

Introduction to Machine Learning  
Instructor: Prof. Ganesh Ramakrishnan  
Lecture 2 - Supervised vs. Unsupervised Learning  
and Method of Least Squares

# Supervised vs Unsupervised

**Task:** Given a basket of fresh fruits, you are asked to identify the *type* of each fruit in the basket

*Eg:* apple, banana, cherry, grape

## Case: 1

- **Observations:** Size (parametrised using length, breadth, etc.), Shape, Color

# Supervised vs Unsupervised

**Task:** Given a basket of fresh fruits, you are asked to identify the *type* of each fruit in the basket

*Eg:* apple, banana, cherry, grape

## Case: 1

- **Observations:** Size (parametrised using length, breadth, *etc.*), Shape, Color
- **Train data:** Fruits in the basket **along with their labels**
- **Goal:** Develop ability to assign labels to new fruits based on **observations** made on them
- **Supervised Learning:** Achieve the **Goal** by learning from **Train data**

## Case 2:

- Given no **label** on each fruit, could you organize the basket by clubbing together fruits of the same type?
- *E.g.:* Group together fruits that exhibit similar shape or color
- Groupings on the basis of *color*:

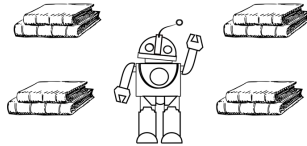
## Case 2:

- Given no **label** on each fruit, could you organize the basket by clubbing together fruits of the same type?
- *E.g.::* Group together fruits that exhibit similar shape or color
- Groupings on the basis of *color*:
  - **Red Color Group**: Apples and cheery
  - **Green Color Group**: Bananas and grapes
- Groupings on the basis of *size*:

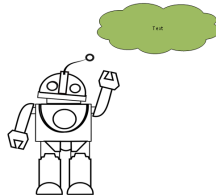
## Case 2:

- Given no **label** on each fruit, could you organize the basket by clubbing together fruits of the same type?
- *E.g.:*: Group together fruits that exhibit similar shape or color
- Groupings on the basis of *color*:
  - **Red Color Group**: Apples and cheery
  - **Green Color Group**: Bananas and grapes
- Groupings on the basis of *size*:
  - **Red color and big size**: Apple
  - **Red color and small size**: Cheery
  - **Green color and big Size**: Banana
  - **Green color and small Size**: Grapes
- This is **unsupervised learning**

# Key Difference between Supervised and Unsupervised Learning



Supervised Learning



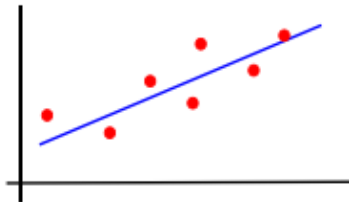
Un-Supervised Learning

- Supervised learning  $\Rightarrow$  Observed output is specified in the sample
- Unsupervised learning  $\Rightarrow$  Desired output is unobserved

# Three Canonical Learning Settings

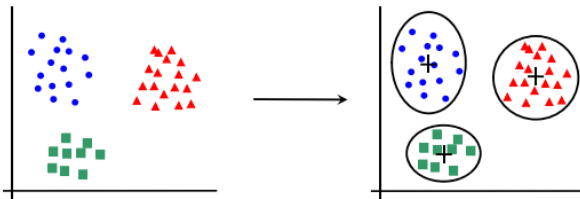
## 1 Regression - Supervised

- Estimate parameters, *E.g.* least square fit



## 2 Classification - Supervised

- Estimate class, *E.g.* handwritten digit classification

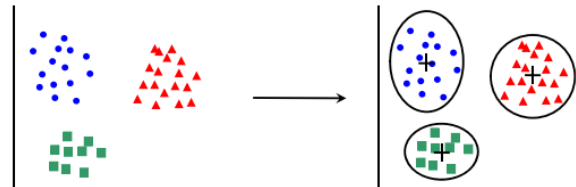




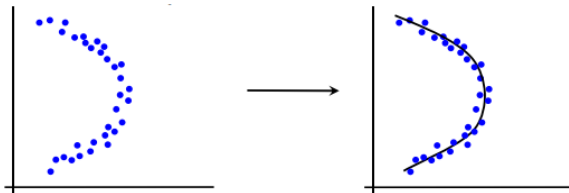
# Three Canonical Learning Settings (contd.)

## 3 Unsupervised Learning - Model the data

- clustering



- dimensionality reduction



# Supervised Learning: More formally

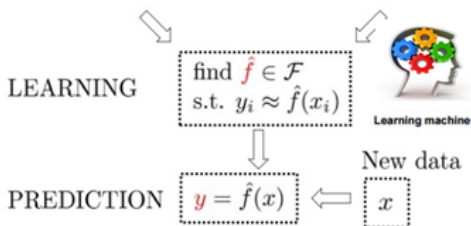
Functions  $F$       Training Data

$$f: X \rightarrow Y \quad \{ (x^i, y^i) \in X \times Y \}$$

## Supervised Learning

Functions  $F$       Training Data

$$f: X \rightarrow Y \quad \{ (x^i, y^i) \in X * Y \}$$



- **Machine Learning in General**
  - Supervised Learning
  - Unsupervised Learning
  - Applications and examples
- **Canonical Learning Problems**
  - Regression Supervised
  - Classification Supervised
  - Unsupervised modeling of data