kaggle.com/praveengovi/coronahack-chest-xraydataset

What is Machine Learning?

- Arthur Samuel described it as: "the field of study that gives computers the ability to learn without being explicitly programmed.“

- Tom 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."

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.

What is Machine Learning?

- Example:
  - Image Classification: A basic problem in Computer Vision

→ Cat

What is Machine Learning?

- Example:
  - Image Classification: A basic problem in Computer Vision

```
def image_classifier(image):

    ### Some Code

    return label
```

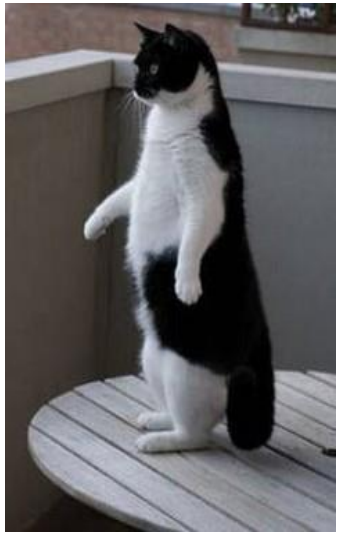
What is Machine Learning?

- Image Classification Challenges:
  - Illumination

What is Machine Learning?

- Image Classification Challenges:
  - Deformation



What is Machine Learning?

- Image Classification Challenges:
  - Occlusion

What is Machine Learning?

- Image Classification Challenges:
  - Background Clutter

What is Machine Learning?

- Image Classification Challenges:
  - Intraclass Variation

What is Machine Learning?

- Image Classification:

```
def image_classifier(image):

    ### Some Code

    return label
```

No obvious way to hard-code the algorithm!!!

What is Machine Learning?

- **Data Driven Approach:**
  - Collect a dataset of images and labels
  - Use Machine Learning to train an image classifier
  - Evaluate the classifier on a withheld set of test images

What is Machine Learning?

- **Data Driven Approach:**

```
def train(train_images, train_labels):

    ### A model for images -> labels

    return model
```

```
def predict(test_images):

    ### Use the trained model for predicting the test labels

    return test_labels
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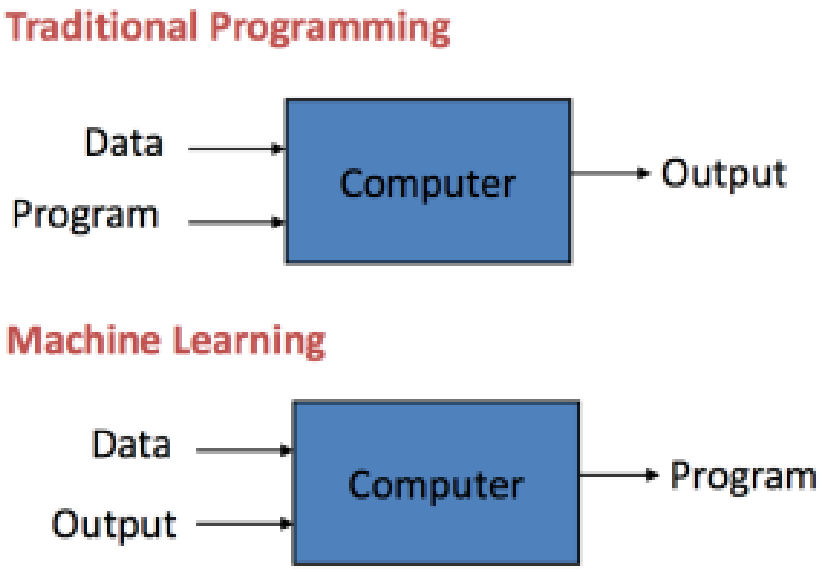


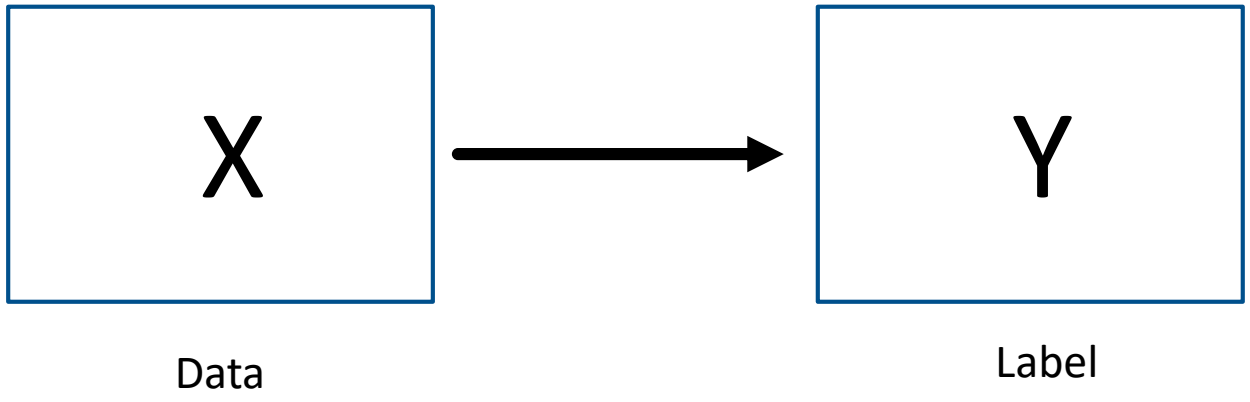
Types of Machine Learning

- **Supervised Learning**
- **Unsupervised Learning**
- **Reinforcement Learning**

Types of Machine Learning

- **Supervised Learning:**

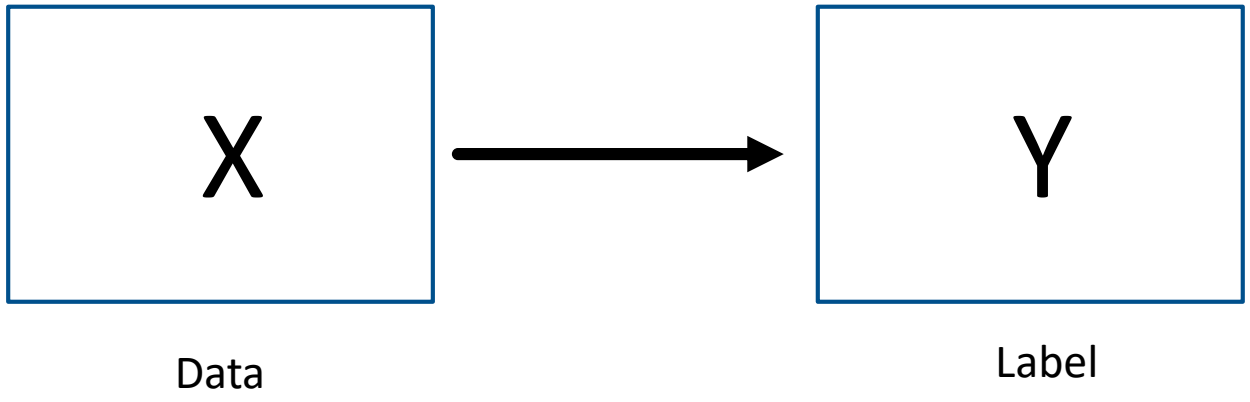
We are given a data set and already know what our correct output should look like, having the idea that there is a **relationship between the input and the output**.



Types of Machine Learning

- **Supervised Learning:**

Supervised Learning uses labeled data to predict a label given some features.



Types of Machine Learning

- **Supervised Learning:**

Example:

Given data about the size of houses on the real estate market, try to predict their price. Price as a function of size is a continuous output.

Given data about the size of houses on the real estate market, try to predict whether the house sells for more or less than the asking price.

Types of Machine Learning

- **Supervised Learning:**

Example:

Given a picture of a person, we have to predict their age on the basis of the given picture

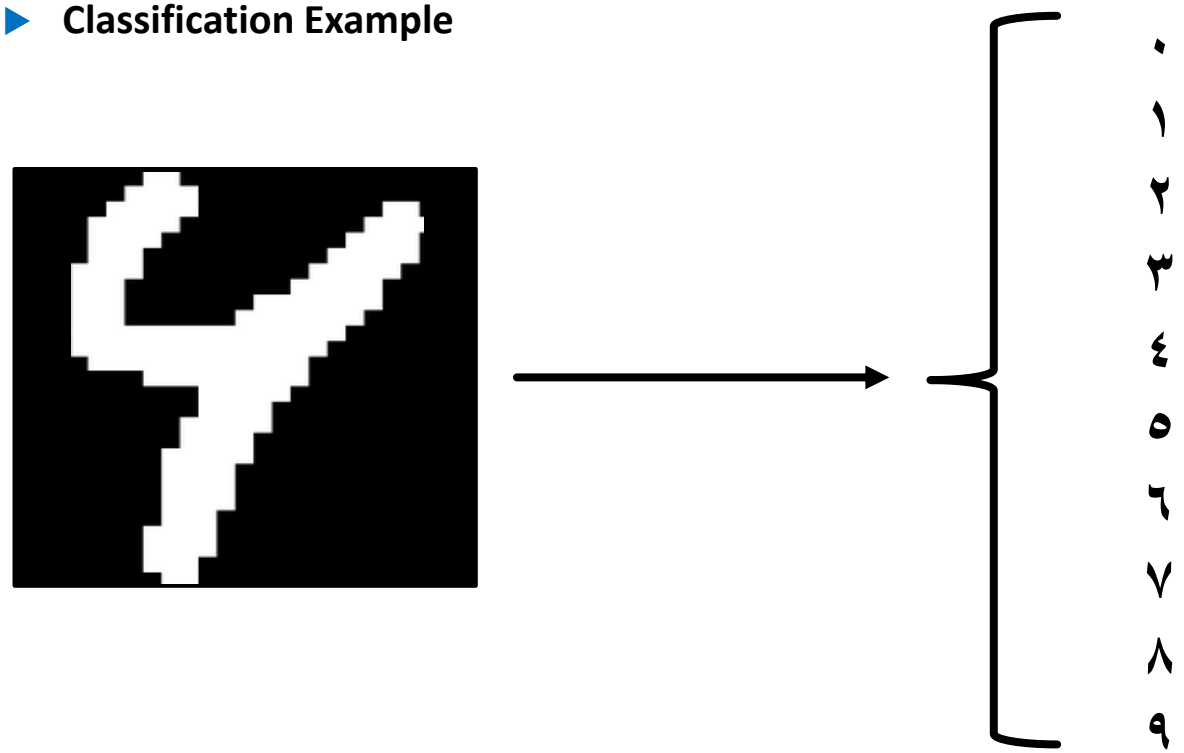
Given a patient with a tumor, we have to predict whether the tumor is malignant or benign.

Types of Machine Learning

- **Supervised Learning**
  - **Regression (Continuous Label)**
    - Given data about the size of houses on the real estate market, try to predict their price. Price as a function of size is a continuous output.
    - Given a picture of a person, we have to predict their age on the basis of the given picture
  - **Classification (Discrete Label)**
    - Given data about the size of houses on the real estate market, try to predict whether the house sells for more or less than the asking price.
    - Given a patient with a tumor, we have to predict whether the tumor is malignant or benign.

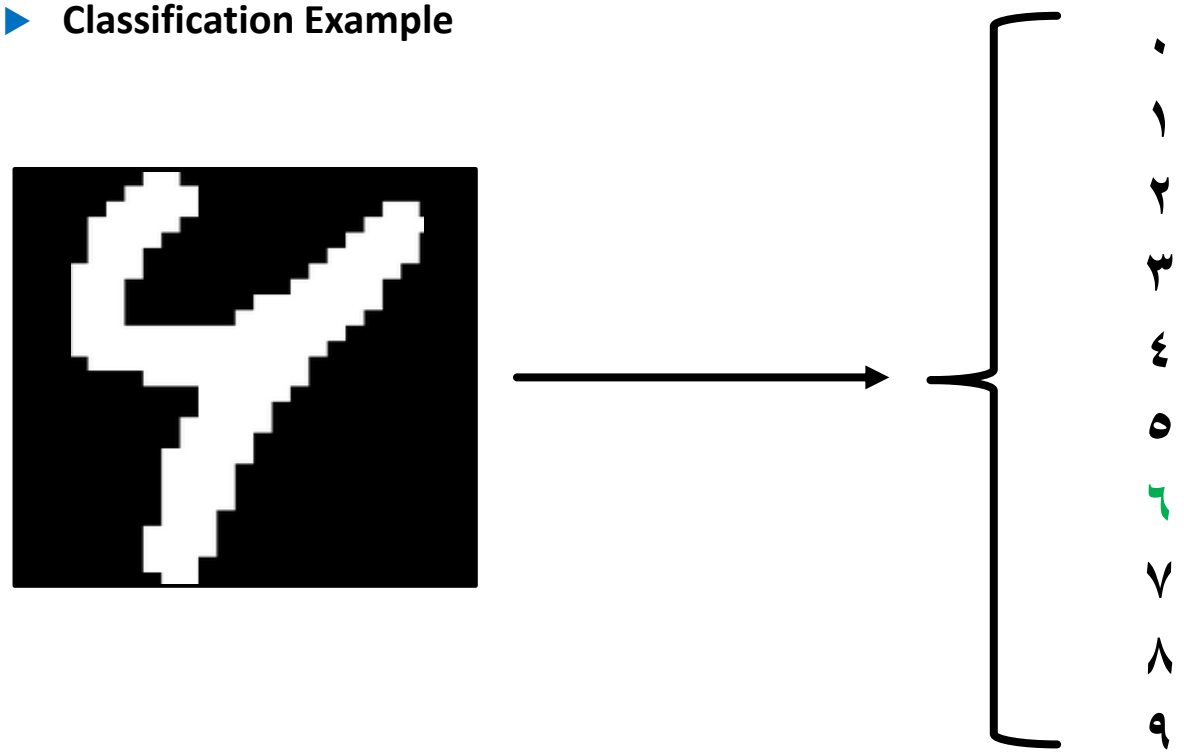
Types of Machine Learning

- **Supervised Learning**
  - **Classification Example**



Types of Machine Learning

- **Supervised Learning**
  - **Classification Example**



Types of Machine Learning

- **Supervised Learning**
  - **Regression or Classification?**
  - Suppose you are working on stock market prediction, and you would like to predict the number of Microsoft shares that will be traded tomorrow

Types of Machine Learning

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  - Suppose you are working on stock market prediction, and you would like to predict the number of Microsoft shares that will be traded tomorrow

  Regression

Types of Machine Learning

- **Supervised Learning**
  - **Regression or Classification?**
  - Suppose you are working on weather prediction, and use a learning algorithm to predict tomorrow's temperature

  Regression

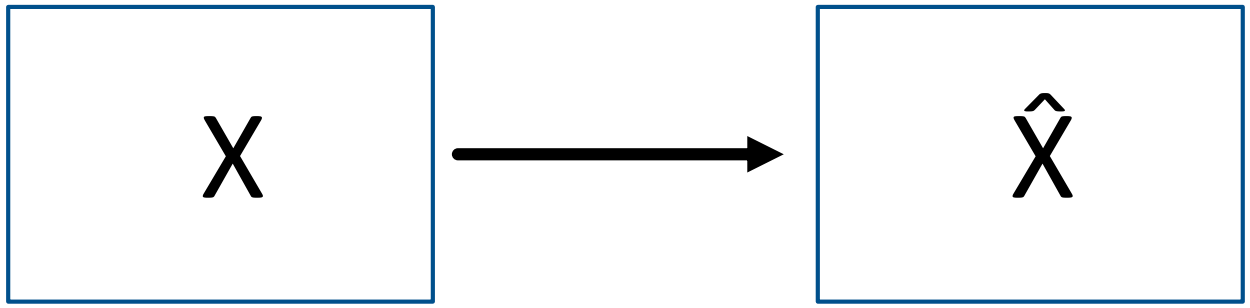
Types of Machine Learning

- **Unsupervised Learning:**

Unsupervised learning allows us to approach problems with little or no idea what our results should look like. We can derive structure from data where we don't necessarily know the effect of the variables.

We can derive this structure by clustering the data based on **relationships among the variables in the data**.

With unsupervised learning there is no feedback based on the prediction results.



Types of Machine Learning

- **Unsupervised Learning:**

Example:

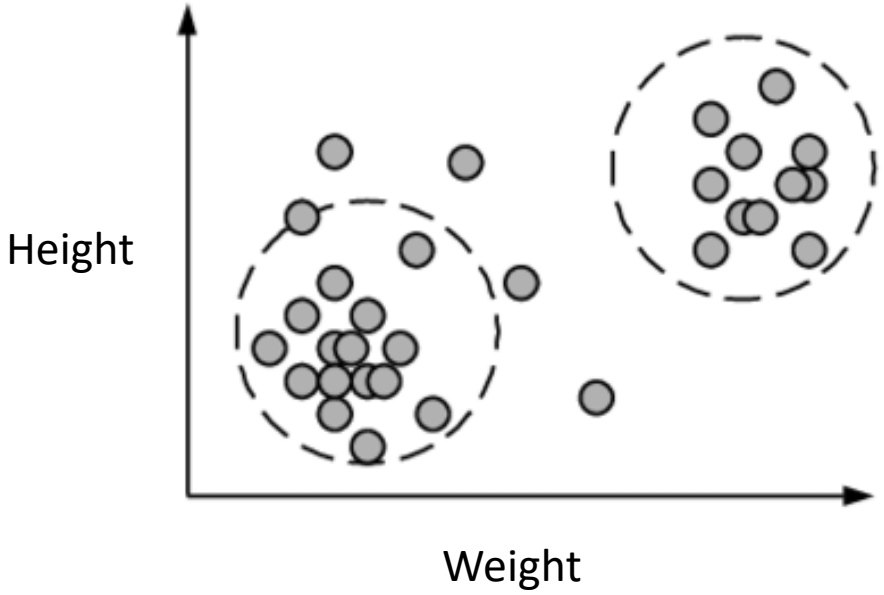
Clustering: Take a collection of 1,000,000 different genes, and find a way to automatically group these genes into groups that are somehow similar or related by different variables, such as lifespan, location, roles, and so on..

Types of Machine Learning

- **Unsupervised Learning:**

Example:

Weight and Height of Athletes



Types of Machine Learning

- **Supervised or Unsupervised Learning?**
  - Given genetic (DNA) data from a person, predict the odds of him/her developing diabetes over the next years

Types of Machine Learning

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  Supervised Learning

Types of Machine Learning

- **Supervised or Unsupervised Learning?**
  - Have a computer examine an audio clip of a piece of music, and classify whether or not there are vocals in that audio clip, or if it is a clip of only musical instruments and (no vocal)

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  Supervised Learning

Types of Machine Learning

- **Supervised or Unsupervised Learning?**
  - Given data on how 1000 medical patients respond to an experimental drug, discover whether there are different categories or “types” of patients in terms of how they respond to the drug, and if so what these categories are

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Unsupervised Learning

Types of Machine Learning

- **Supervised or Unsupervised Learning?**
  - Given a large dataset of medical records from patients suffering from heart disease , try to learn whether there might be different clusters of such patients for which we might tailor separate treatments

Types of Machine Learning

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Unsupervised Learning

Good Resources!

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Browse > Data Science > Machine Learning

Offered By

Stanford

Machine Learning

4.9 130,724 ratings | 97%

Andrew Ng TOP INSTRUCTOR

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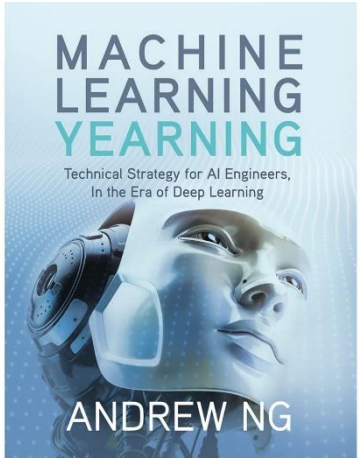
About this Course

15,637,851 recent views

Machine learning is the science of getting computers to act without being explicitly programmed. In the past decade, machine learning has given us self-driving cars, practical speech recognition, effective web search, and a vastly improved understanding of the human genome. Machine learning is so pervasive today that you probably use it dozens of times a day without knowing it. Many researchers also think it is the best way to make progress towards human-level AI. In this class, you will learn about the most effective machine learning techniques, and gain



https://www.coursera.org/learn/machine-learning

Good Resources!

MACHINE LEARNING | LESSONS | CONTACT | BLOG | DEEP LEARNING

Welcome to **Introduction to Machine Learning for Coders!** taught by Jeremy Howard (Kaggle's #1 competitor 2 years running, and founder of Enlitic). Learn the most important machine learning models, including how to create them yourself from scratch, as well as key skills in data preparation, model validation, and building data products.

"fast.ai... can actually get smart, motivated students to the point of being able to create industrial-grade ML deployments"

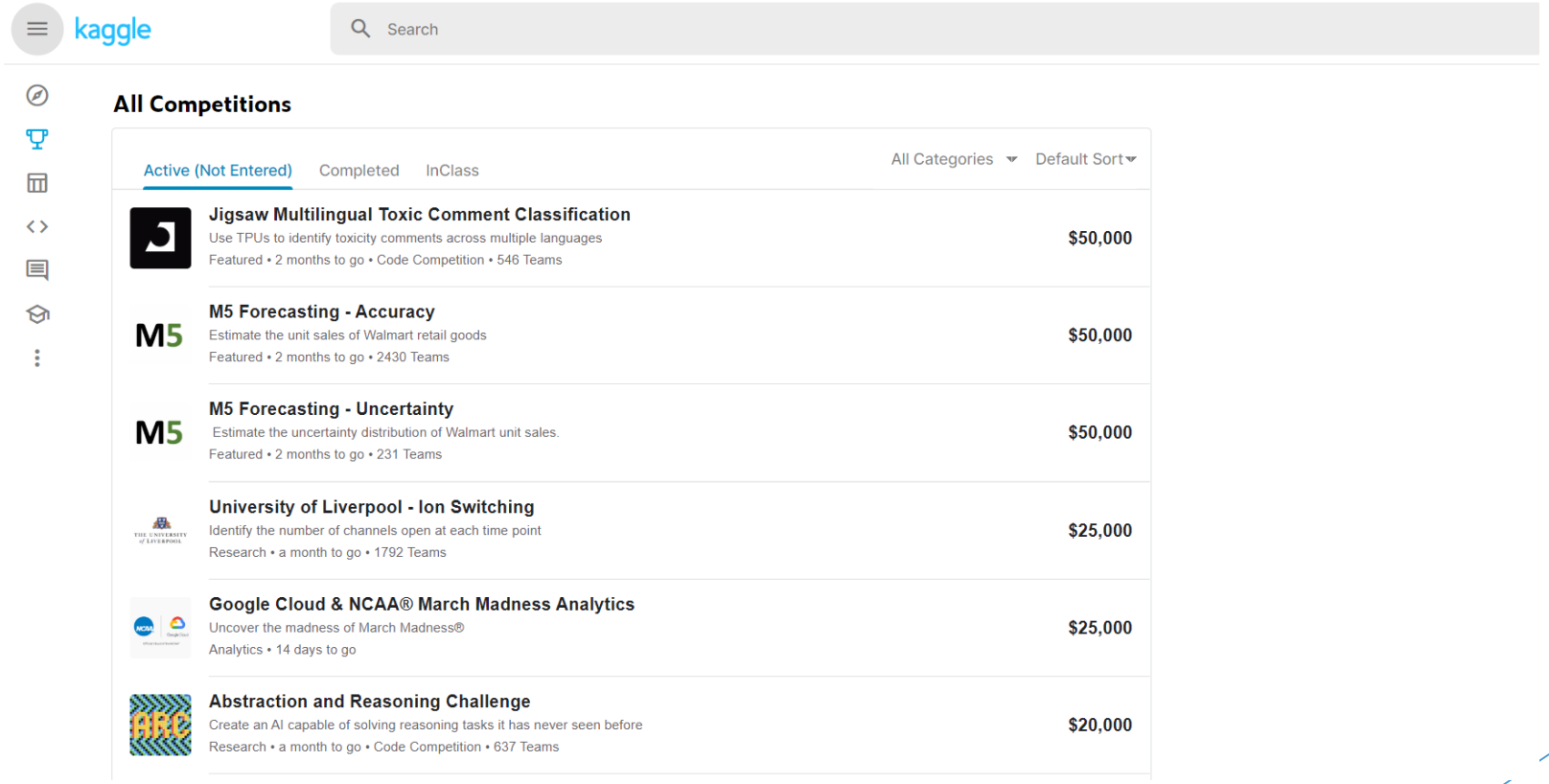
Harvard Business Review
The Business of Artificial Intelligence

There are around 24 hours of lessons, and you should plan to spend around 8 hours a week for 12 weeks to complete the material. The course is based on lessons recorded at the University of San Francisco for the Masters of Science in Data Science program. We assume that you have at least one year of coding experience, and either remember what you learned in high school math, or are prepared to do some independent study to refresh your knowledge.

UNIVERSITY OF SAN FRANCISCO

http://course18.fast.ai/ml

Good Resources!



https://www.kaggle.com/competitions

References

- https://www.coursera.org/learn/machine-learning
- http://cs231n.stanford.edu/