# Machine Learning (ML)

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# Outline

# Machine Learning



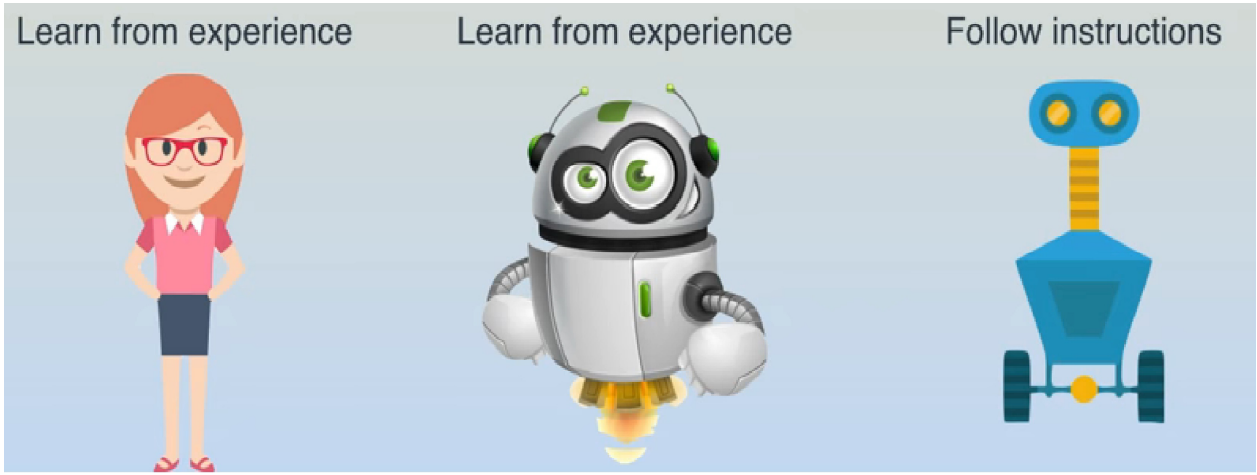



Figure 1: ML

- Human: Learn from past experiences
- Computer: Need to be programmed about what to do
- Can we get computers to learn from experiences?
  - Yes, Machine learning
  - Past experience: Data
  - How to make the computer to learn from the previous data?

# Price of a House




Figure 2: Regression

- Predict price(dollars) of the house given its size(Sq.ft).
- What is the price of this medium sized house?

# Contd ...



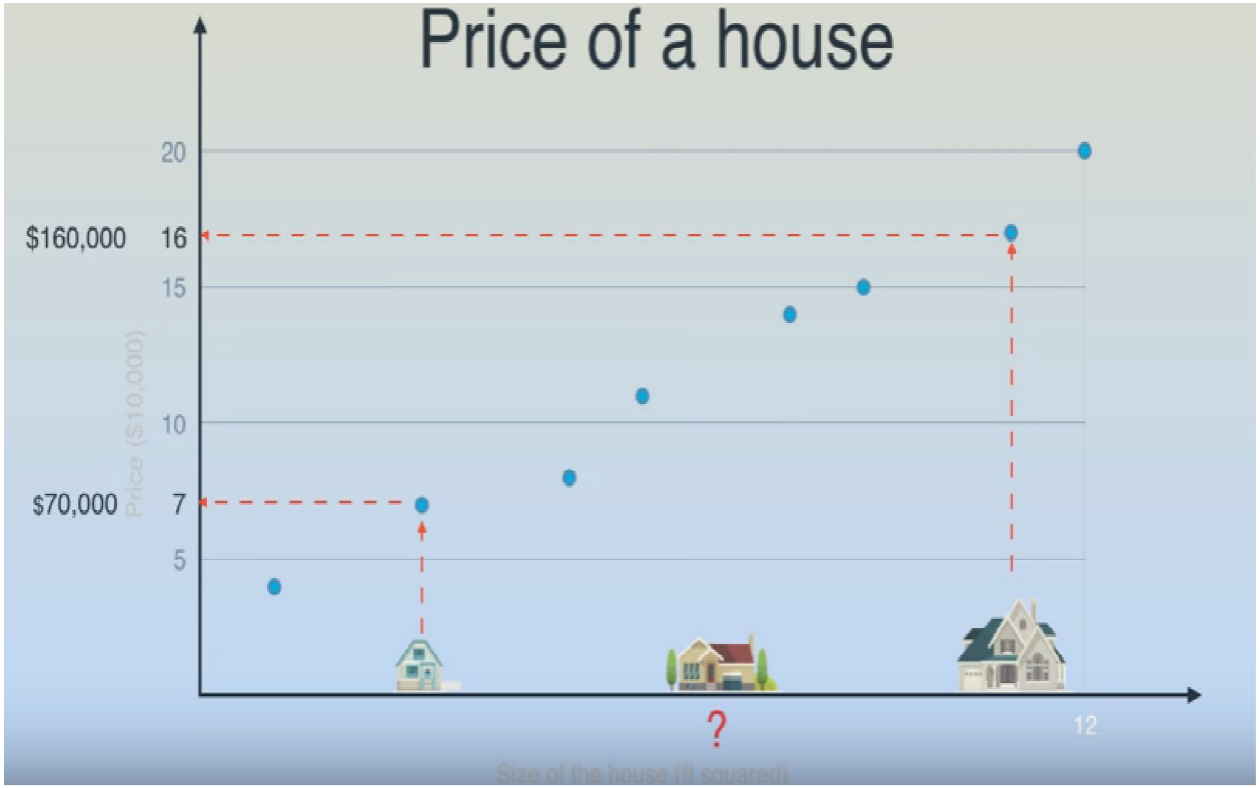



Figure 3: Regression

- What is the best estimate for the price of the house?

# Contd ...




Figure 4: Linear Regression

- How to find this line?

# How to fit the line?



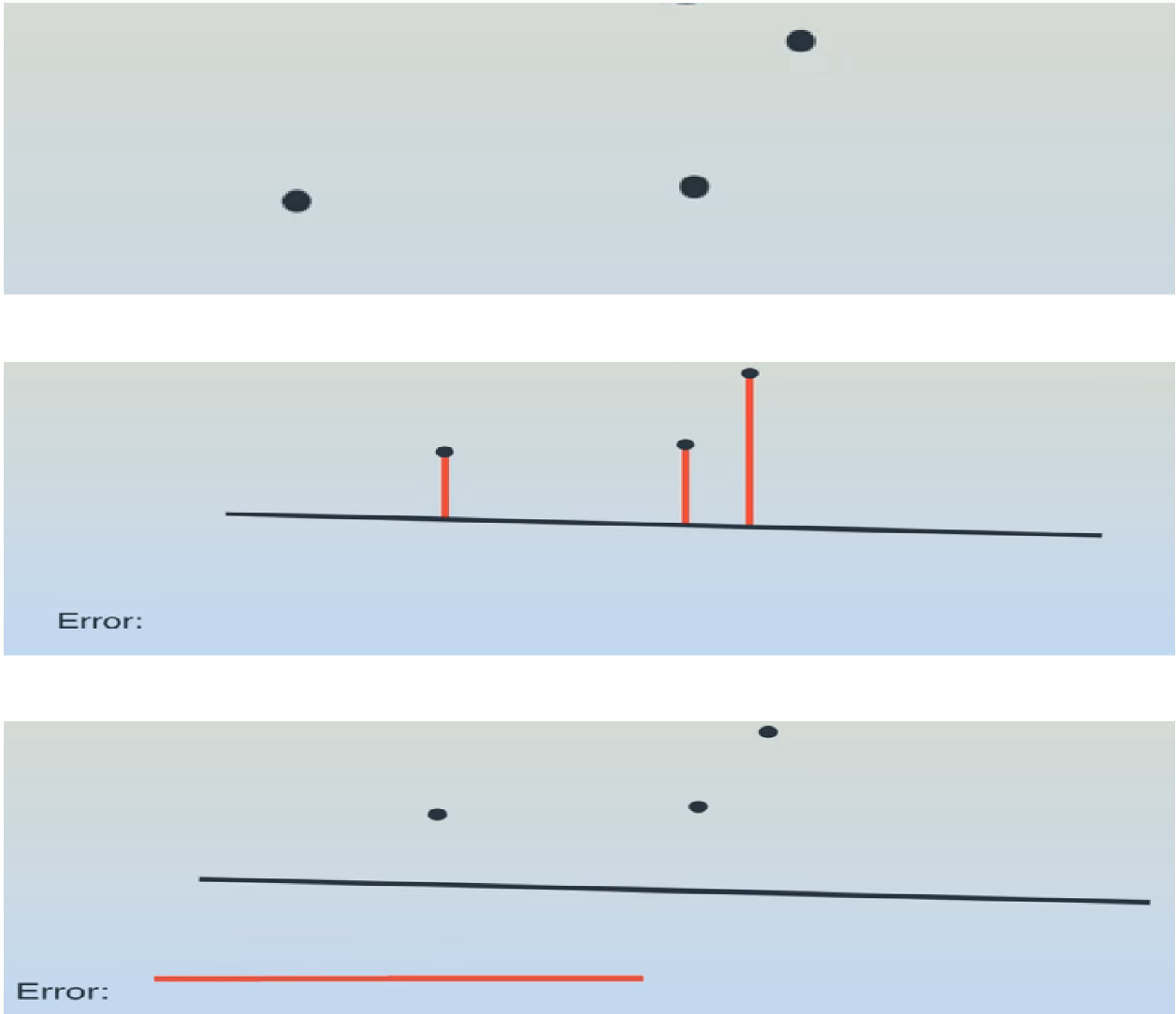



Figure 5: Example

# Contd ...



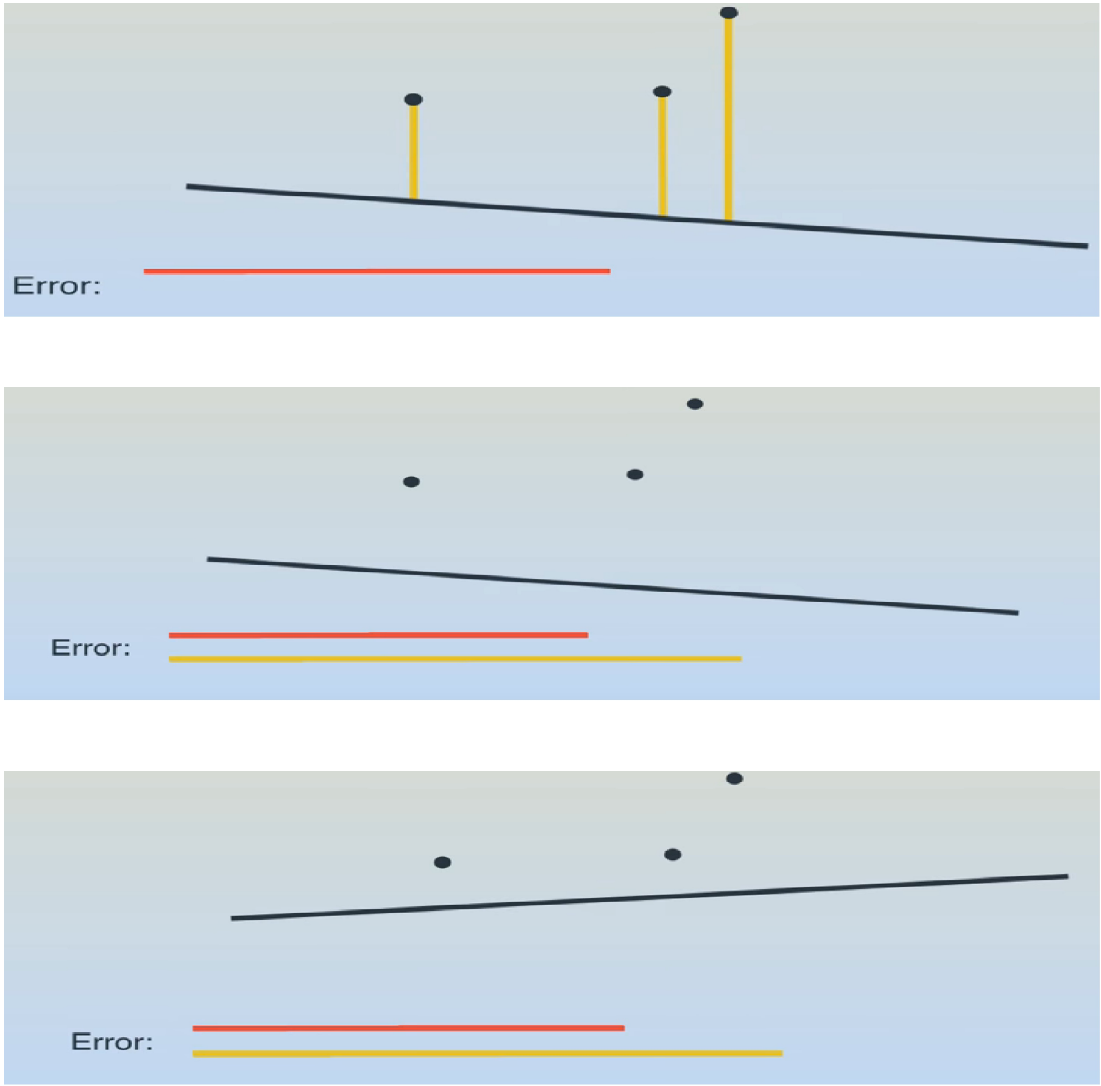



Figure 6: Example

# Contd ...



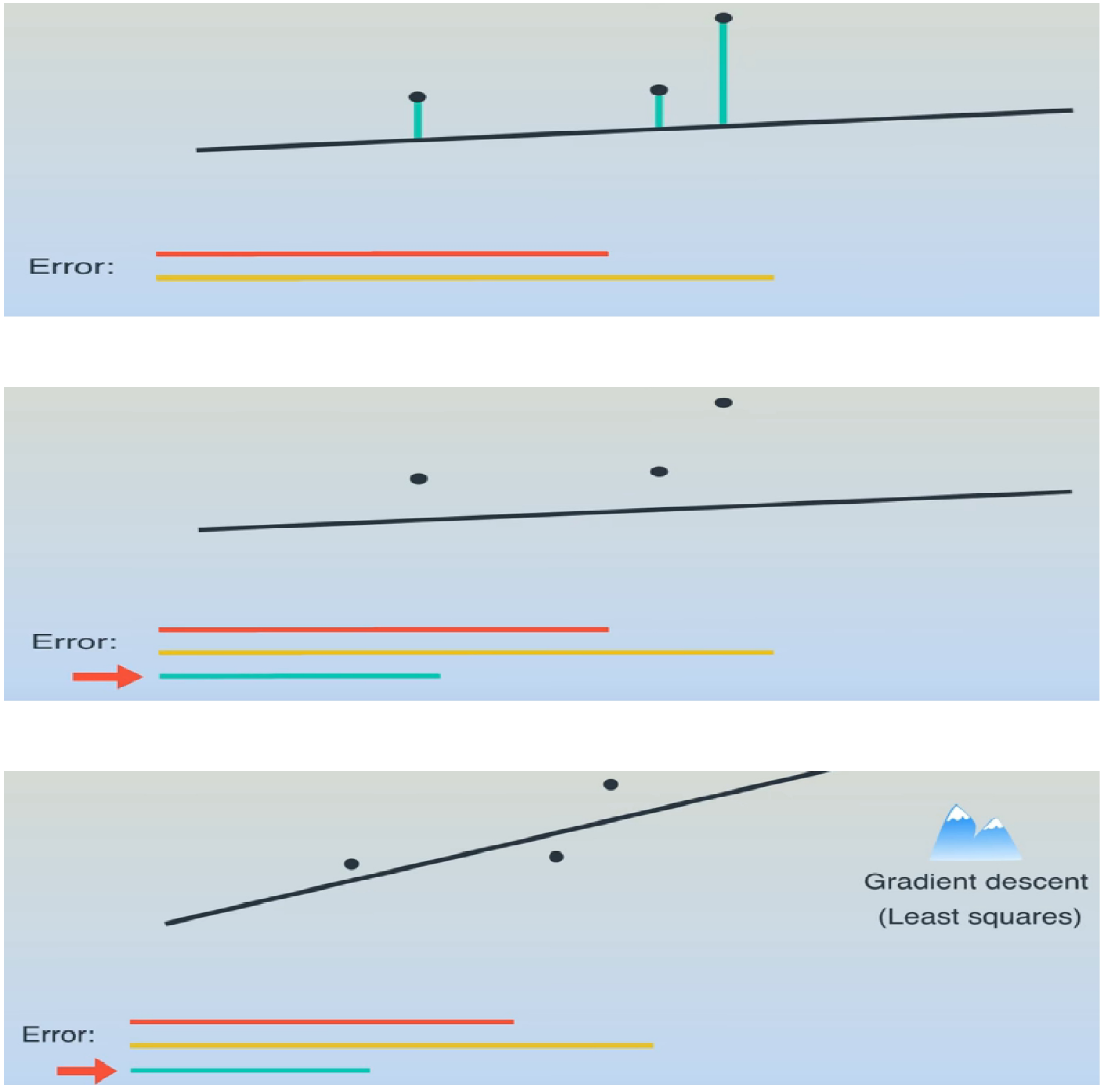
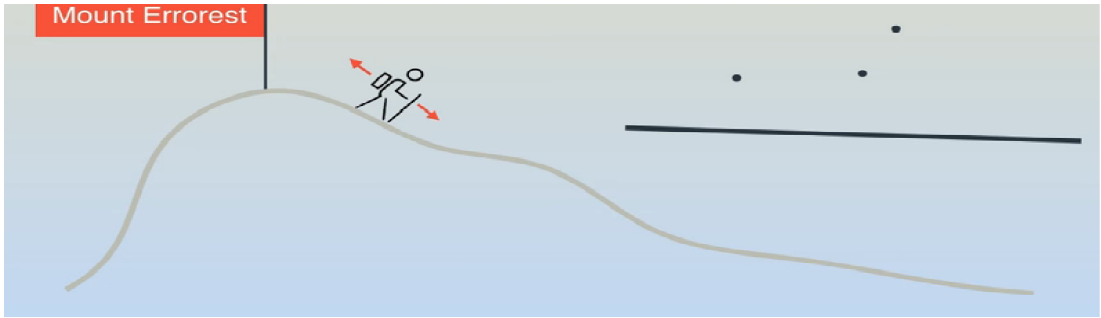


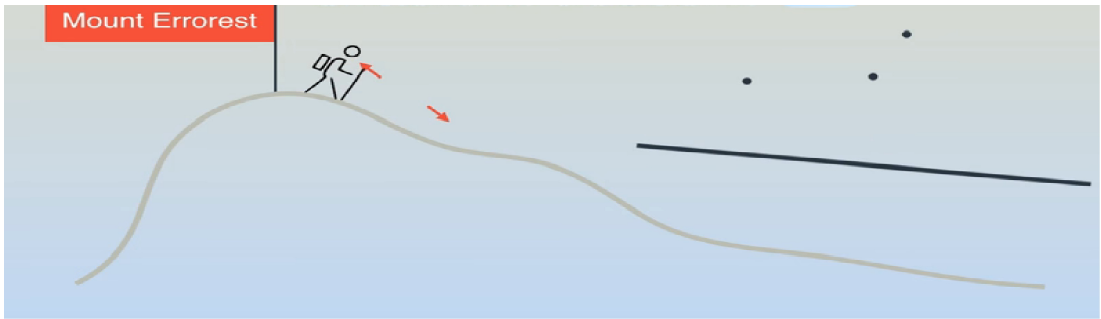

Figure 7: Example

# Gradient Descent



- Descent: Reducing the error
- Identify direction that descent more



# Contd ...



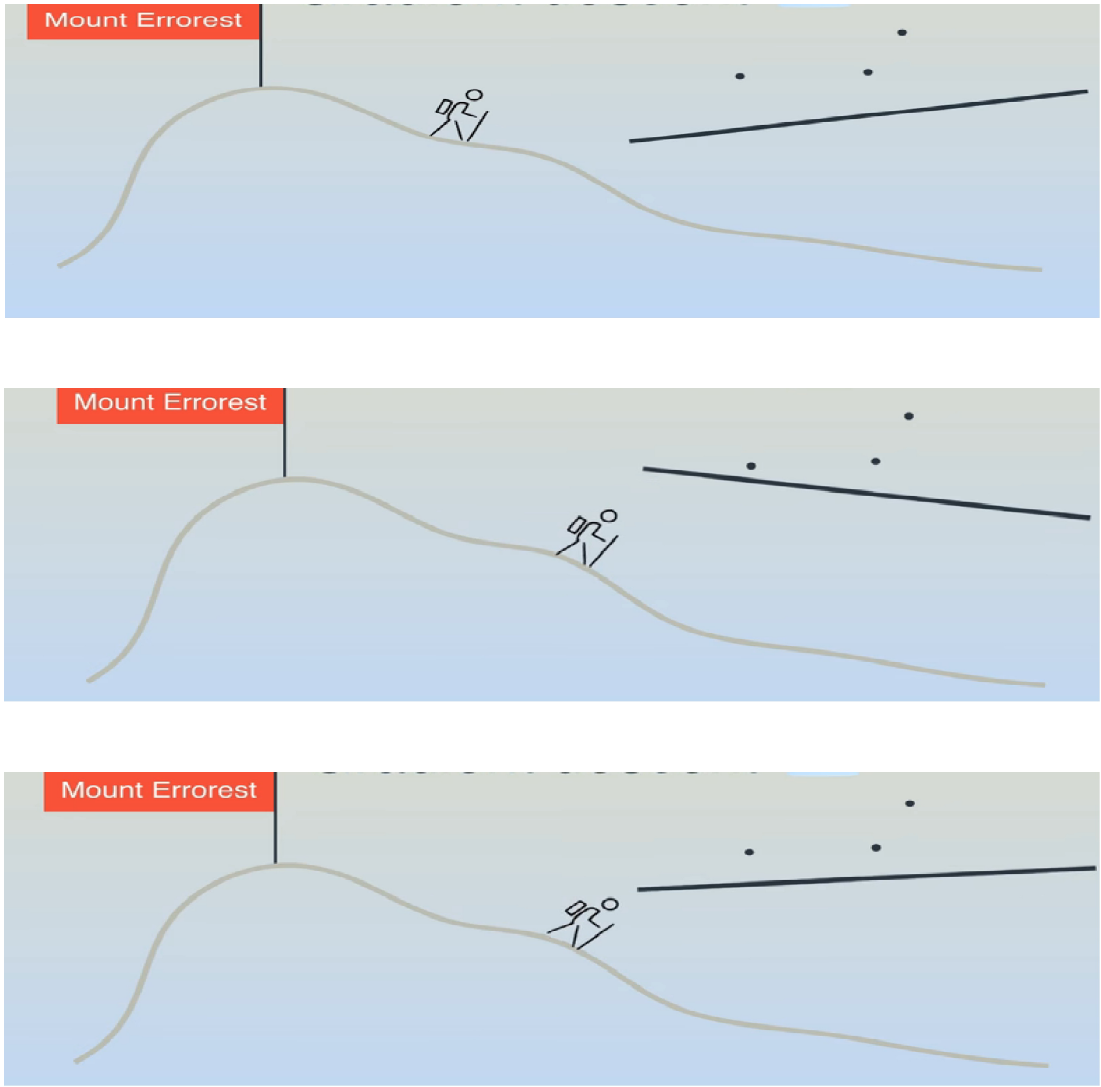



Figure 8: Example

# Contd ...



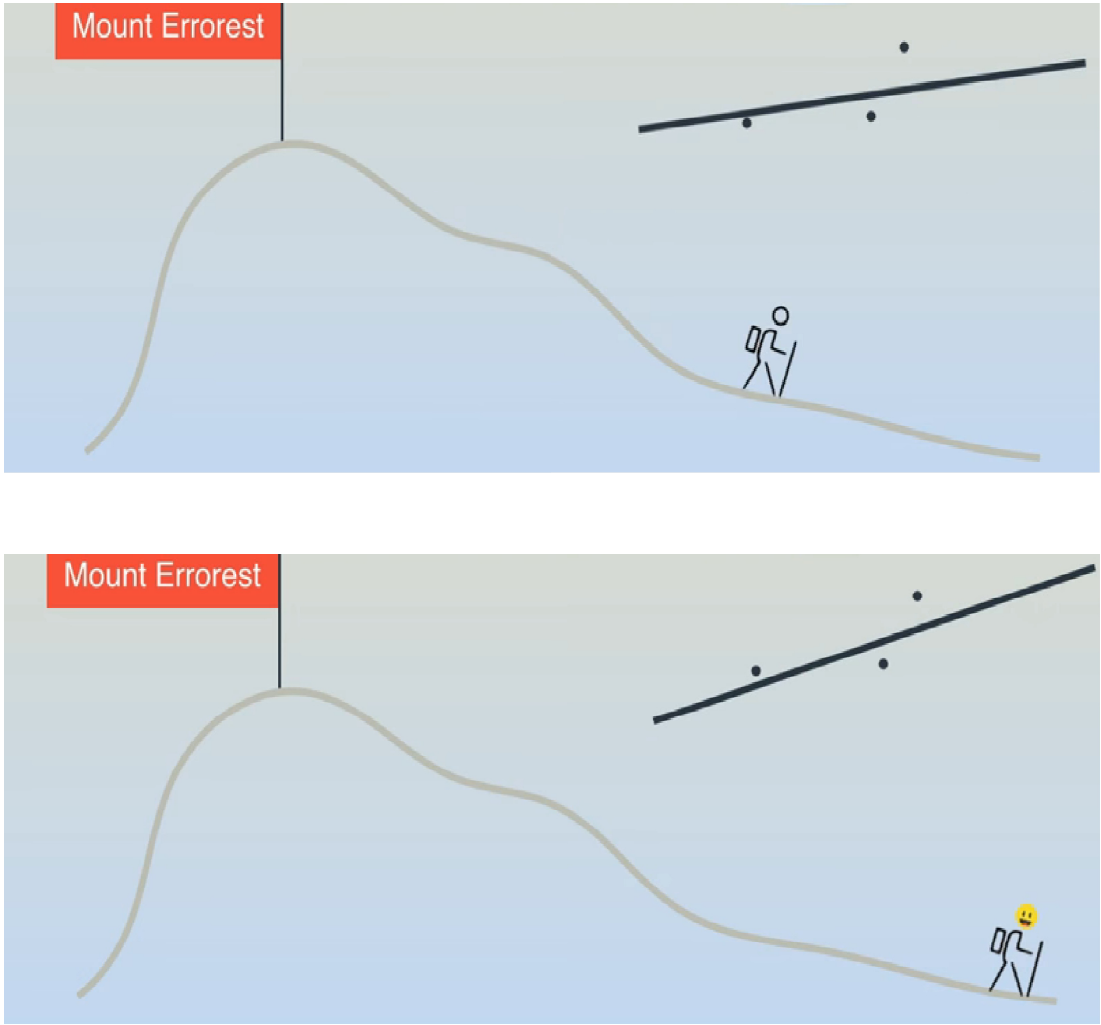



Figure 9: Example

# Linear and Polynomial Regression



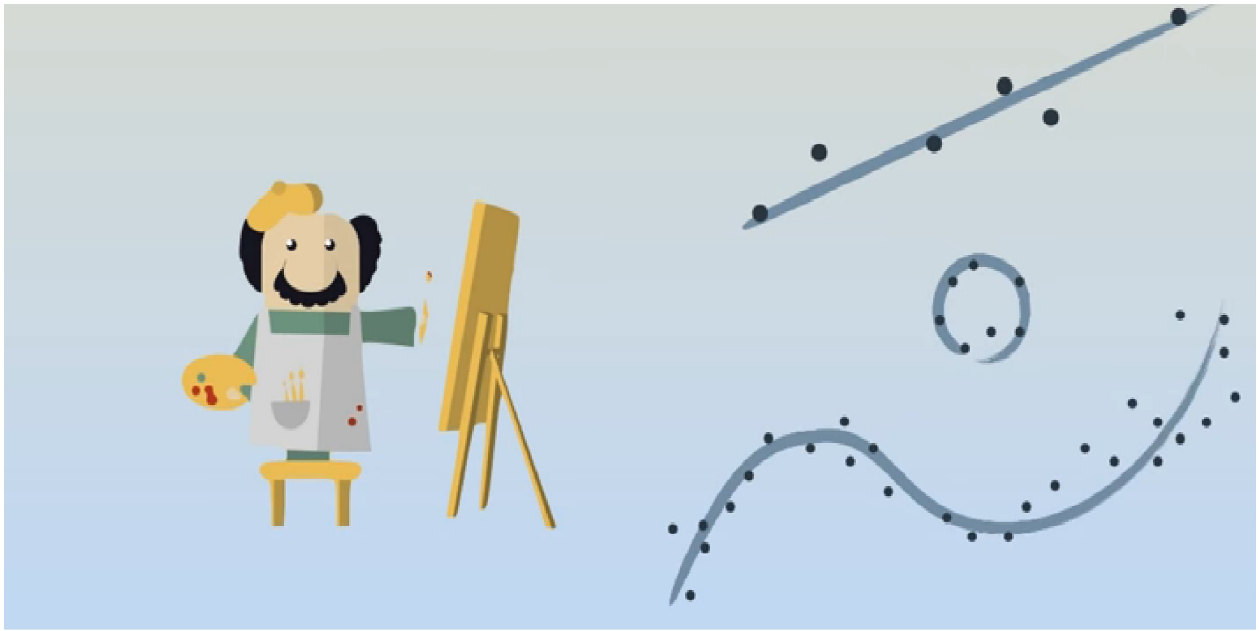
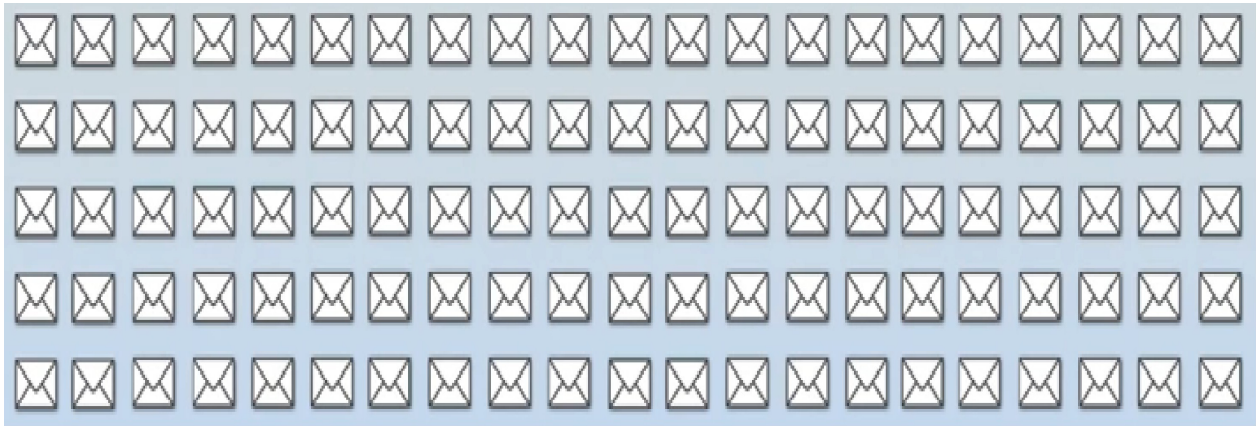


Figure 10: Example

# Detecting Spam E-mails



- 100 emails
  - 25: Spam
  - 75: Non-Spam



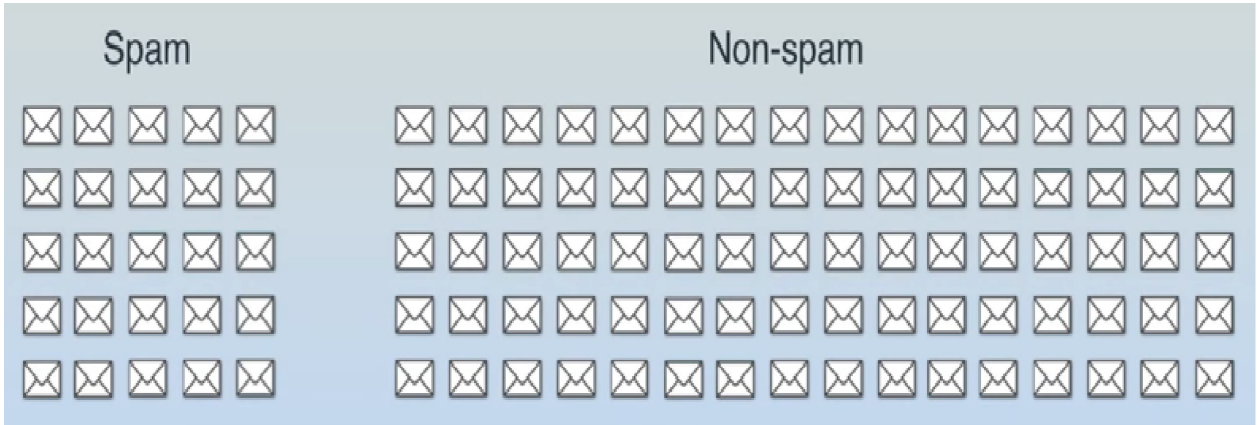



Figure 11: Example

# Contd ...



- Feature: Word "Cheap"


Figure 12: Example

# Contd ...



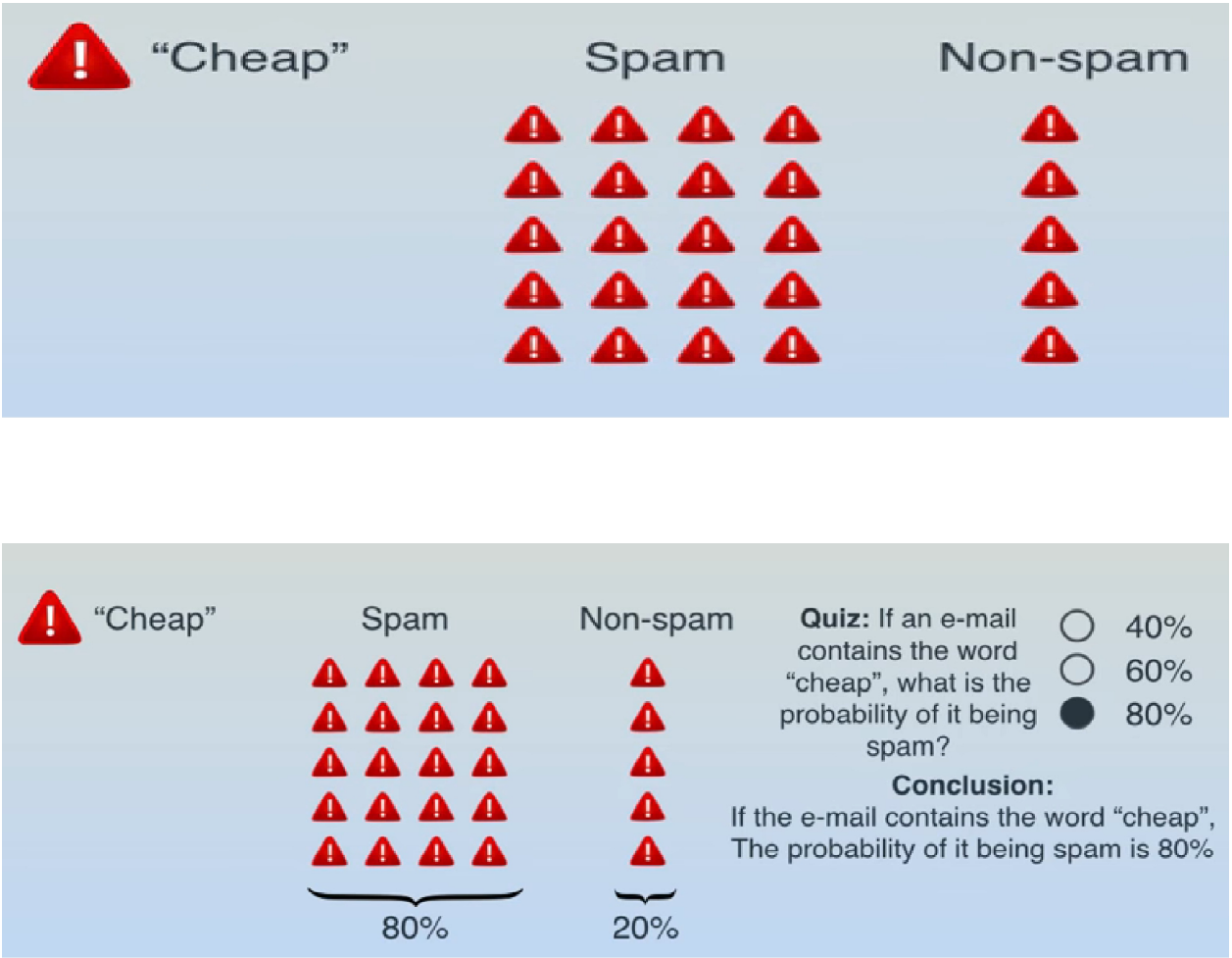



Figure 13: Example

# Contd ...



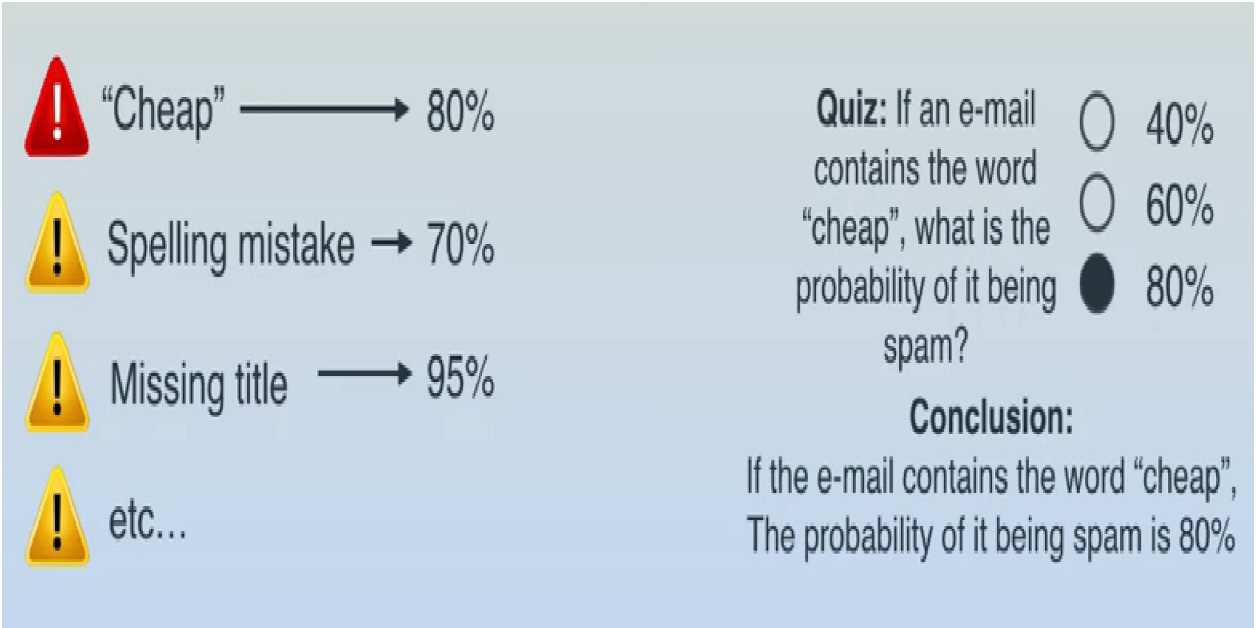



Figure 14: Example

# Naive Bayes Classifier



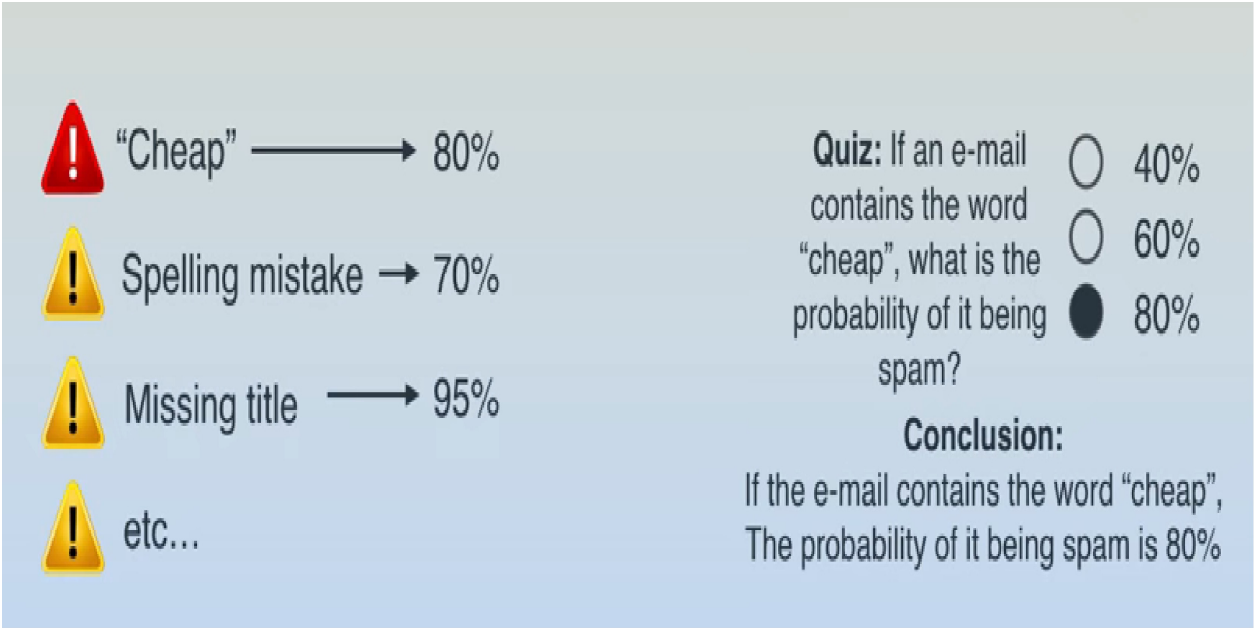



Figure 15: Example

# App Recommendation



- User's downloaded app
  - Pokemon Go
  - SnapChat
  - Whatsapp

| Gender | Age | App |
|---|---|---|
| F | 15 | |
| F | 25 | |
| M | 32 | |
| F | 40 | |
| M | 12 | |
| M | 14 | |

Figure 16: Example

# Contd ...



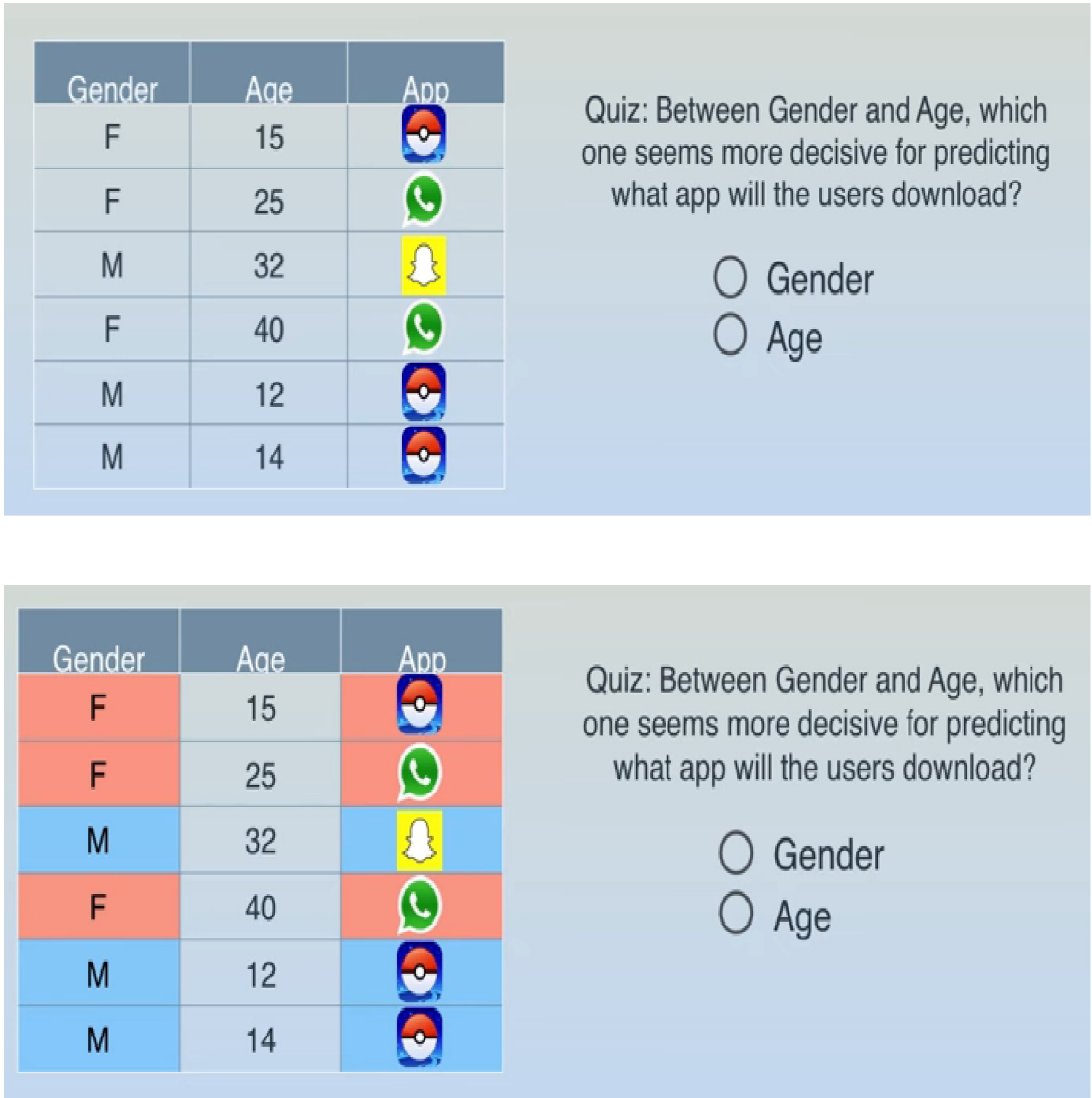



Figure 17: Example

# Contd ...



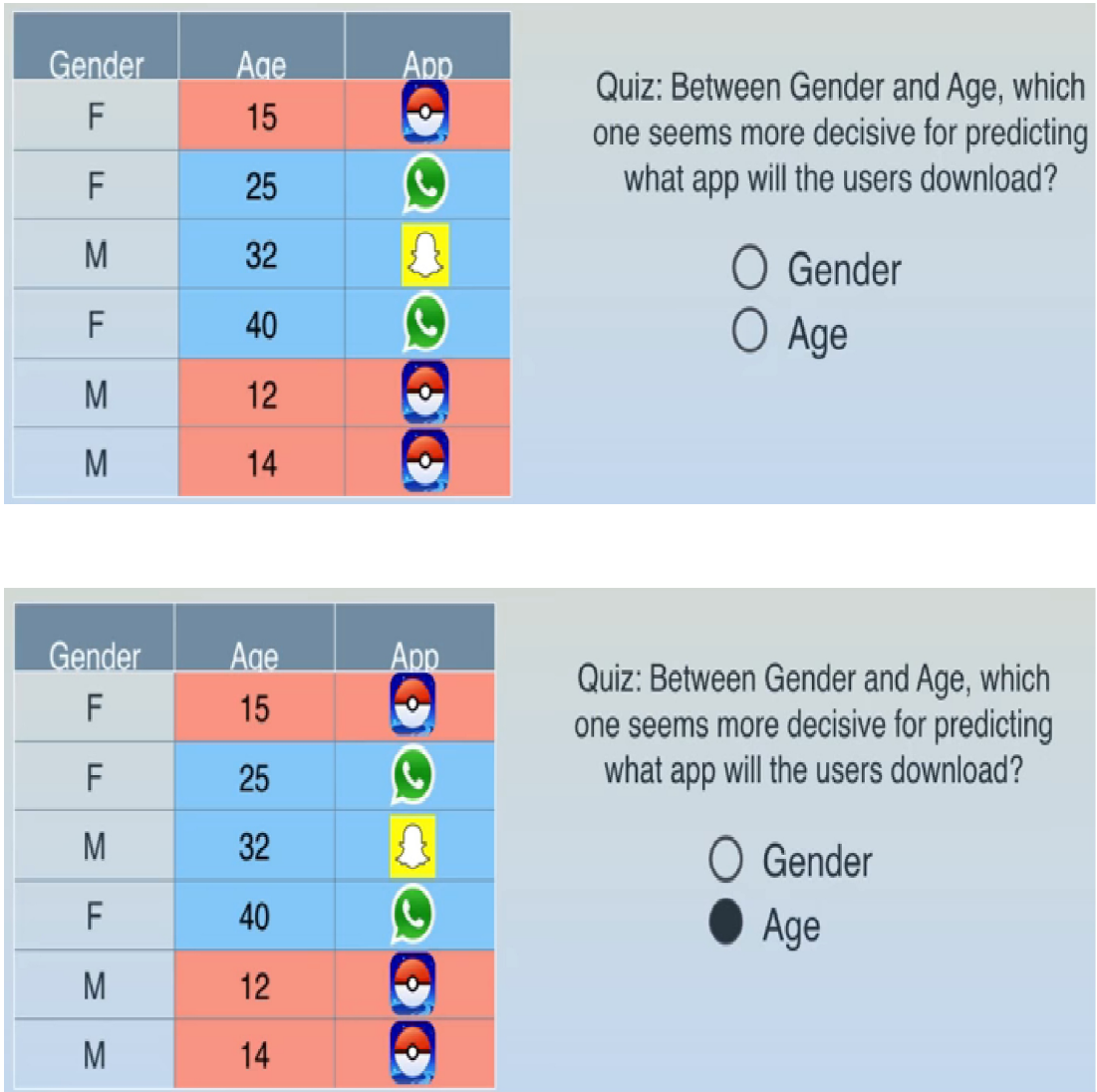



Figure 18: Example

# Contd ...



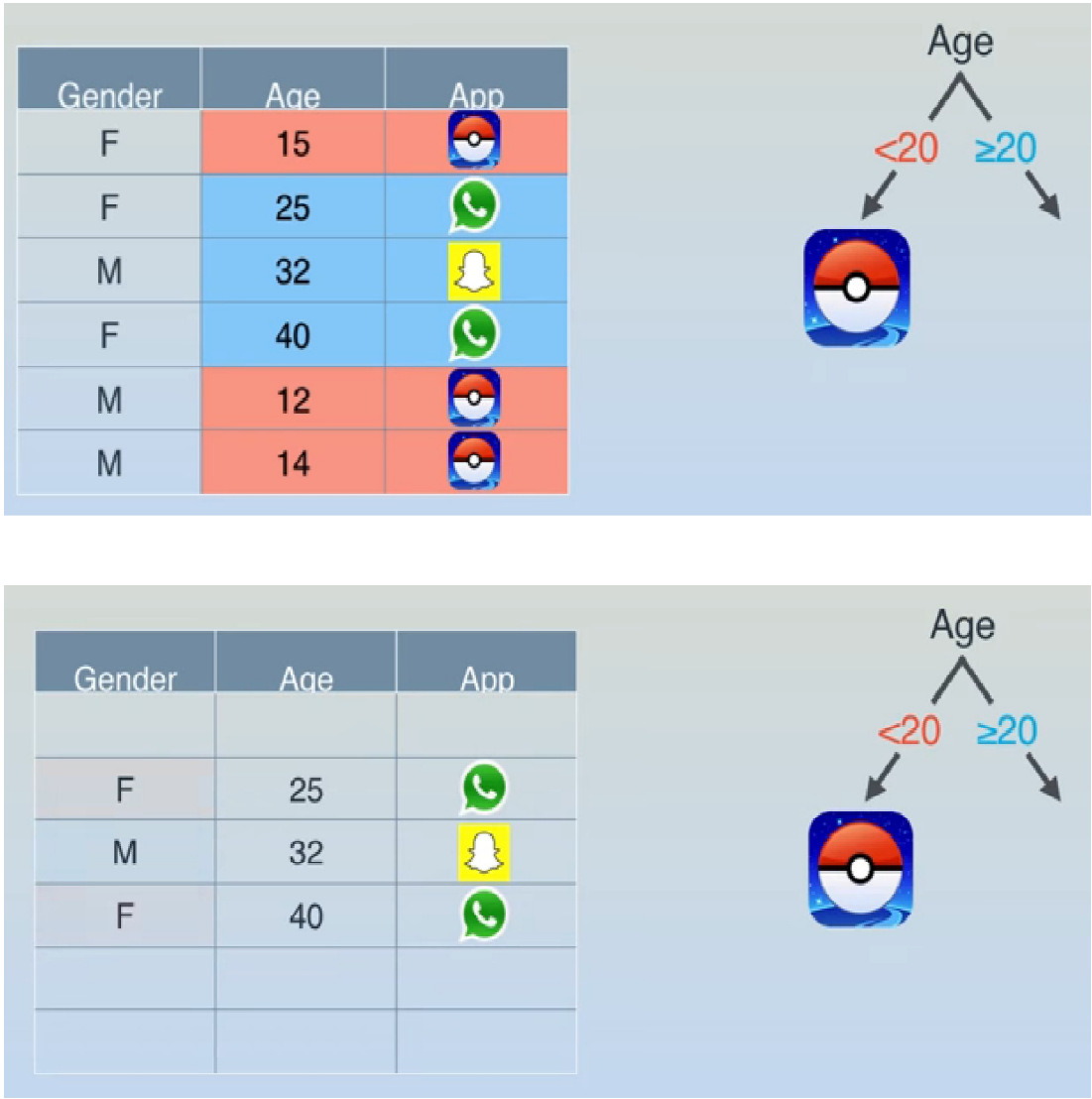



Figure 19: Example

# Decision Tree



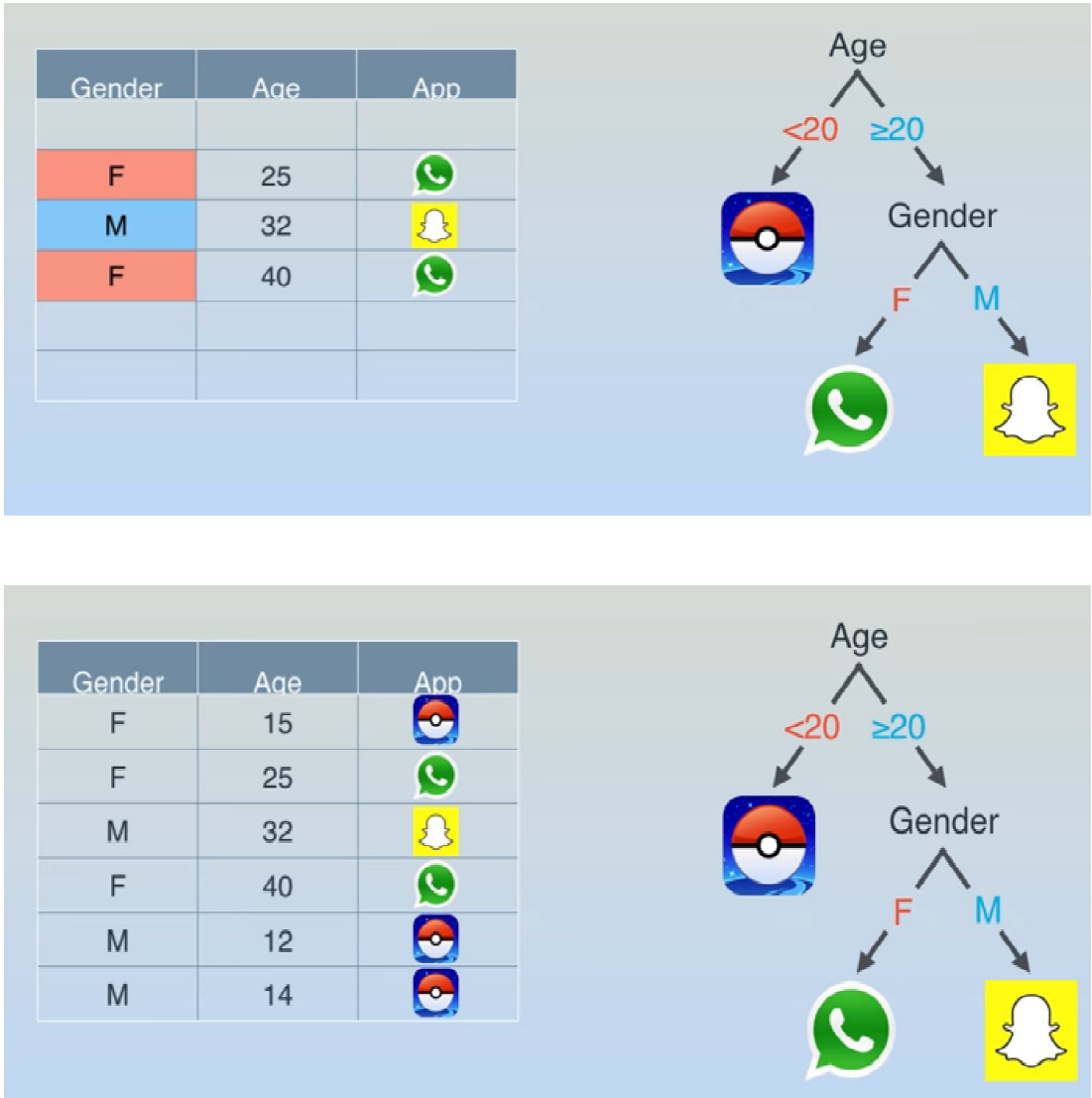



Figure 20: Example

# Acceptance at the University



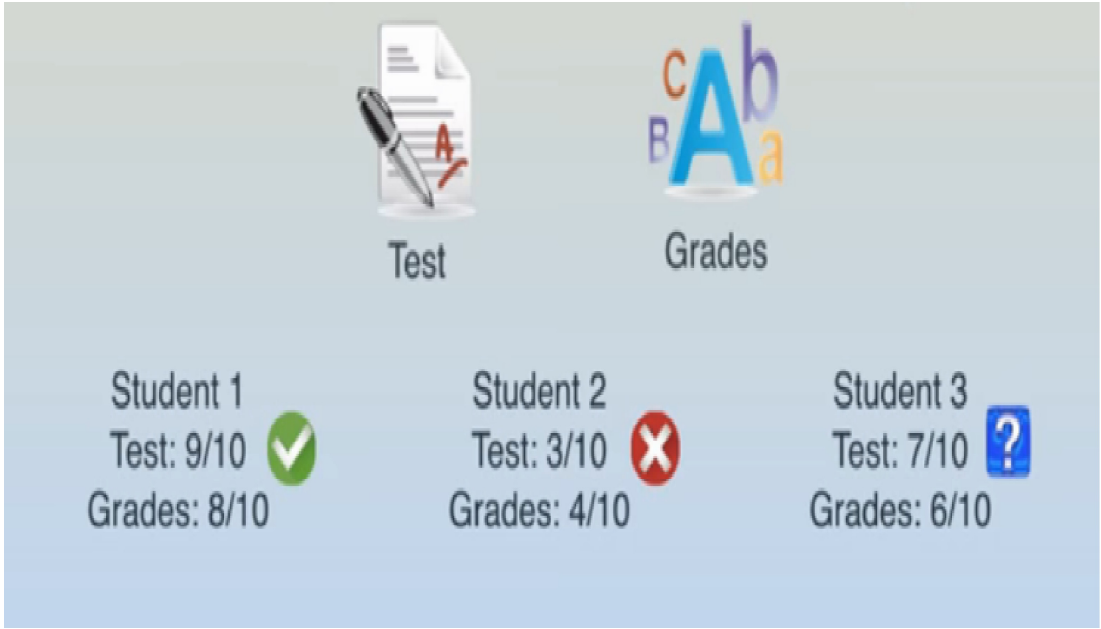



Figure 21: Example

# Contd ...



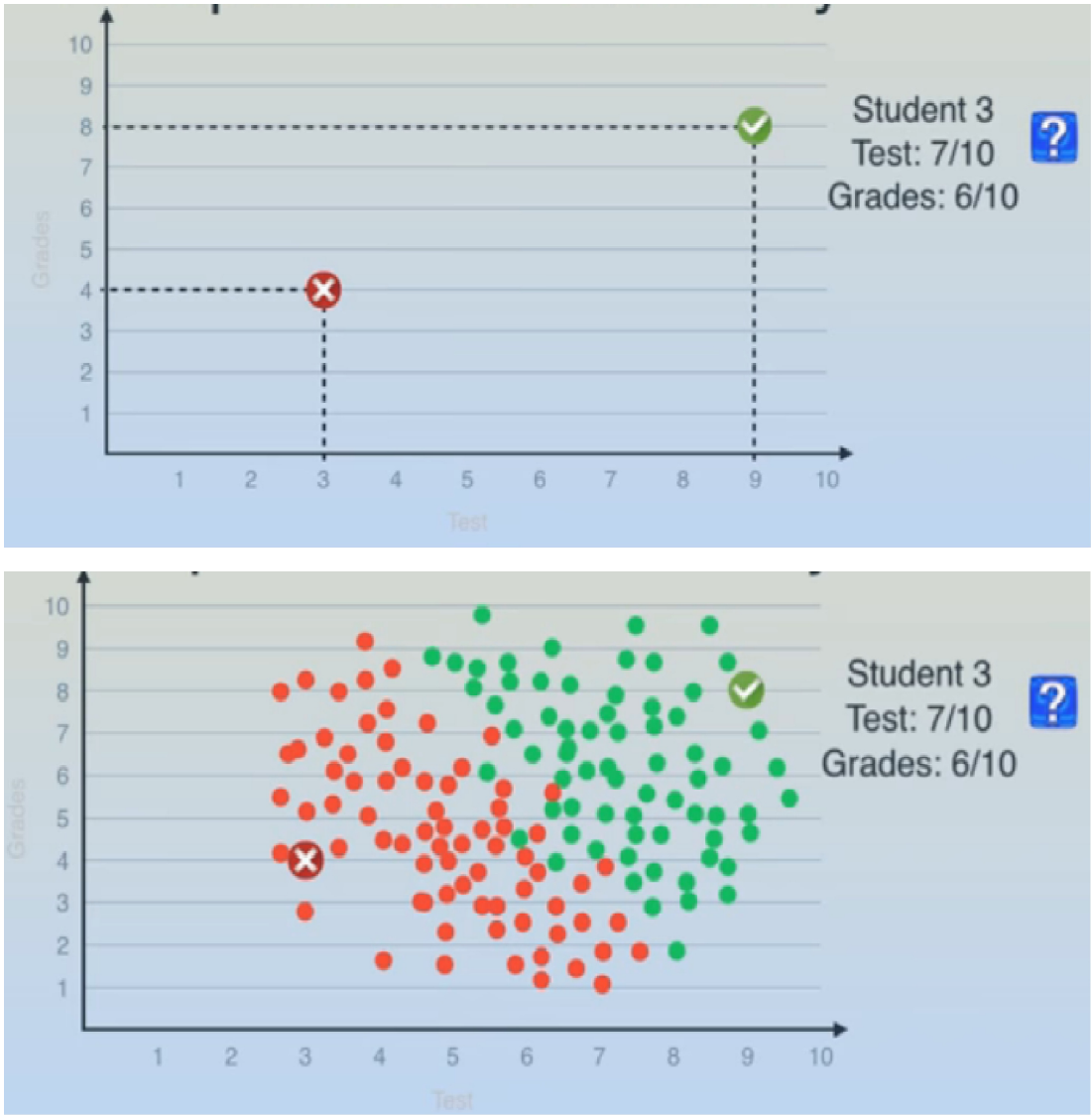



Figure 22: Example

# Contd ...



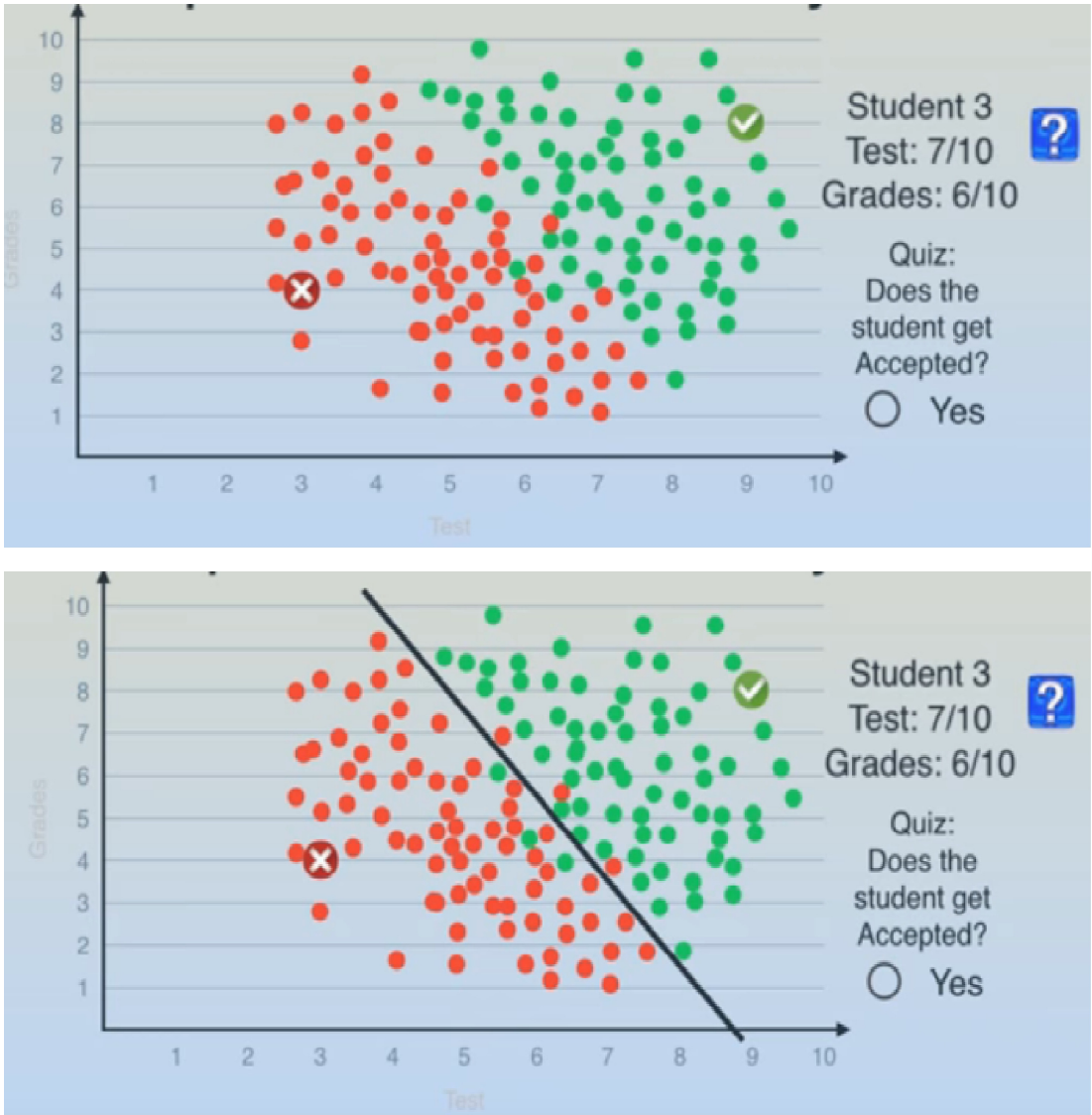



Figure 23: Example

# Logistic Regression



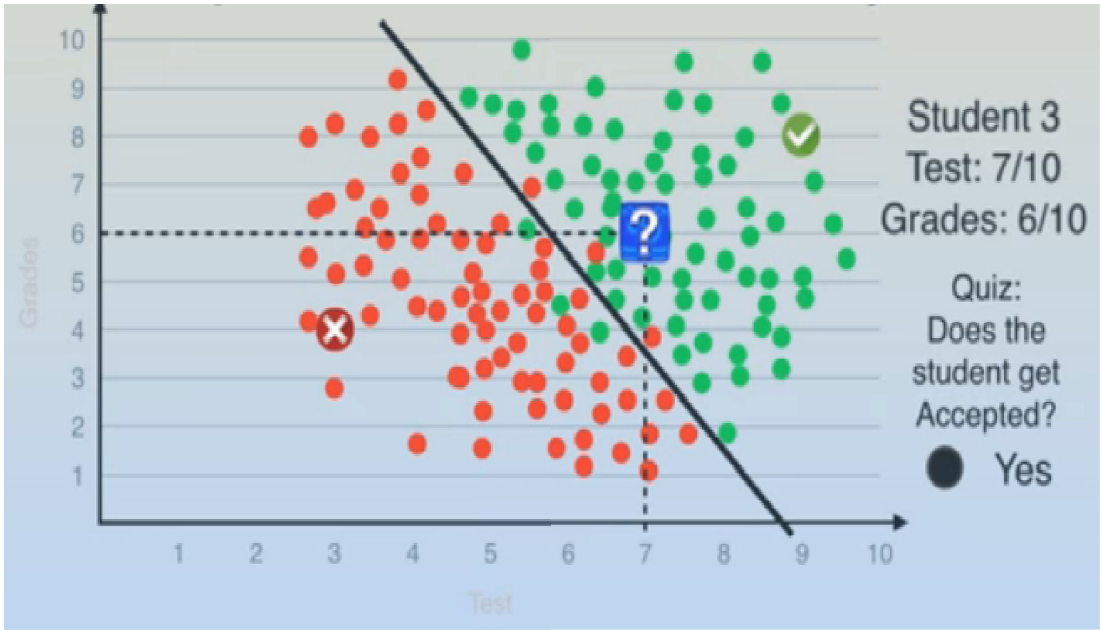



Figure 24: Example

- How to find the line that best cuts the data points into two?

# Contd ...



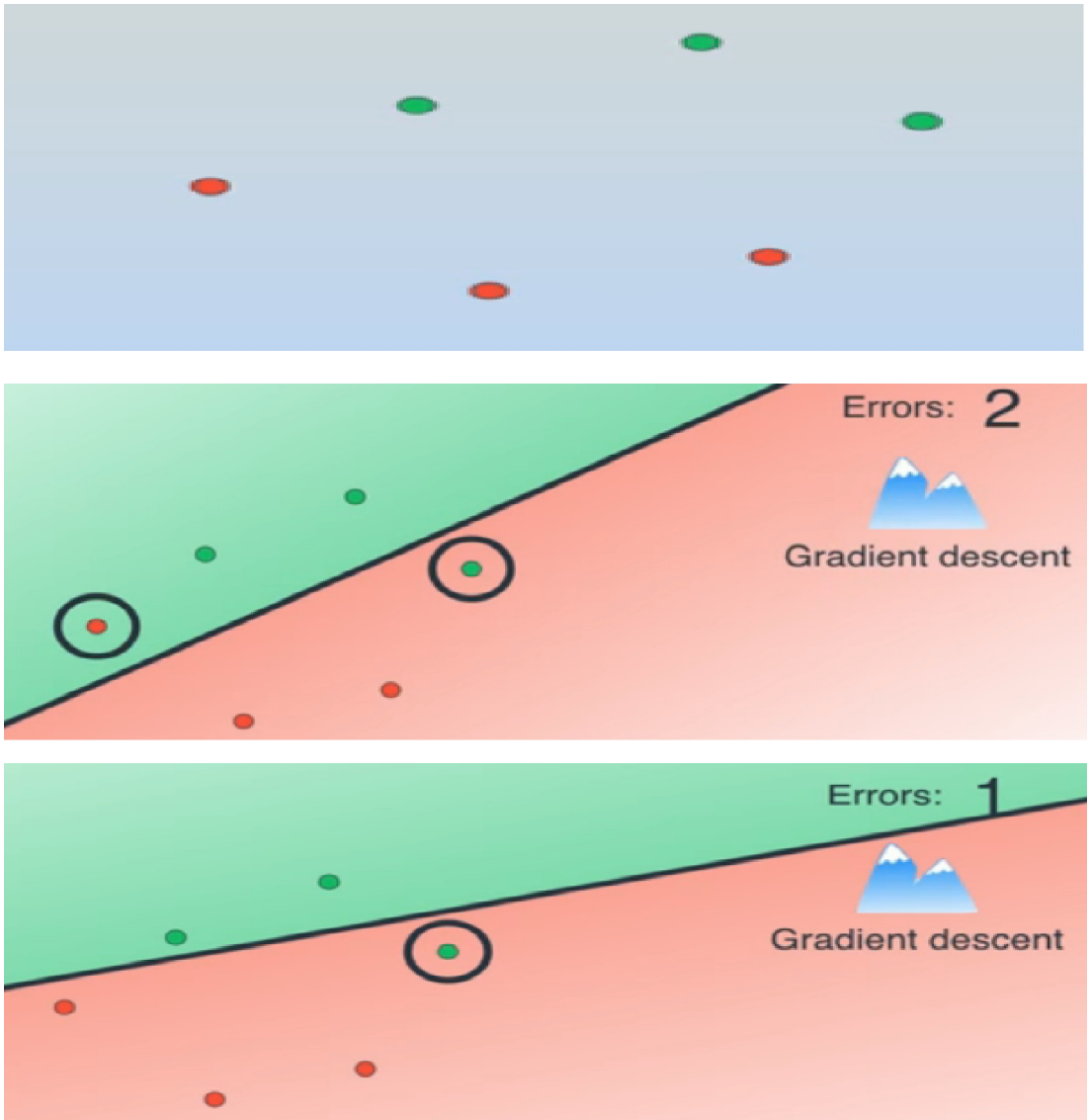



Figure 25: Example

# Contd ...



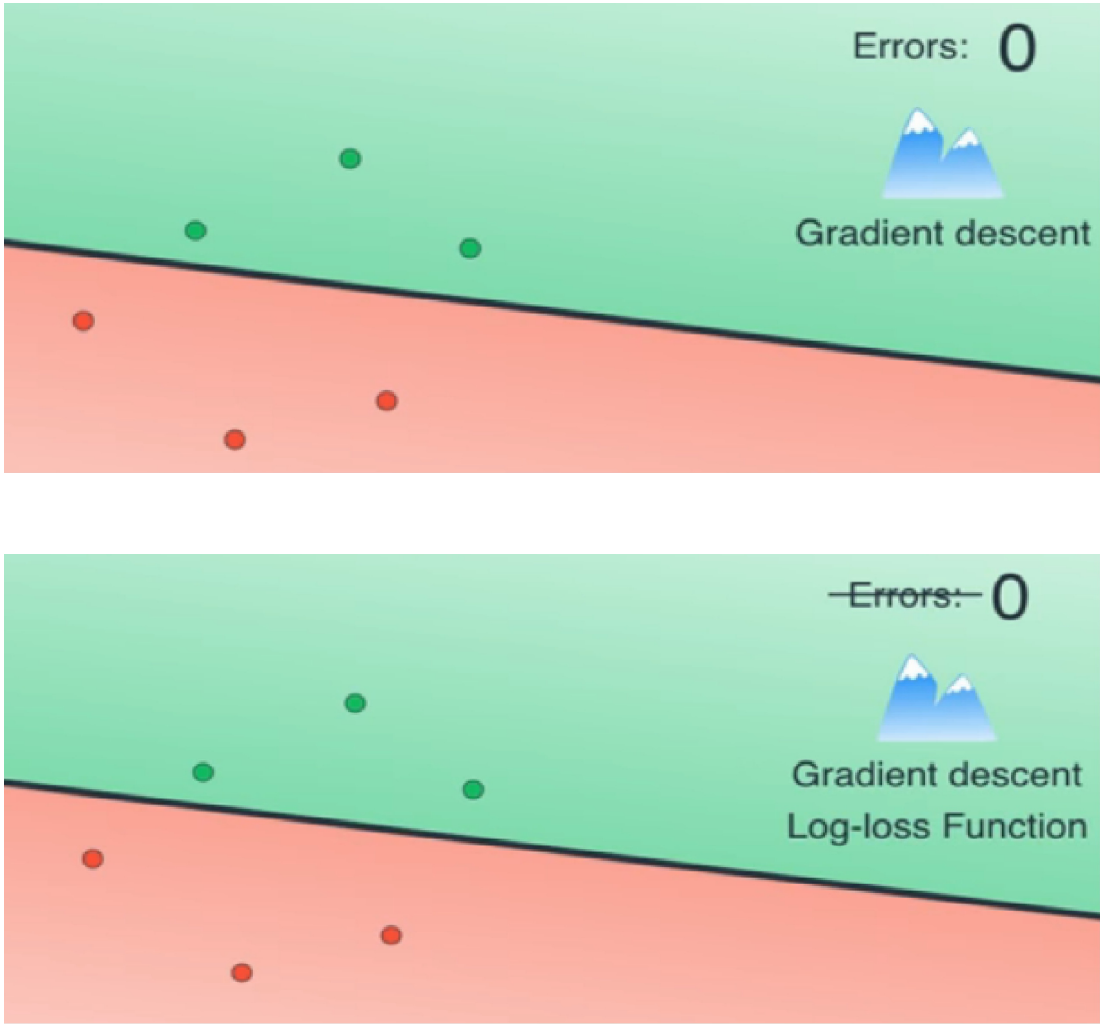



Figure 26: Example

# Neural Network



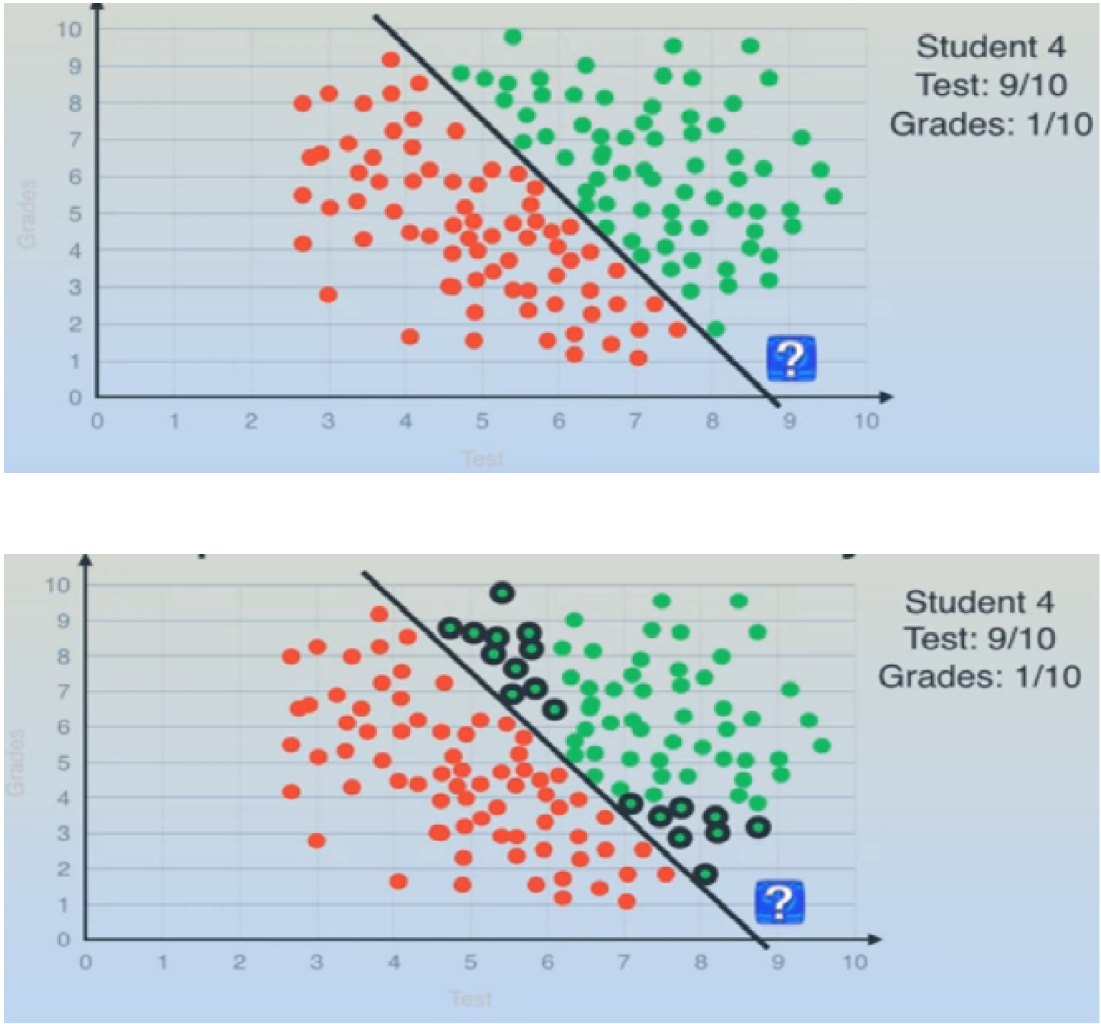



Figure 27: Example

# Contd ...



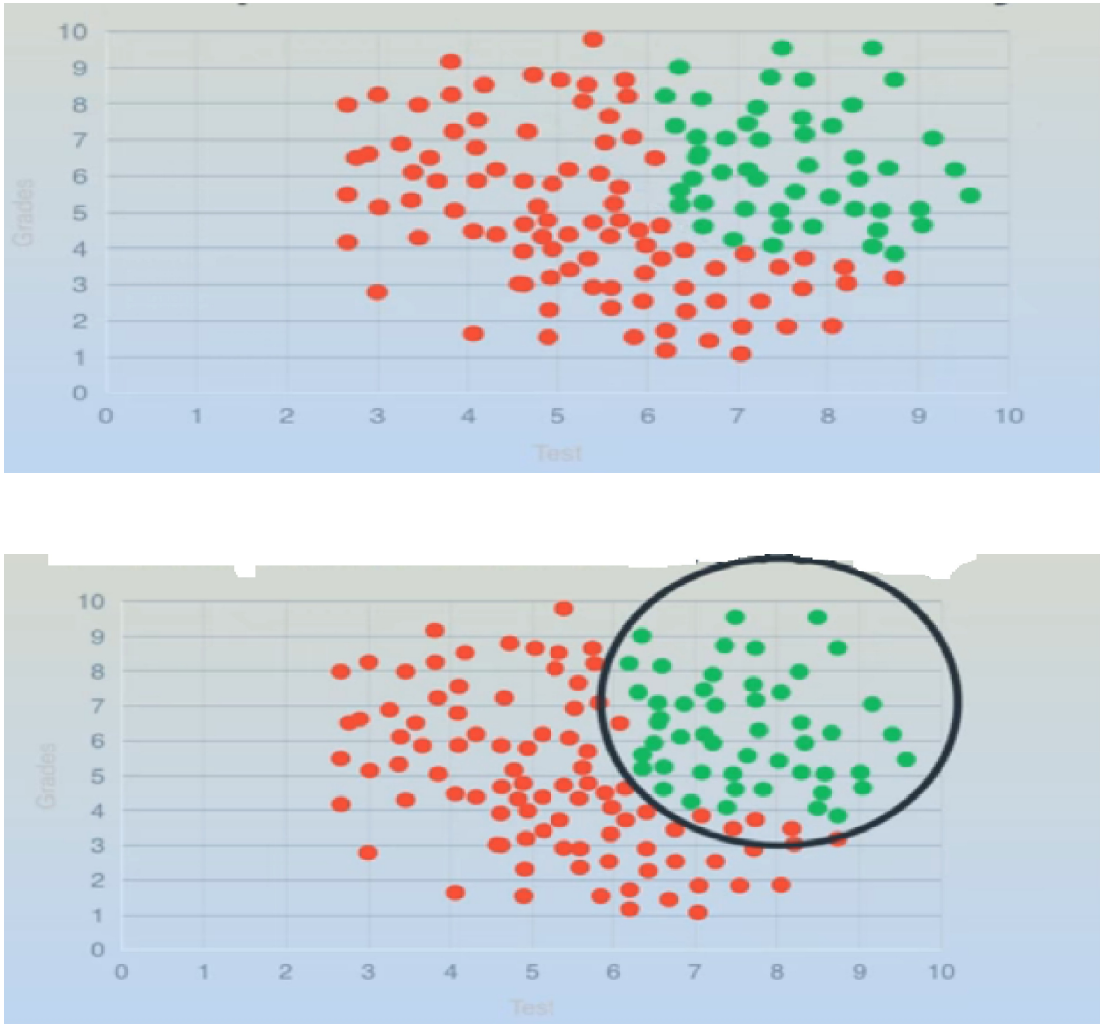



Figure 28: Example

# Contd ...



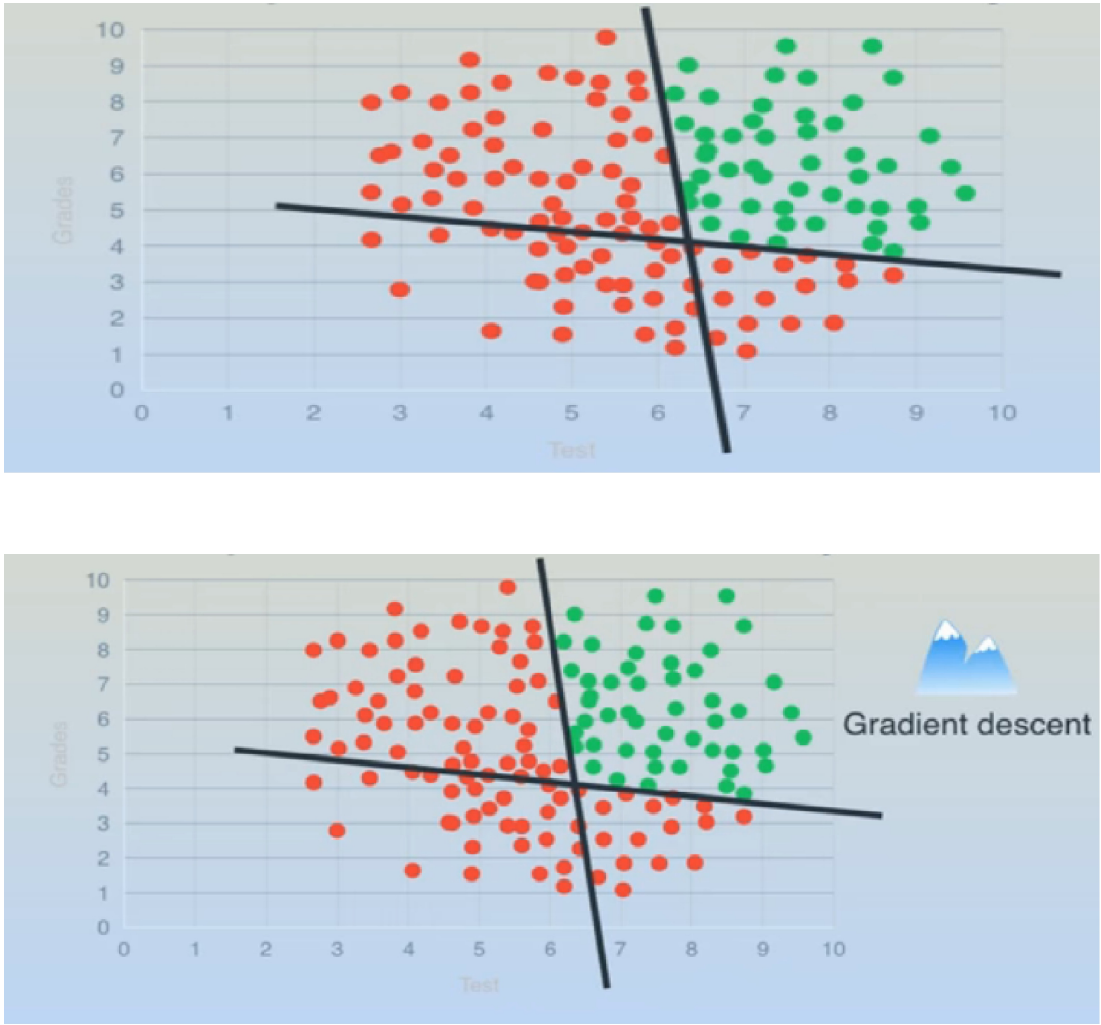



Figure 29: Example

# Contd ...



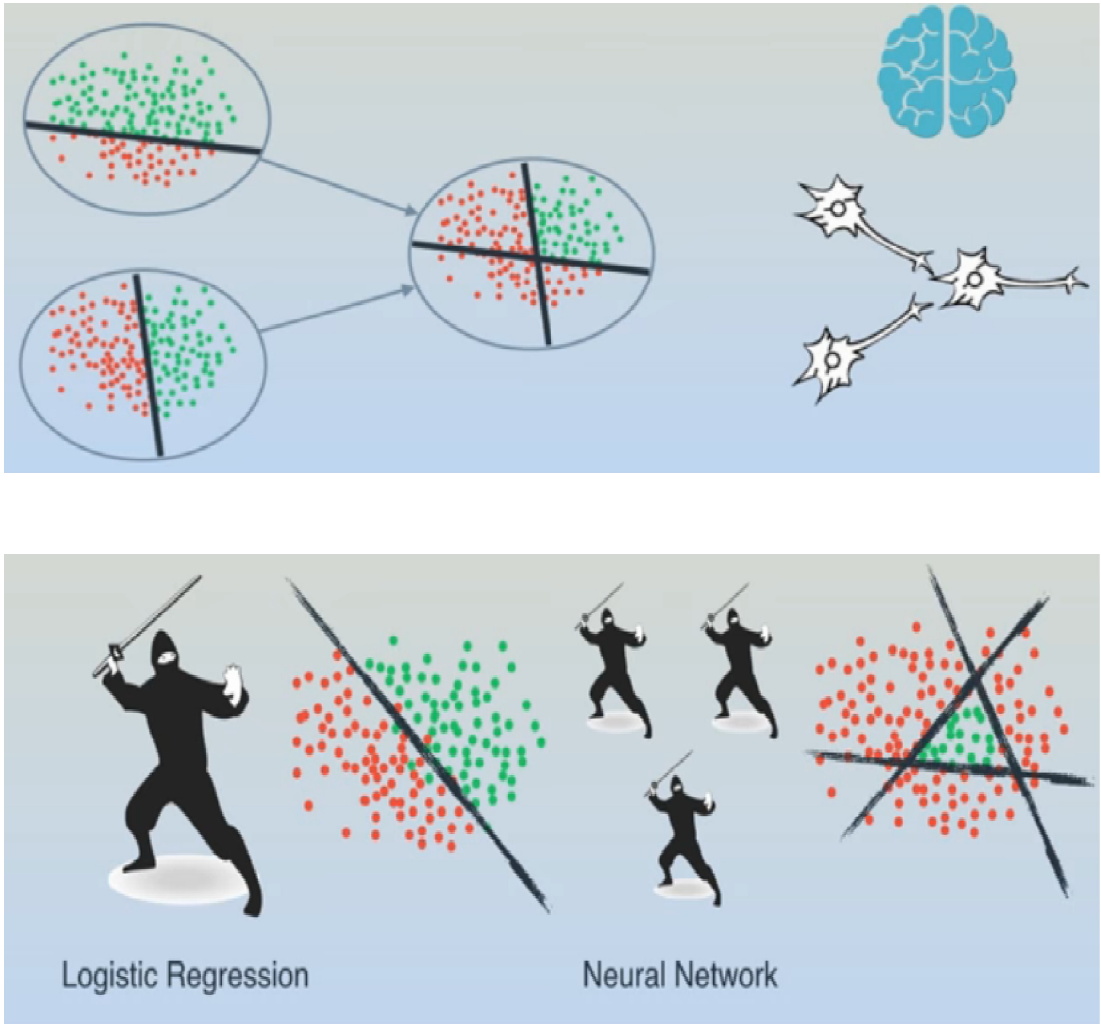



Figure 30: Example

# Support Vector Machine



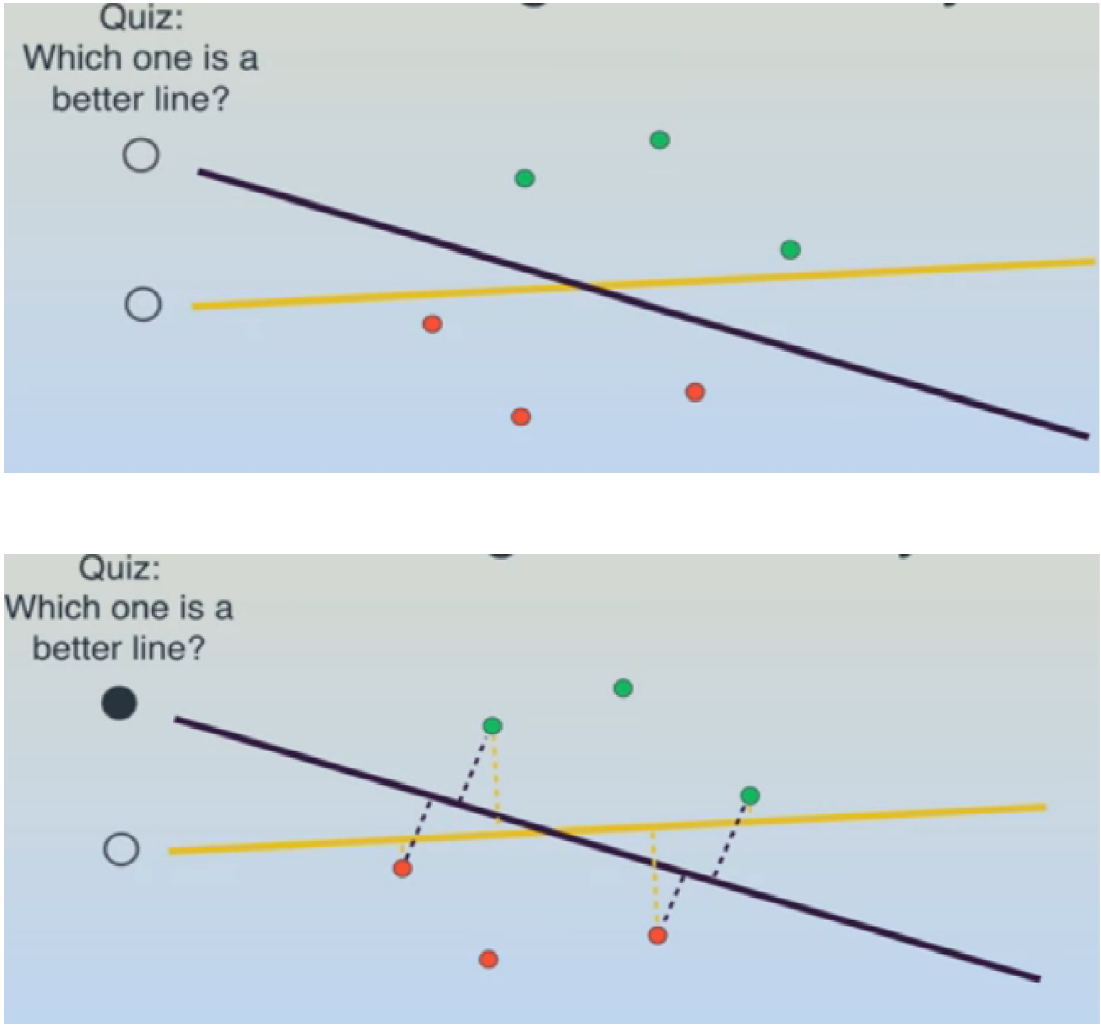



Figure 31: Example

# Contd ...



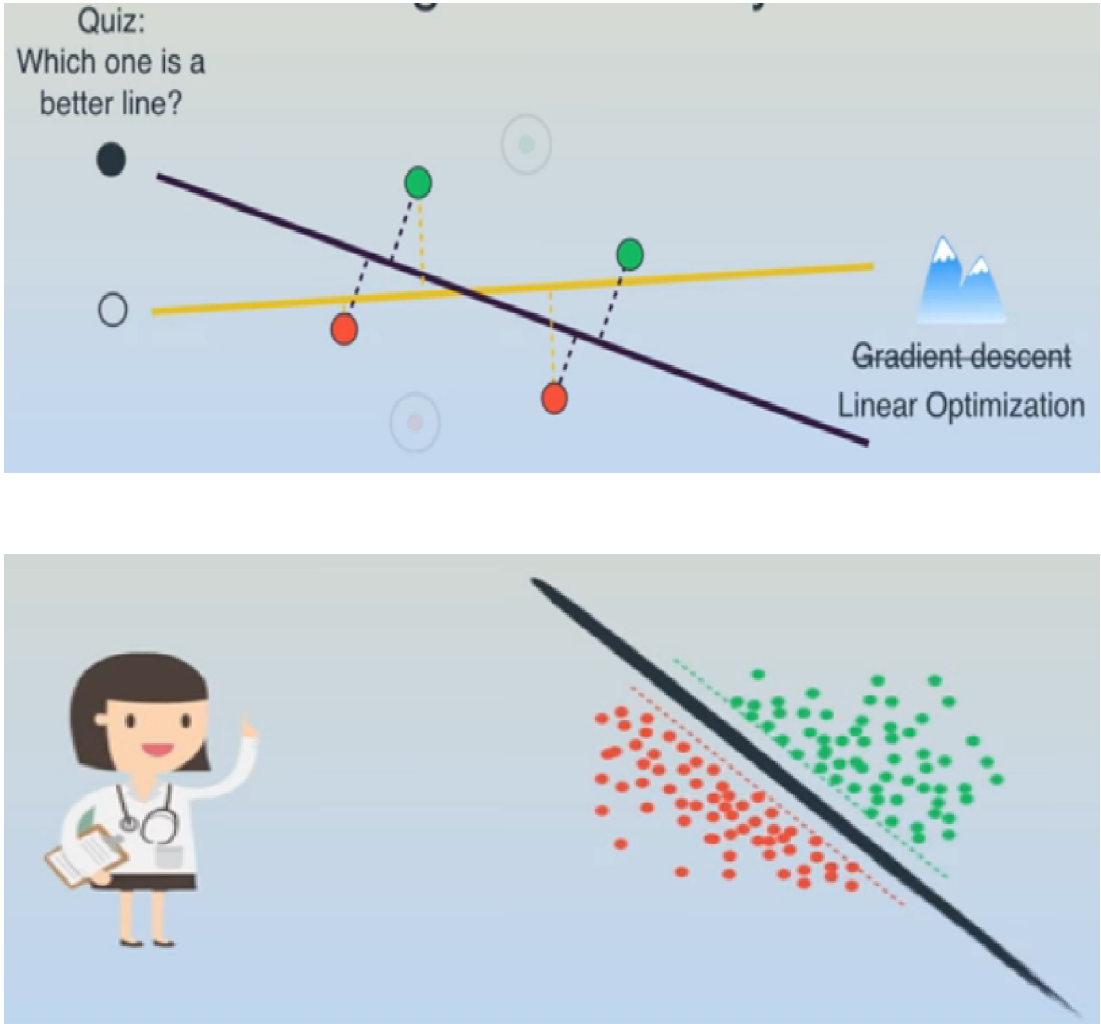



Figure 32: Example

# When the line is not enough?



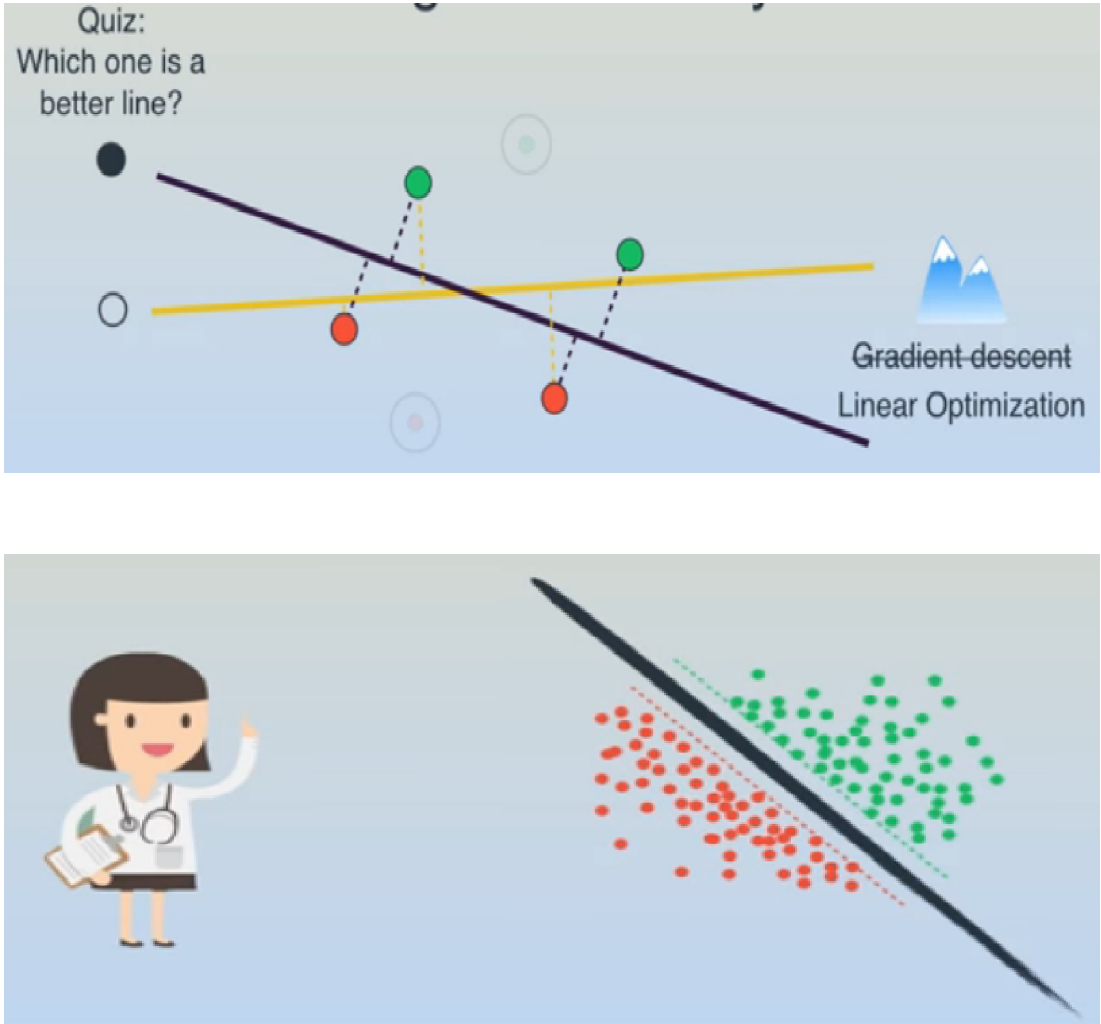



Figure 33: Example

# Kernel Trick



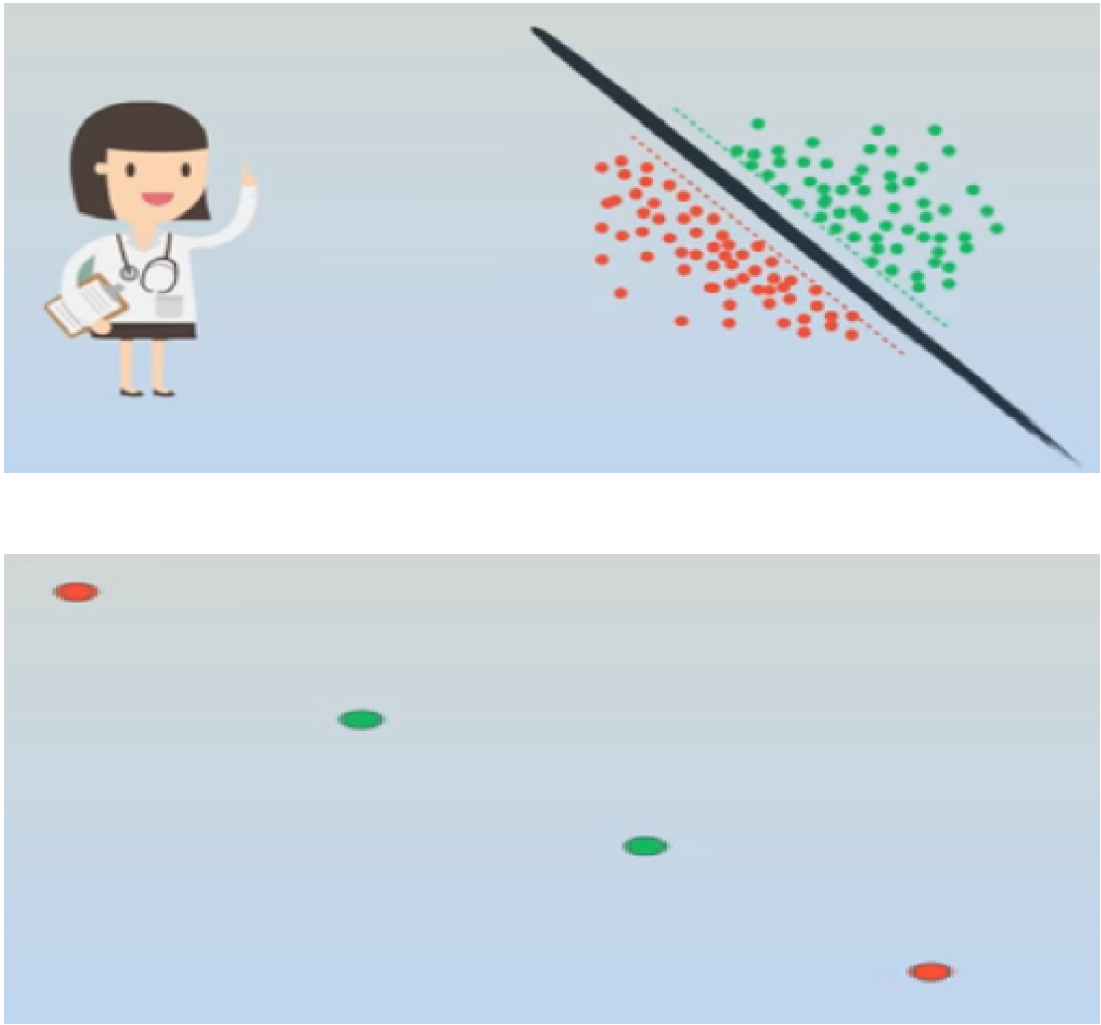


Figure 34: Example

# Contd ...



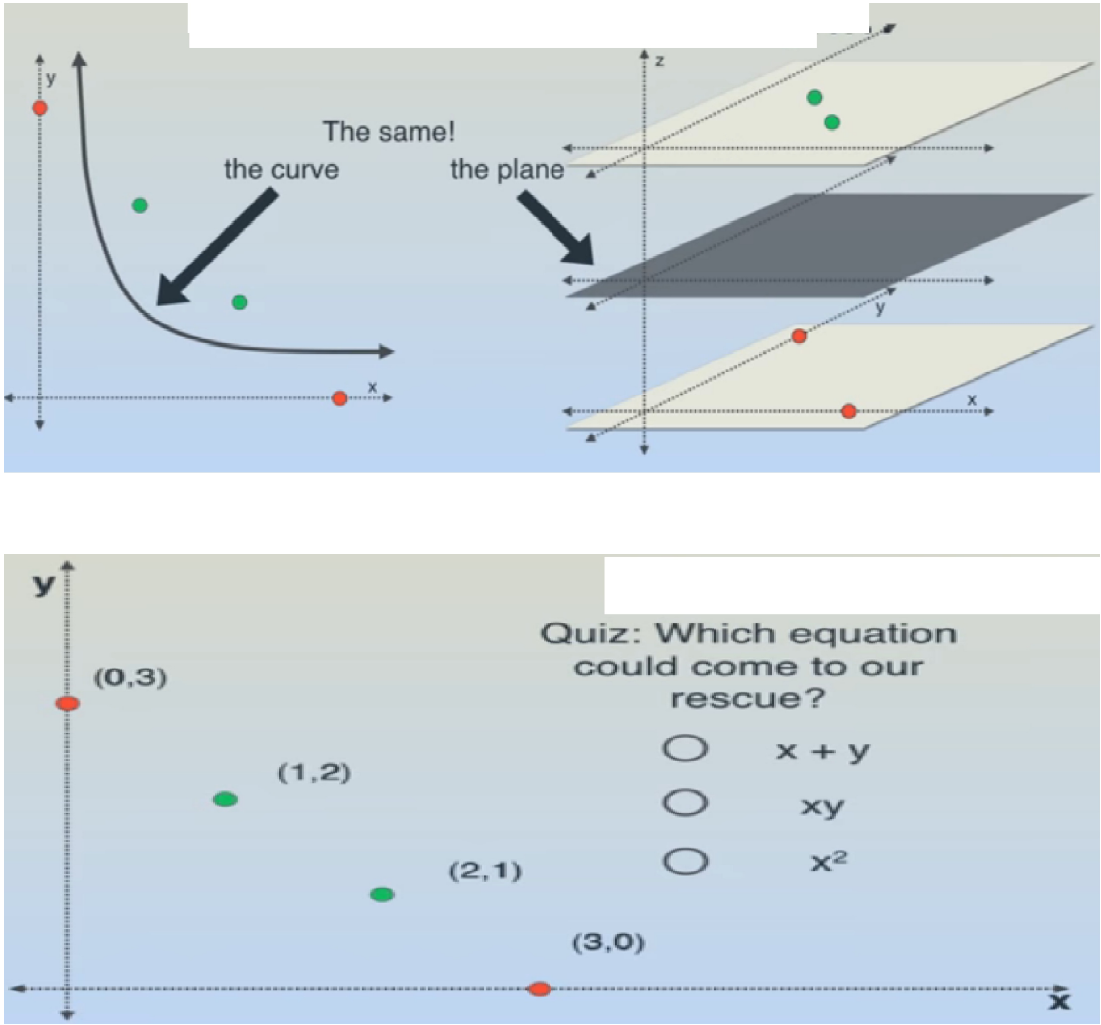
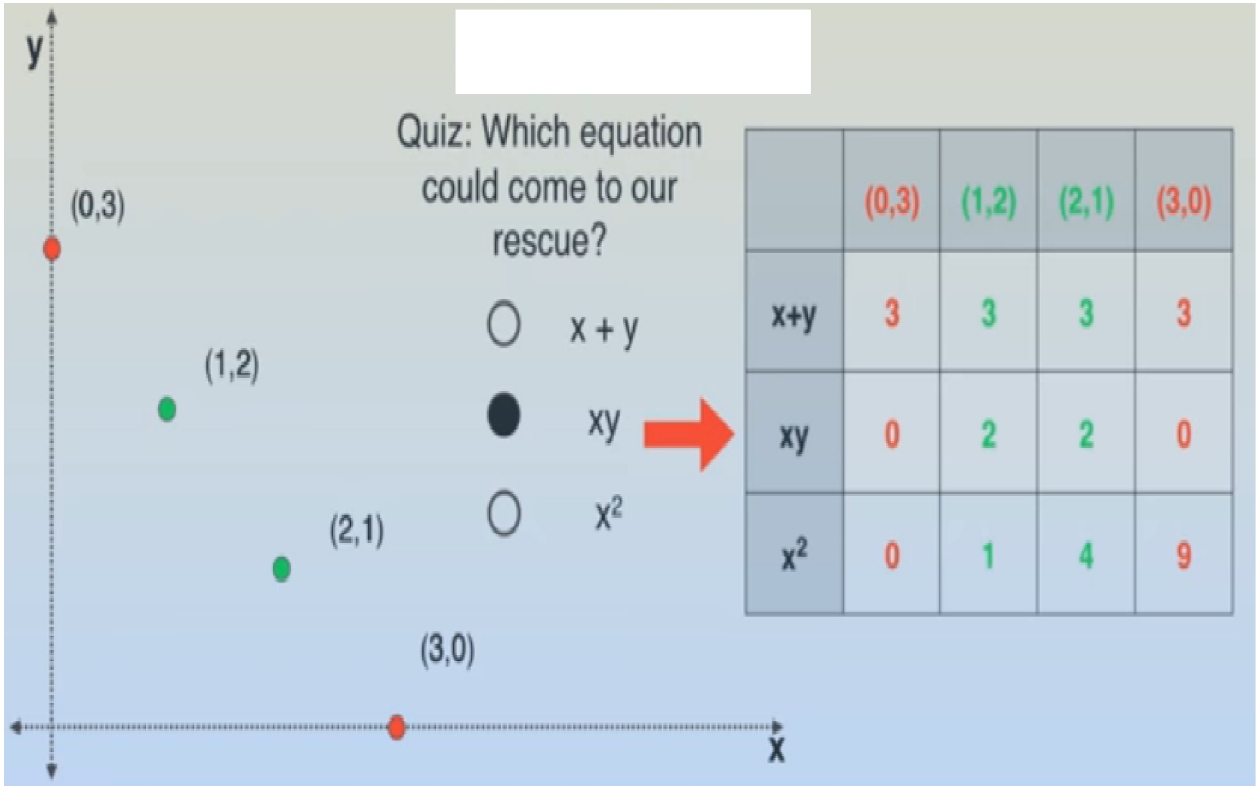



Figure 35: Example

# Contd ...






| | (0,3) | (1,2) | (2,1) | (3,0) |
|---|---|---|---|---|
| x+y | 3 | 3 | 3 | 3 |
| xy | 0 | 2 | 2 | 0 |
| $x^2$ | 0 | 1 | 4 | 9 |

# Contd ...



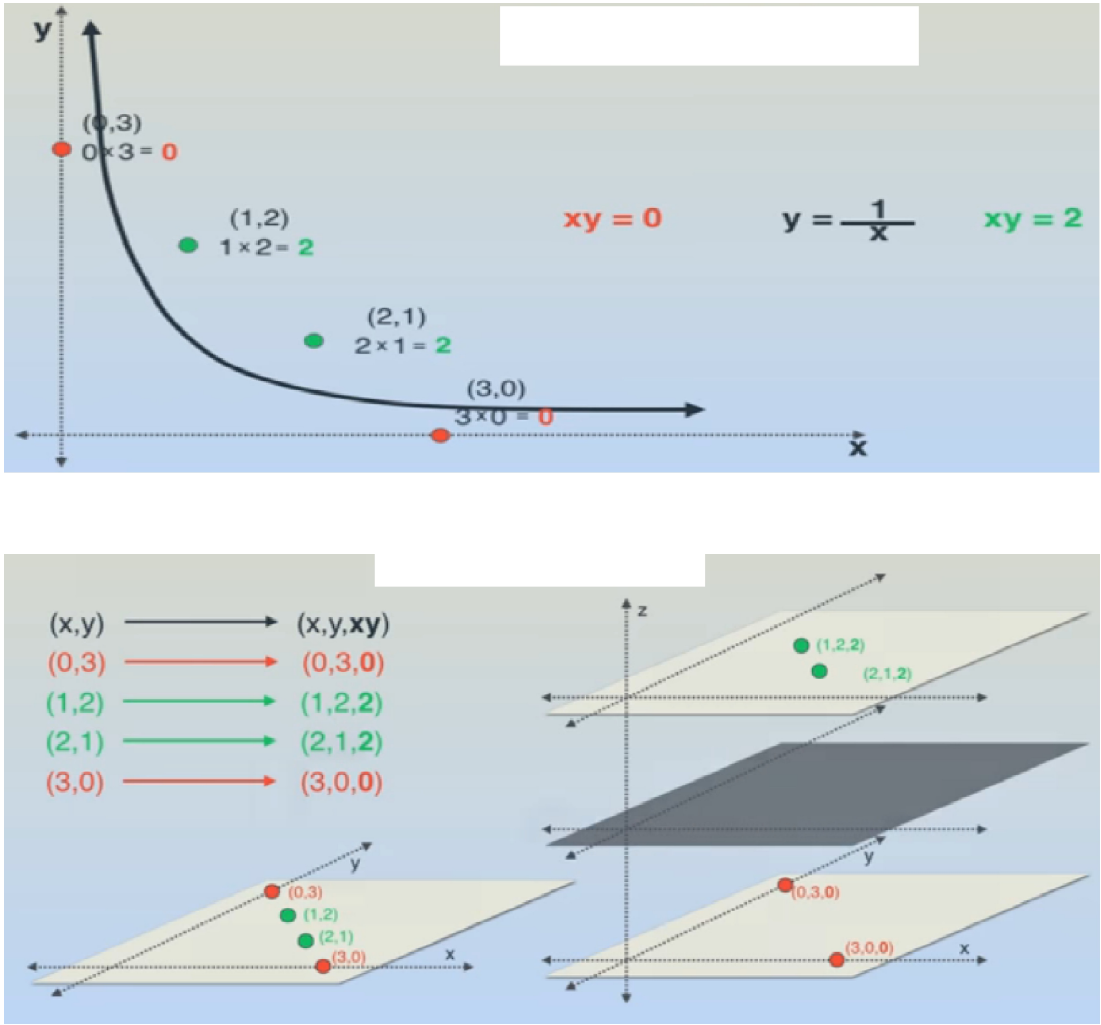



Figure 36: Example

# Contd...



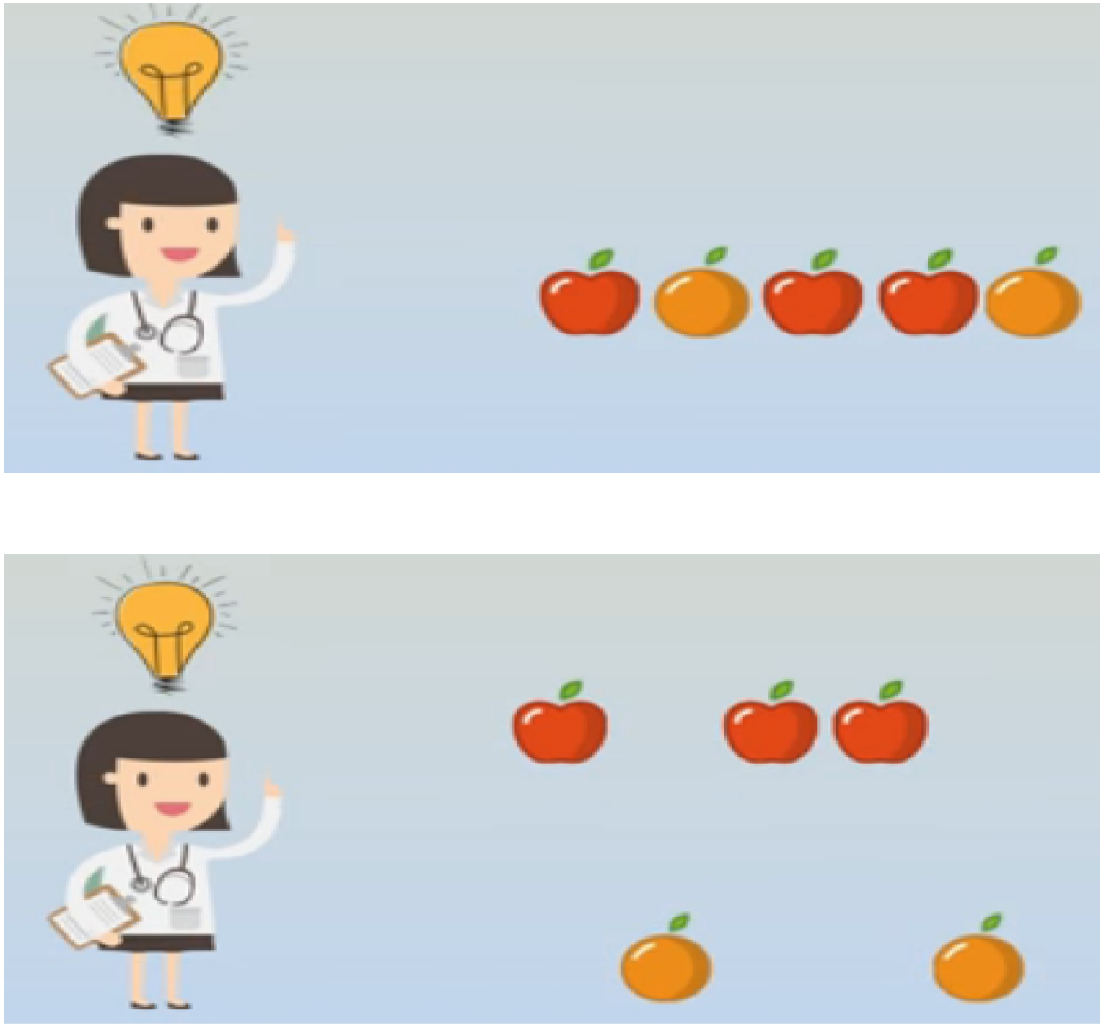


Figure 37: Example

# K-means Clustering



- Chain of pizza parlors
- People eat pizza the most, is spotted the location
- Optimal places or best location to put three pizza parlors

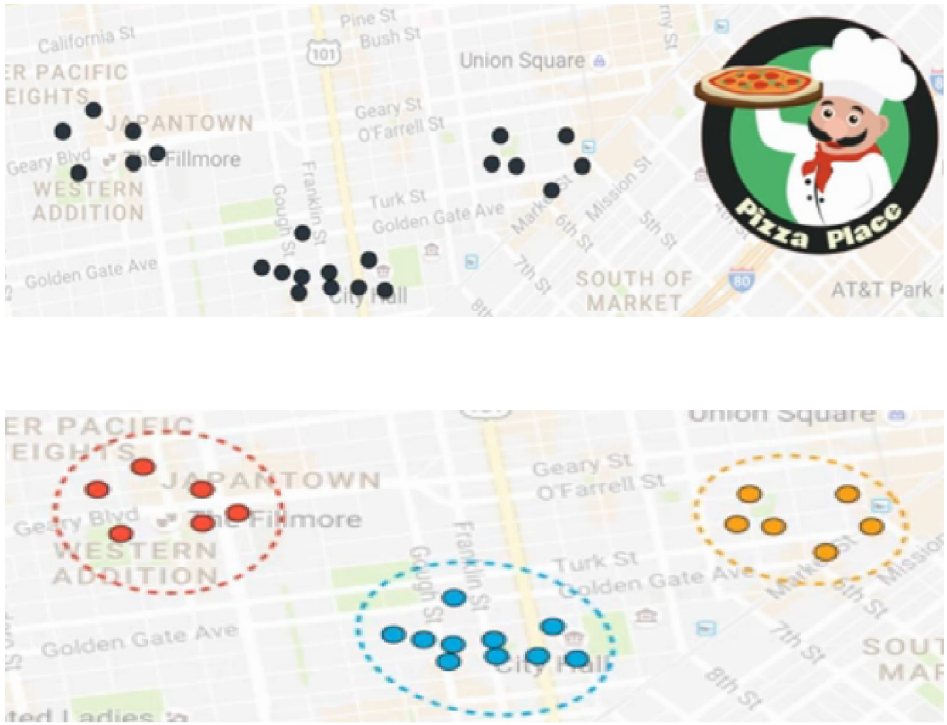



Figure 38: Example

# Contd...



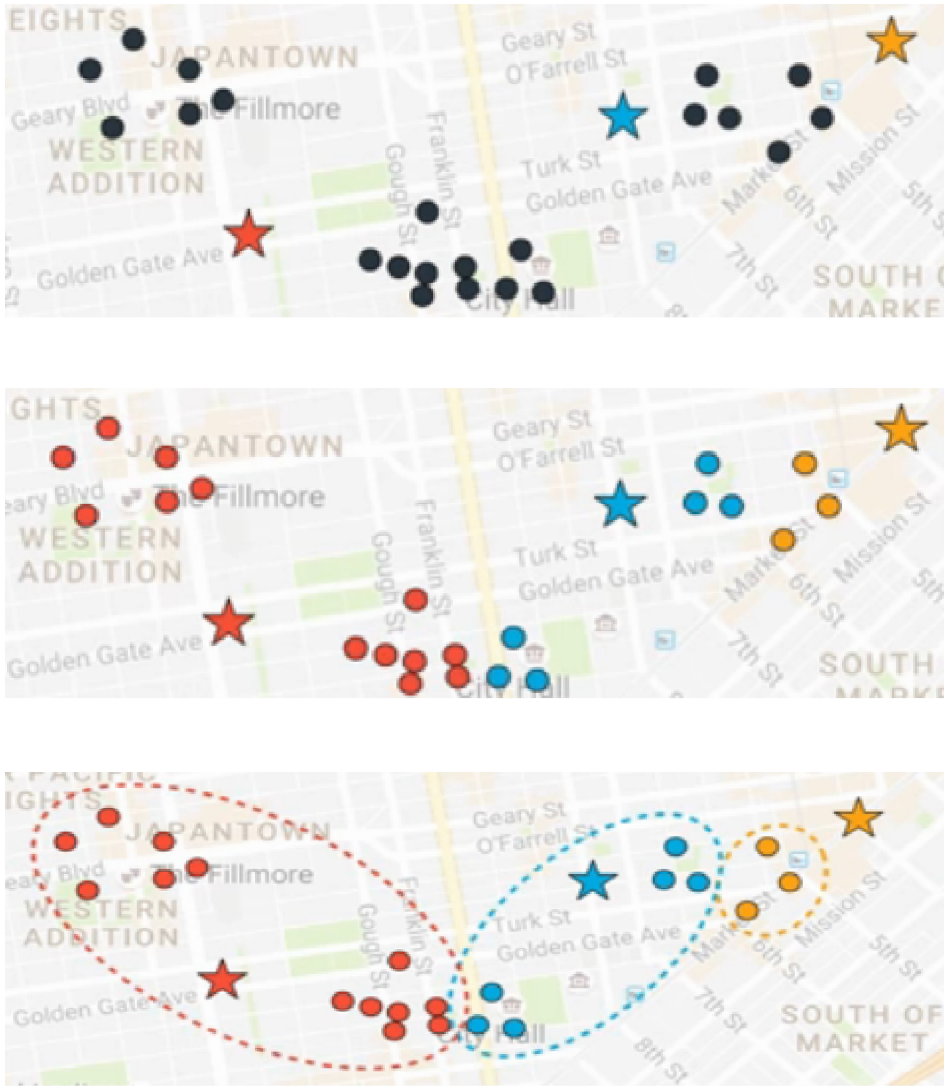



Figure 39: Example

# Contd...



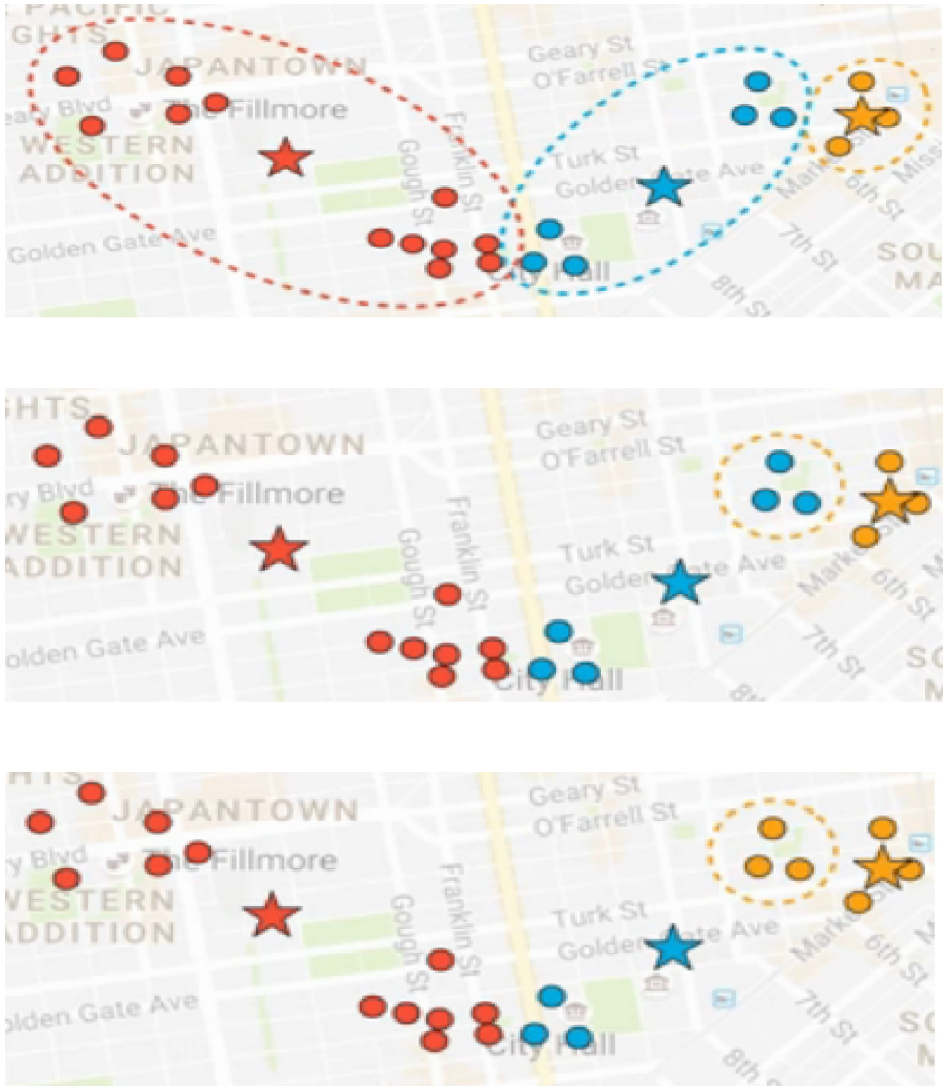



Figure 40: Example

# Contd...



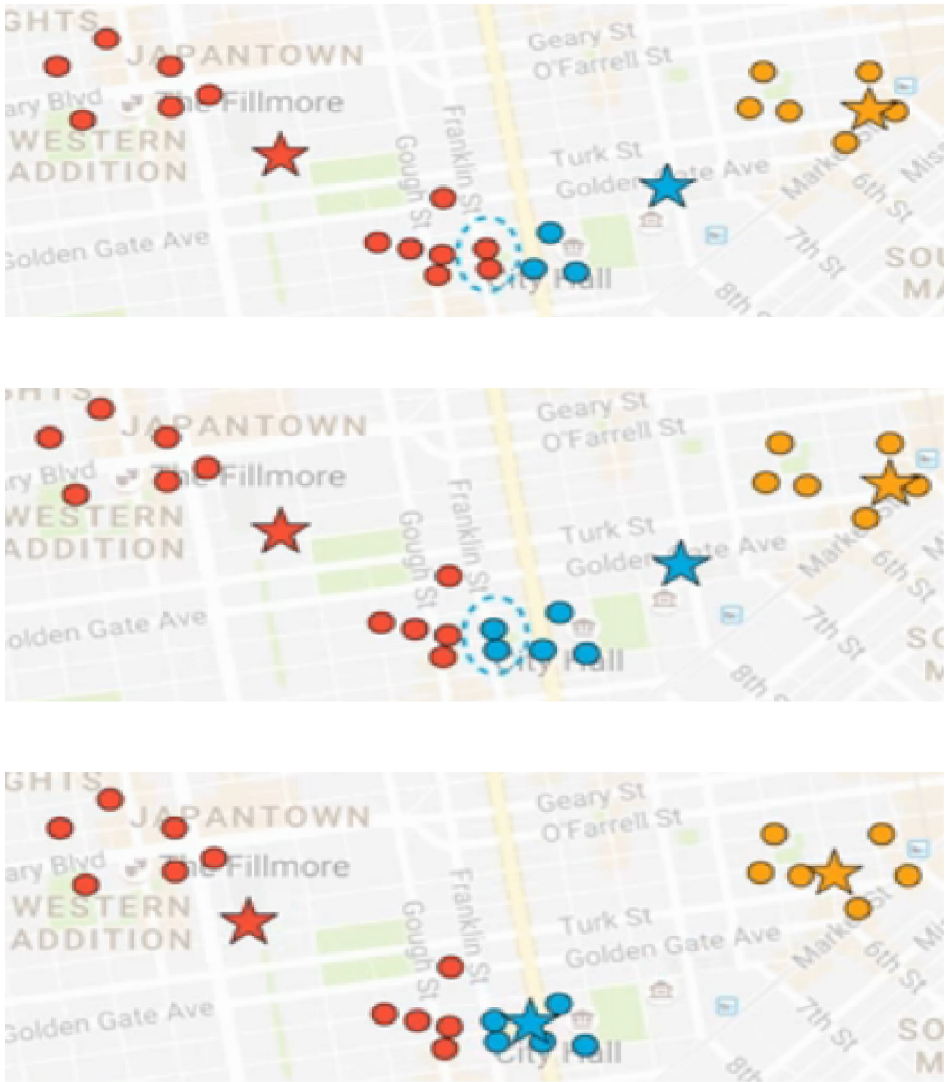



Figure 41: Example

# Contd...



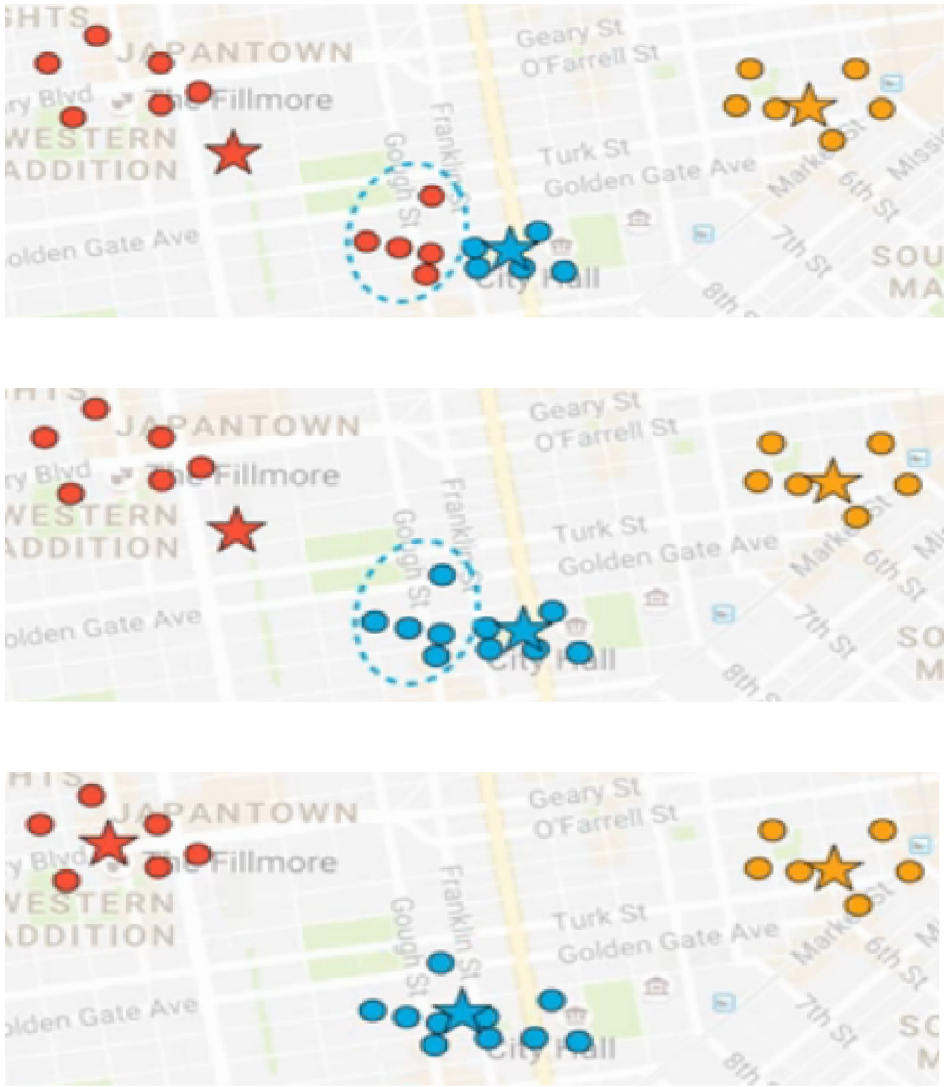



Figure 42: Example

# Hierarchical Clustering



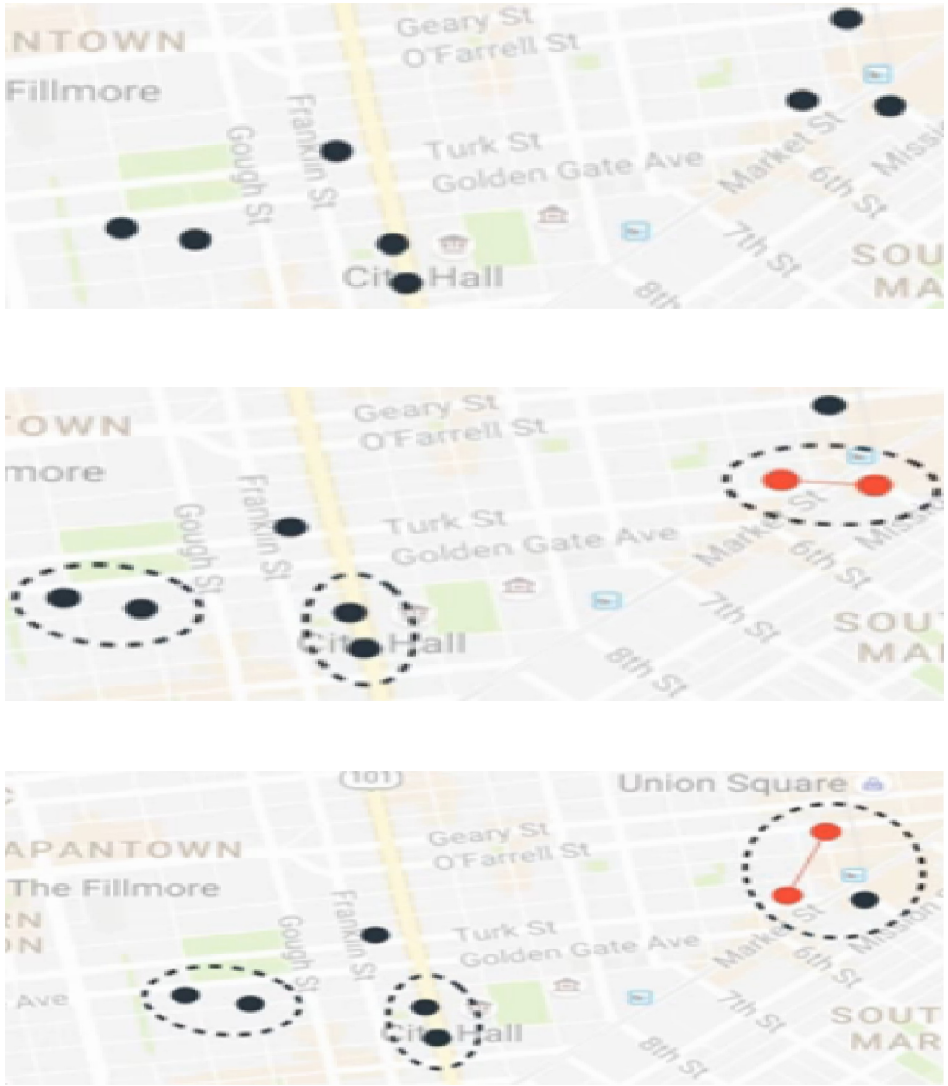



Figure 43: Example

# Contd...




Figure 44: Example

# Contd...



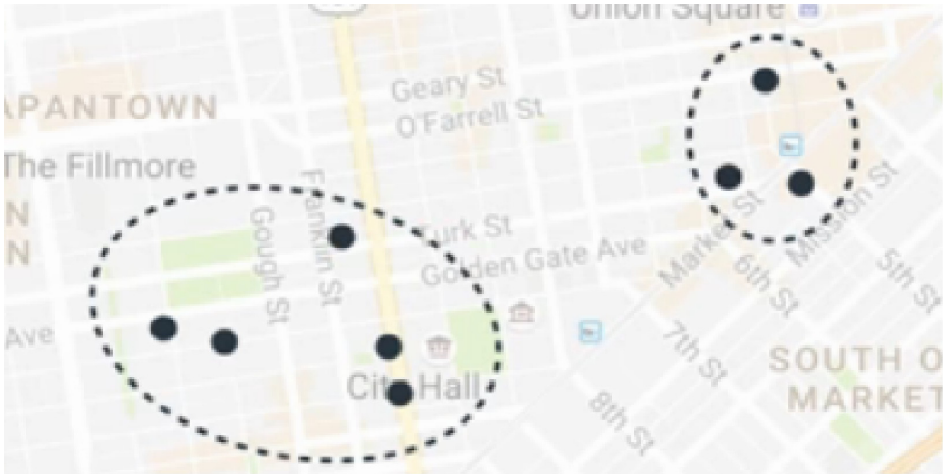



Figure 45: Example

# Summary



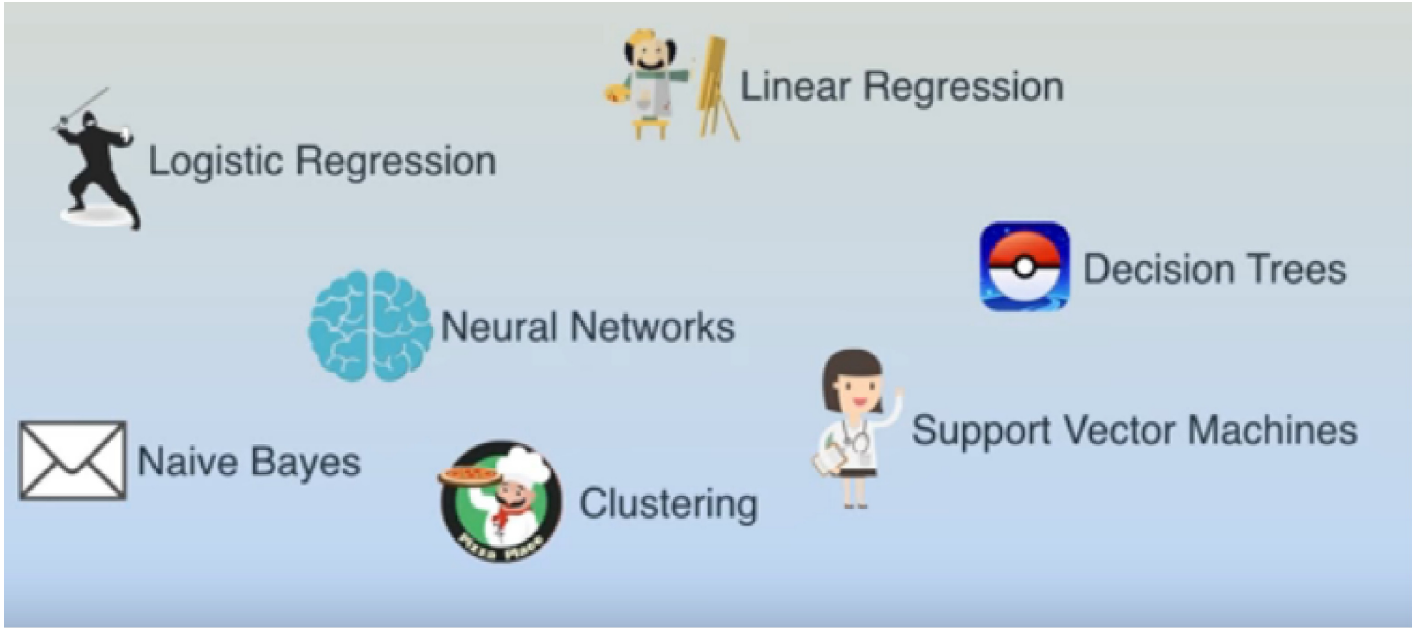



Figure 46: Example