Machine Learning Fundamentals- DTSC 102

Lecture 1
Introduction to ML

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Contents

- Course Overview
- Machine Learning: what and why?
- Machine Learning Classes
- Examples

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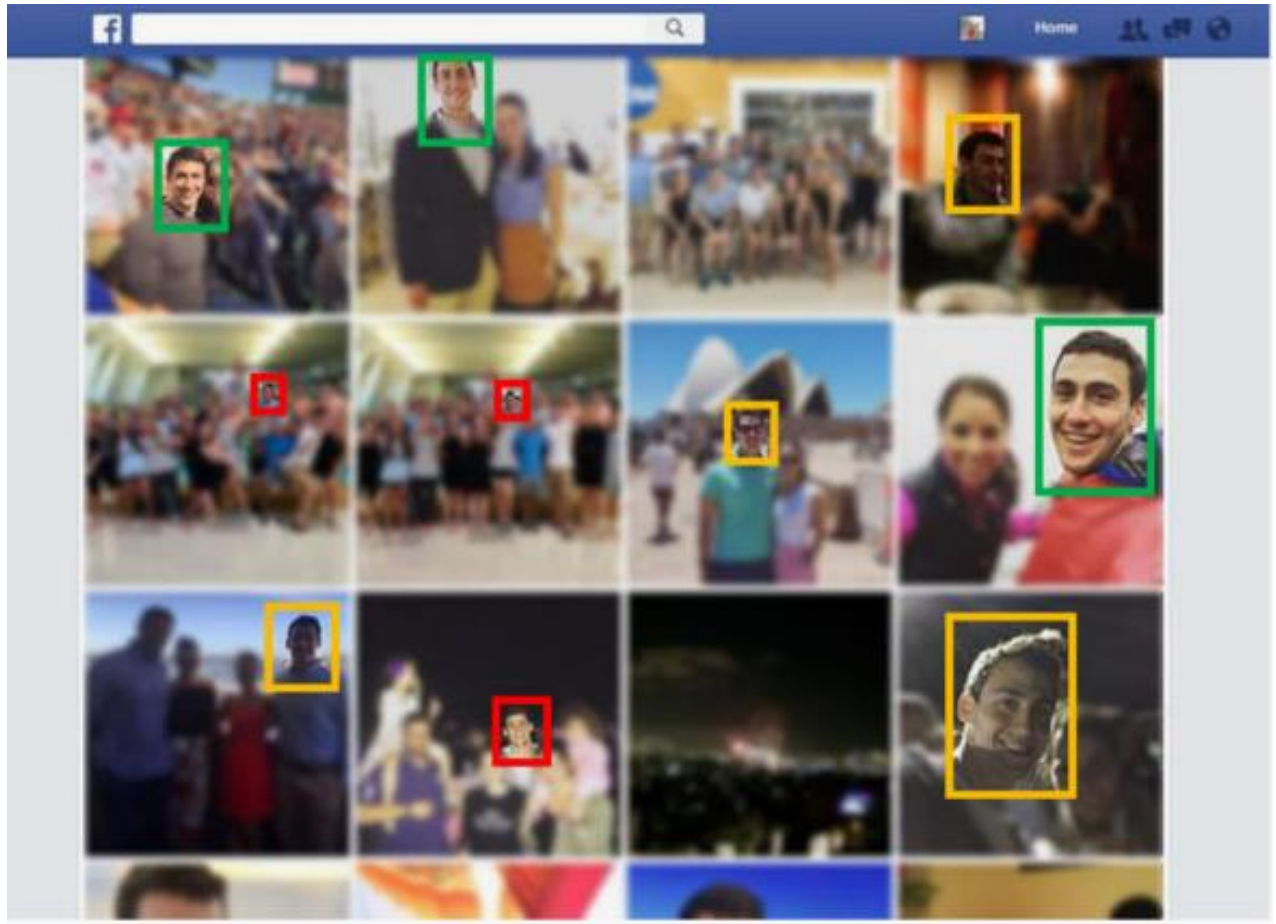
Course Assessment

Assessment Type	Weight	
Final Exam	40%	
Project	20%	
Lab Assignments	40%	

Machine Learning: We use it everyday!

- Facebook's Face Recognition



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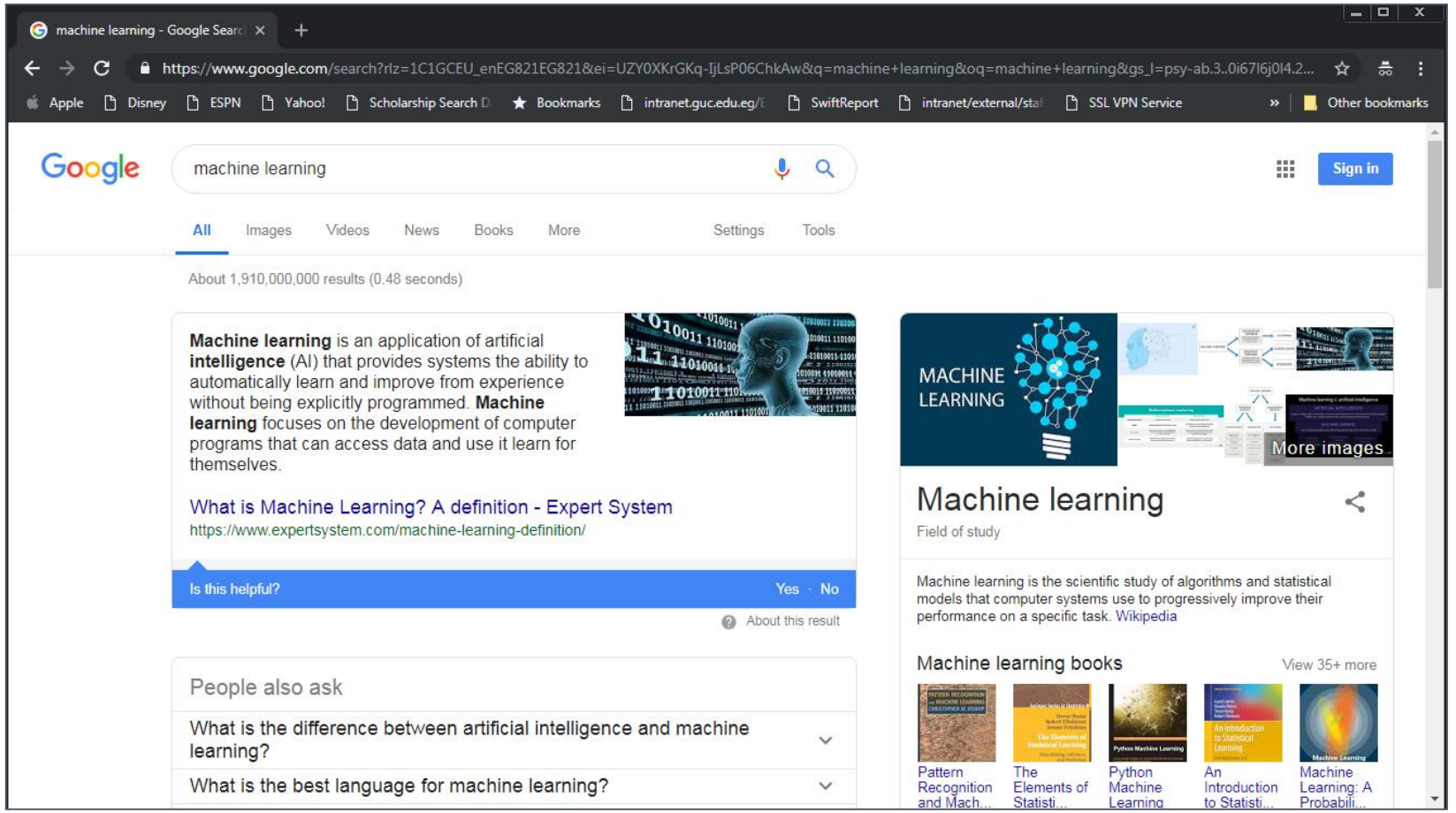
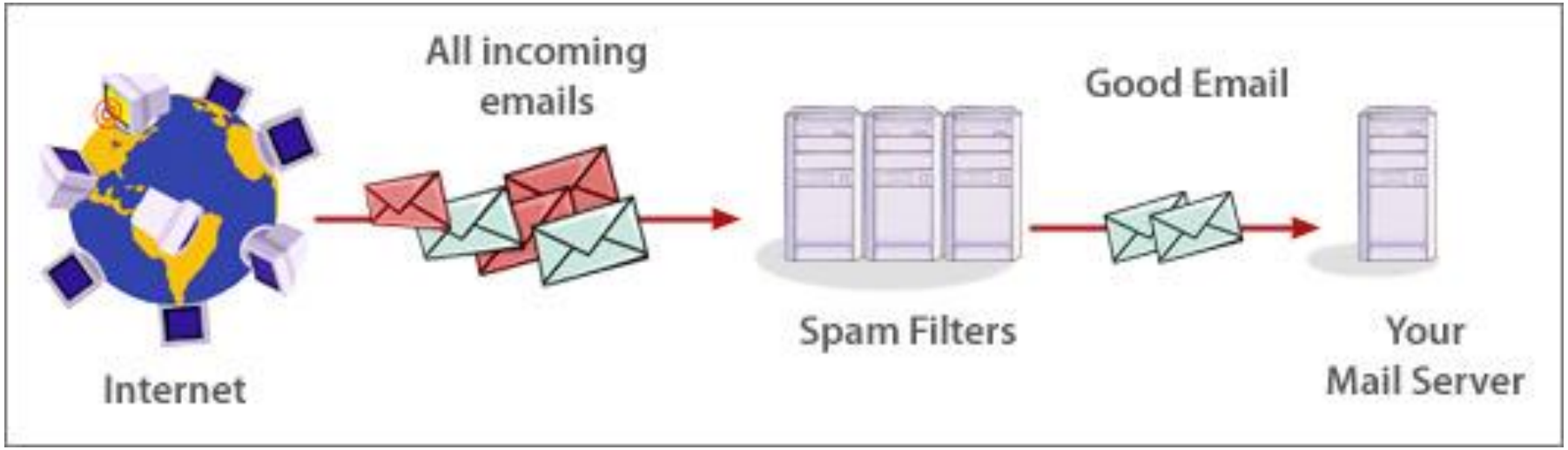
Machine Learning: We use it everyday!

- Google Search



Machine Learning: We use it everyday!

- Spam Filtering in e-mails

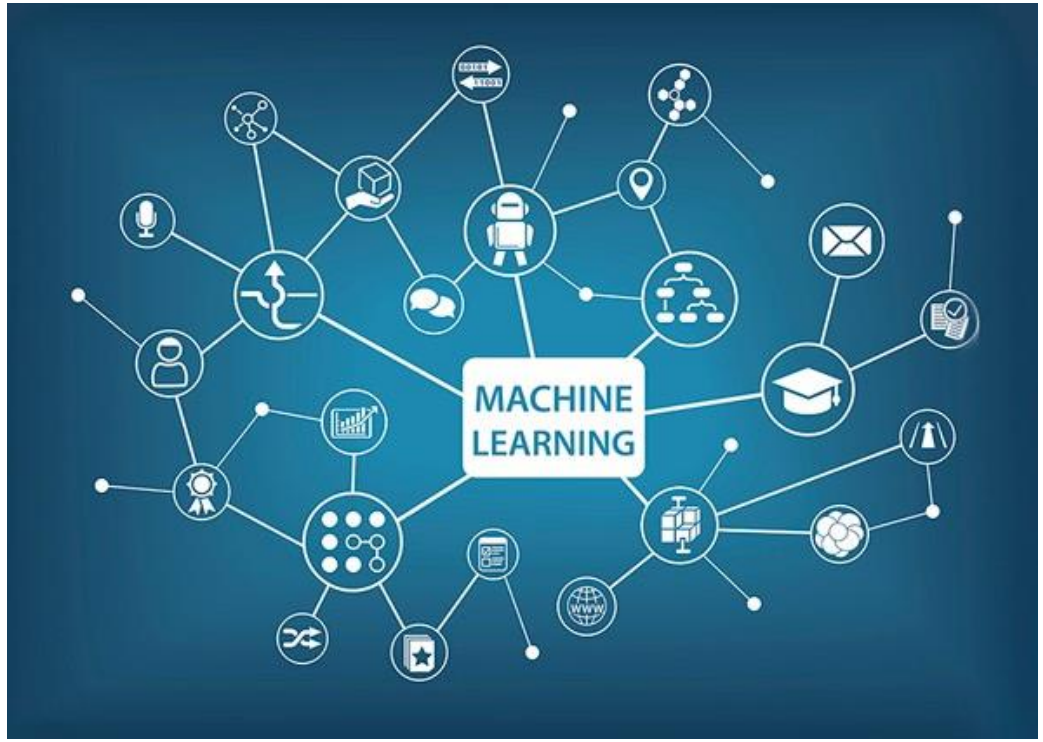


Machine Learning: We use it everyday!

And in many other scenarios:

- Data Mining programs detecting fraudulent credit card transactions
- Learning users' preferences
- Self-driving vehicles

and many more…



Growth of Machine Learning

Machine Learning is the preferred approach for:

- Speech recognition
- Natural language processing
- Computer vision
- Medical outcomes analysis
- Robot control
- Computational biology
- Sensor networks

Growth of Machine Learning

Machine Learning is accelerating due to:

- Improved machine learning algorithms
- Big Data and need for big data analytics
- Faster computers
- Software that is too complex to write by hand
- Sensors & IO devices constructing IoT
- Demand for self-customization to user and environment

So What is Machine Learning?

It is the science of getting computers to learn without being explicitly programmed,

Through constructing computer programs that automatically improve with experience

So What is Machine Learning?

Machine Learning:

Study of Algorithms that

- Improve their performance P
- at some task T
- With experience E

So a well defined learning task is represented as

{P,T,E}

Machine Learning Examples

Example: Spam Filtering process

- T : Classifying e-mails as spam or not
- E : Watching you label emails as spam or not spam
- P : number of correctly classified e-mails as spam/not spam

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Machine Learning Examples

Example: Image Recognition

- T : Detecting faces in images
- E : Given example training images
- P : number of correctly recognized faces

Example training images for each orientation

Types of Machine Learning

- **Supervised Learning**
  - Also known as predictive learning
  - Given: Training set D of N input-output pairs $D = \{(x_i, y_i)\}, i = 1, \dots N$
  - Goal: Learn a mapping from inputs x to outputs y
  - Has two types:
    1. Regression: when y is a continuous value output
    2. Classification: when y is a discrete value output

- **Unsupervised Learning**
  - Also known as descriptive learning
  - Given: Training set D of N inputs $D = \{x_i\}, i = 1, \dots N$
  - Goal: Finding interesting patterns in the data
  - Has two types:
    1. Clustering: grouping data into cohesive groups
    2. Non-Clustering: finding structure in a chaotic environment

Other types:
- Reinforcement Learning

Supervised Learning

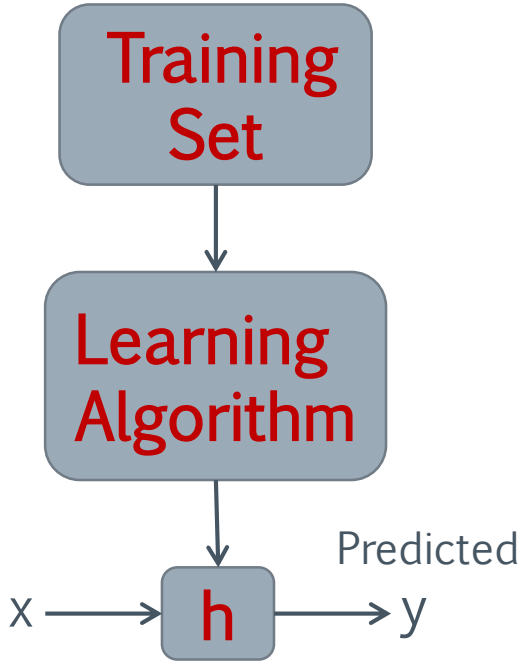
➢ Given:

Training set D of N input-output pairs

$$D = \{(x_i, y_i)\}, i = 1, \dots N$$

where

- x_i is the input variable (also called input features)
- y_i is the output/target value
- (x_i, y_i) is a training example



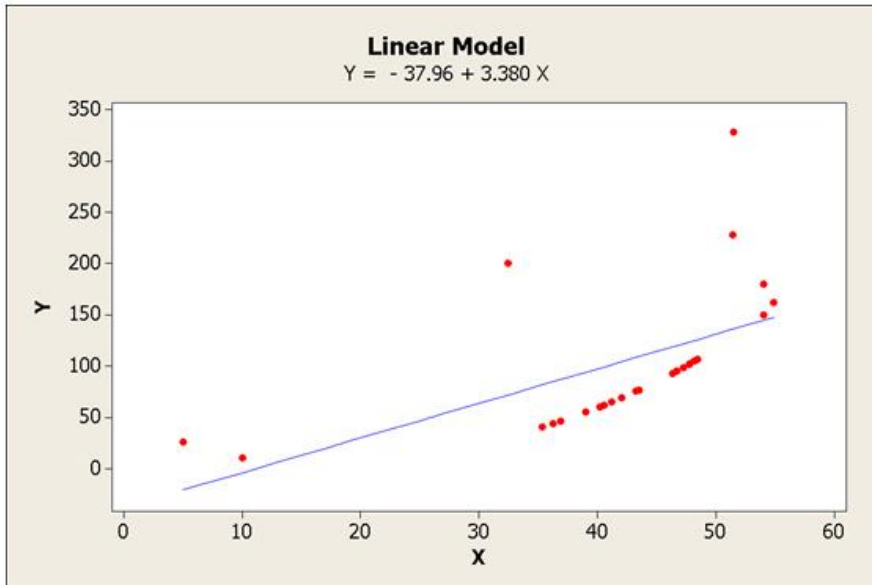
➢ Goal: Learn a function *h: x → y* such that *h(x)* is a good predictor for the corresponding value of *y*

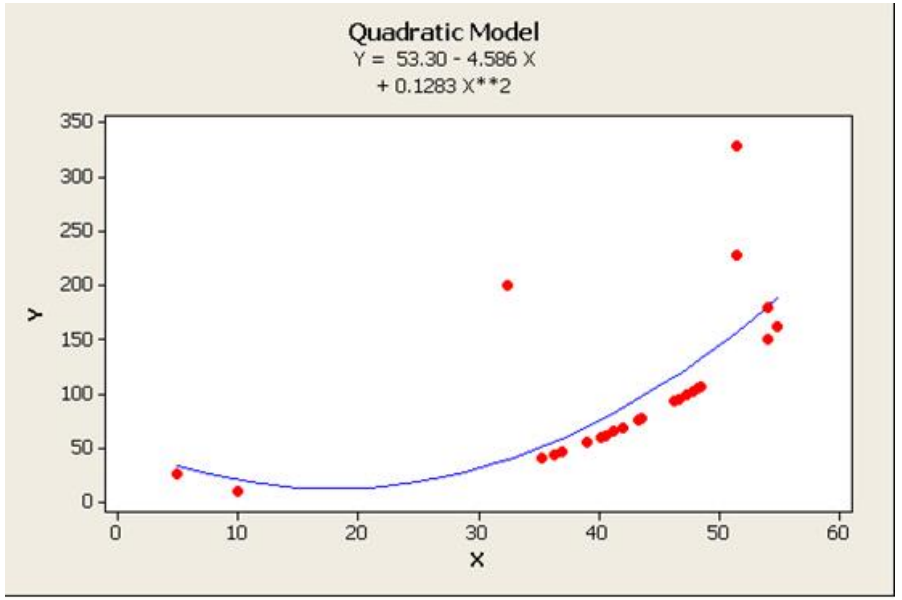
Supervised Learning

Example: Predicting house prices

- Assume we are given a training set of living areas and prices for *n* houses
- Perform **Regression** to estimate the hypothesis function to predict continuous valued output

Living area (feet^2)	Price (1000$s)
2104	400
1600	330
2400	369
1416	232
3000	540
⋮	⋮



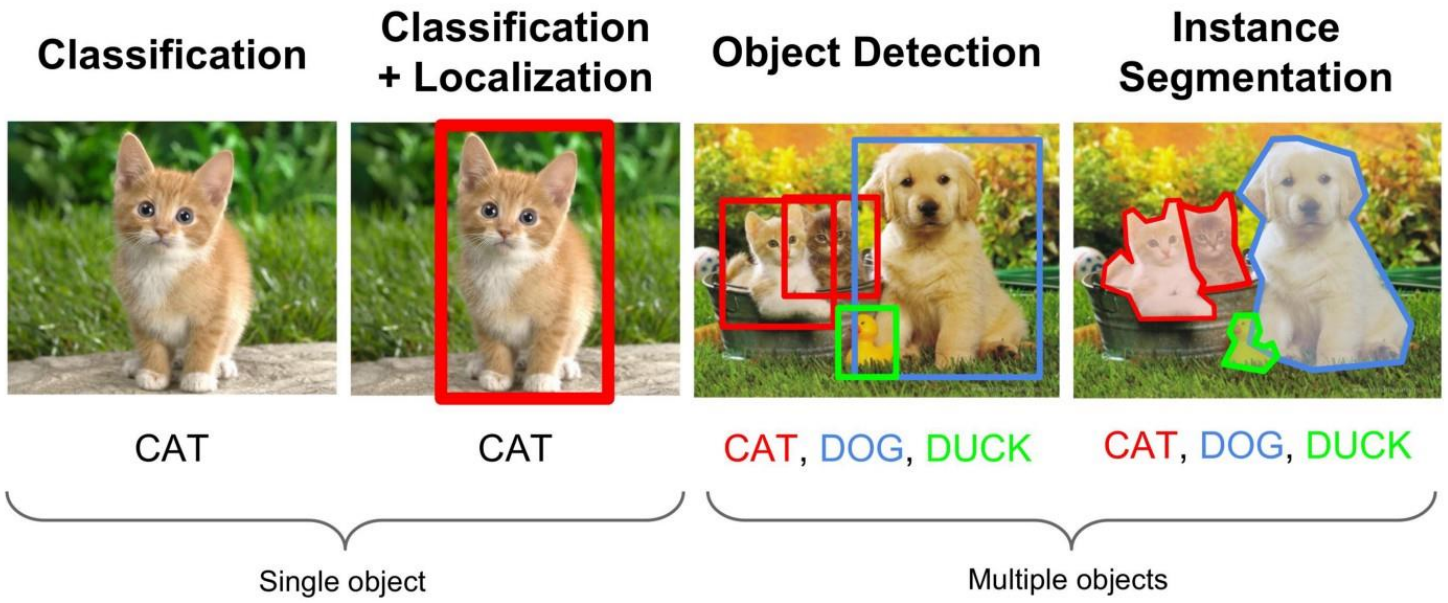


Supervised Learning

Example: Shape Recognition

- Assume we are given a training set of different shapes corresponding to two classes C=Yes/No
- Perform **Classification** to estimate the hypothesis function to predict discrete valued output
- If C=2 output classes
  - ✓ Binary Classification

  If C>2
  - ✓ Multiclass Classification



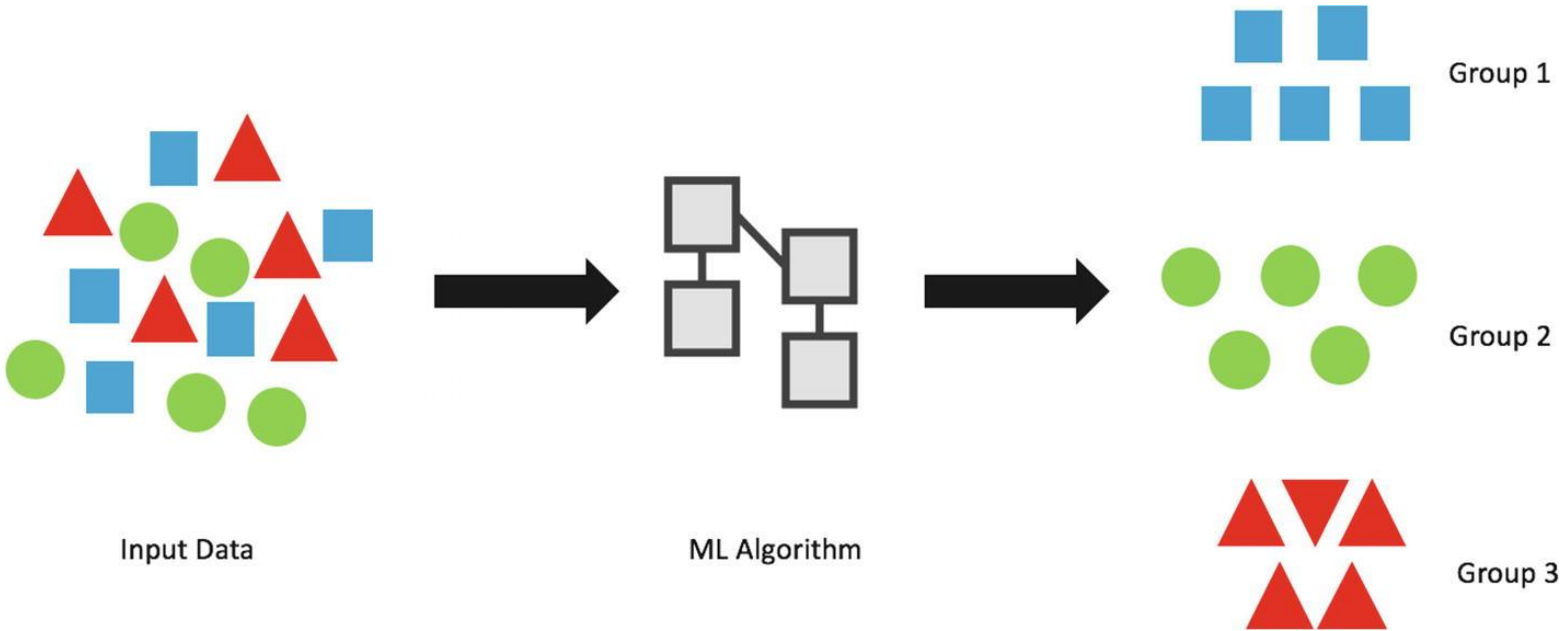
Unsupervised Learning

- Given:

Only input data is given without any outputs

- Goal:

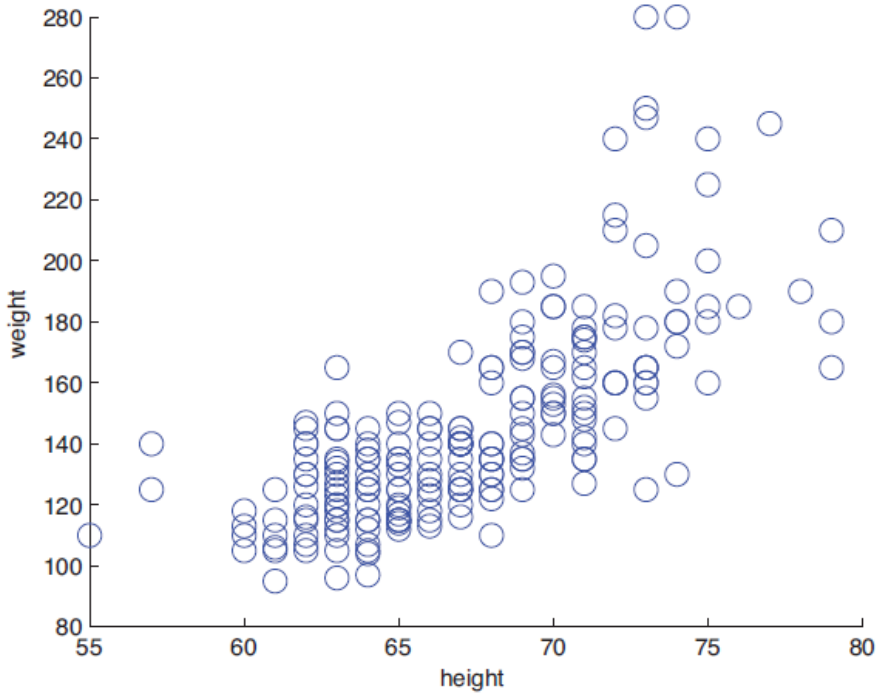
Deriving structure from data where we don't necessarily know the effect of the variable

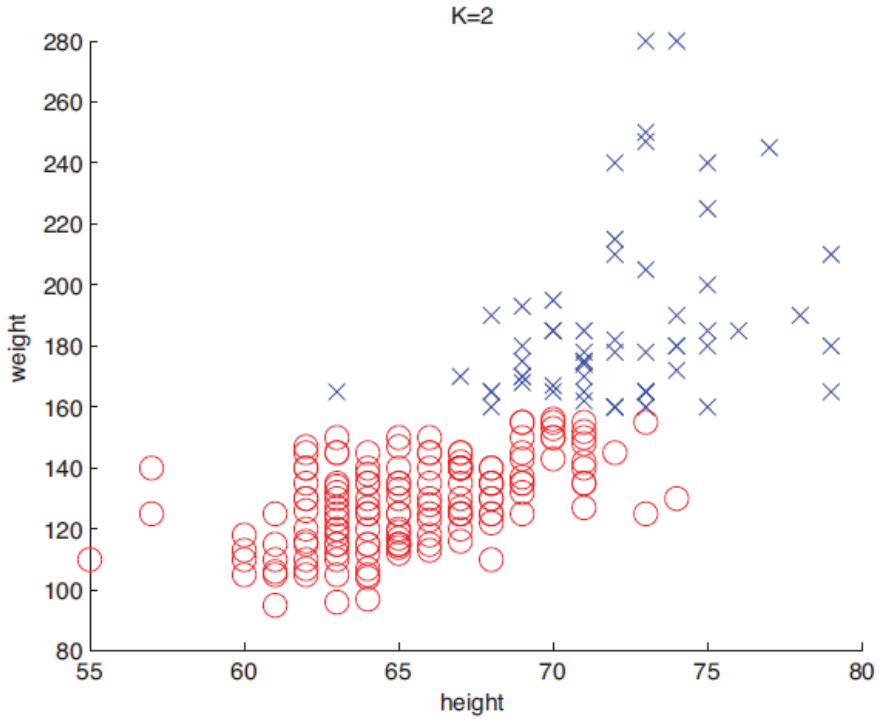


Unsupervised Learning

Example: Clustering according to height and weight

- Assume we are given a heights and weights of a group
- Perform **Clustering** to divide the data into groups





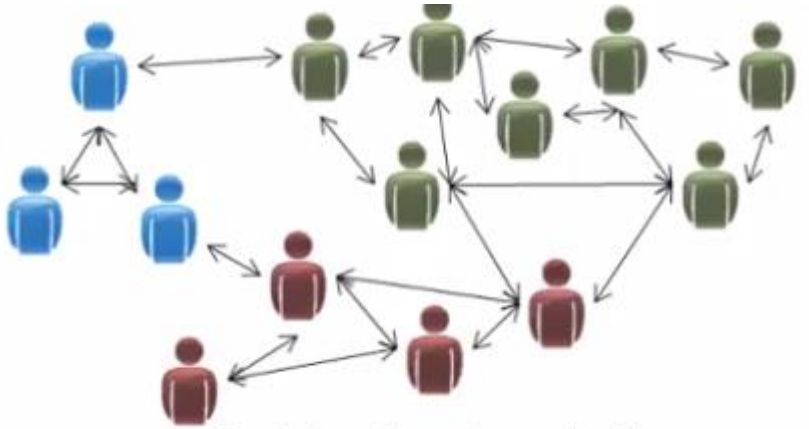
Unsupervised Learning

More examples:

- Organizing computer clusters:
  servers who work together are placed together for better data center performance
- Social Network Analysis
  Detecting cohesive groups and suggesting friends
- Market Segmentation
  Grouping customers into segments for better marketing

Organize computing clusters

Market segmentation



Social network analysis

Unsupervised Learning

Example: Cocktail Party Problem

- Assume a cocktail party where everyone is speaking at the same time
- Trying to recognize what everyone is saying
- Perform a **non-clustering** algorithm to find structure in a chaotic environment