

Artificial Neural Network

LECTURE 1

INTRODUCTION TO MACHINE LEARNING

Logistics

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Outline

Learning, machine learning

Machine learning applications

Classification

Clustering

Decision Trees

Neural Networks

R. Duda, P. Hart & D. Stork, *Pattern Classification* (2nd ed.), Wiley

Learning vs. Machine Learning

Learning is any process by which a system improves performance from experience.

Machine Learning is concerned with computer programs that automatically improve their performance through experience.

Formal Definition for Learning

Learning by a machine is defined as:

Learning = Improving performance at some task with experience

- Improve over task T , (*Identify digits*)
- With respect to performance measure, P (*number of digits identified correctly*)
- Based on experience, E . (*sample input data*)

Machine Learning Applications

Numerous machine learning applications have been introduced under the impact of:

- Availability of large data sets
- Increasing computational power
- Introduction of better and more effective algorithms
- Support from industries

Machine Learning Applications

Face Recognition

Handwriting Reading

Writer Recognition

Speaker Recognition

Speech Recognition

Robotics

Web Search

Text Categorization

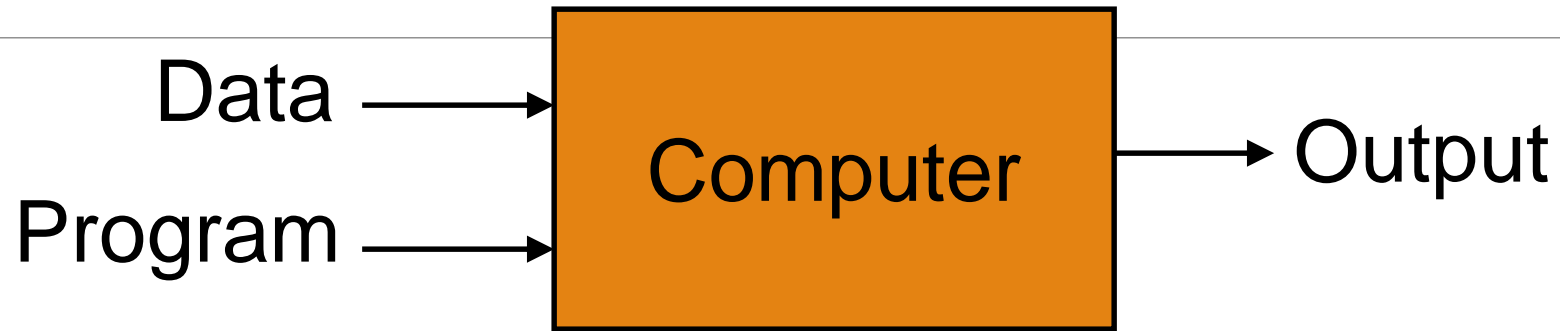
Information Retrieval

Data Mining

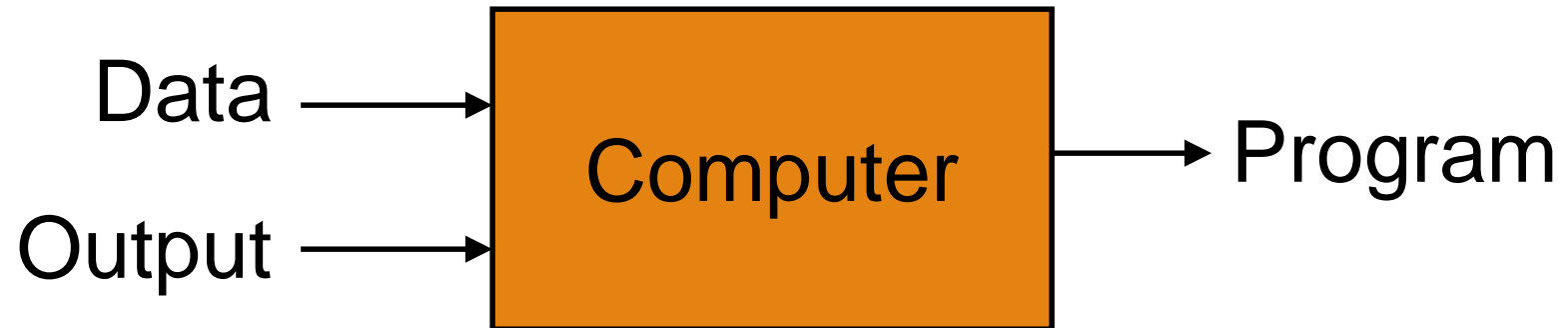
Intrusion Detection

Genome Sequence Matching

Traditional Programming



Machine Learning



Machine Learning Process

Machine learning through experiment consists of the following stages:

1. Gathering data through measurements
2. Pre-processing data: Feature extraction
3. Selecting some of the data items : Feature selection
4. Developing model: Training
5. Verifying validity of the model: Testing

Measurements

Machine learning depends heavily on data, and is its most crucial aspect.

Data gathering is performed through sensors/transducers

In most cases data requires preprocessing:

- Formatting
- Cleaning
- Decomposing
- Discretizing
- Scaling

Feature Selection

We may think that it is better to include as much data as possible. Some data only add more dimensions and complexity to your dataset.

Predicting the impact of each data item (**feature**) is called **feature selection**.

Example: to predict which customers will make large purchases in an online store.

Relevant data:

- age
- location
- gender

Training

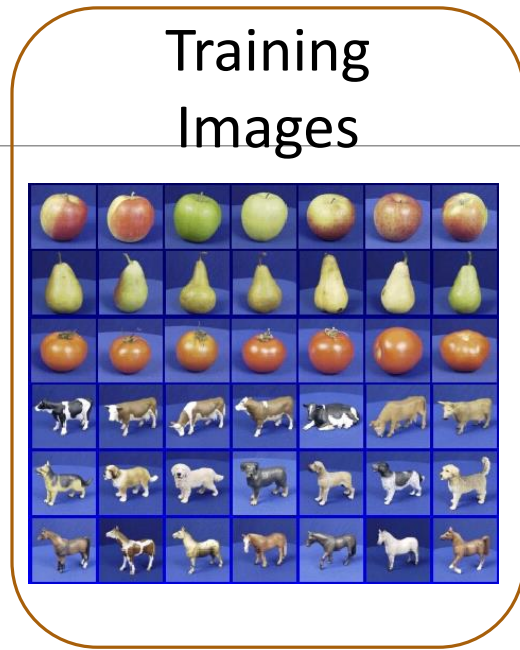


Image Features



Training



Learned model

Training Labels



Testing



Test Image



Image Features



Learned model



Prediction

Classification and Clustering

Classification and **clustering** refer to the process of categorizing based on common features

Clustering groups objects with similar features.

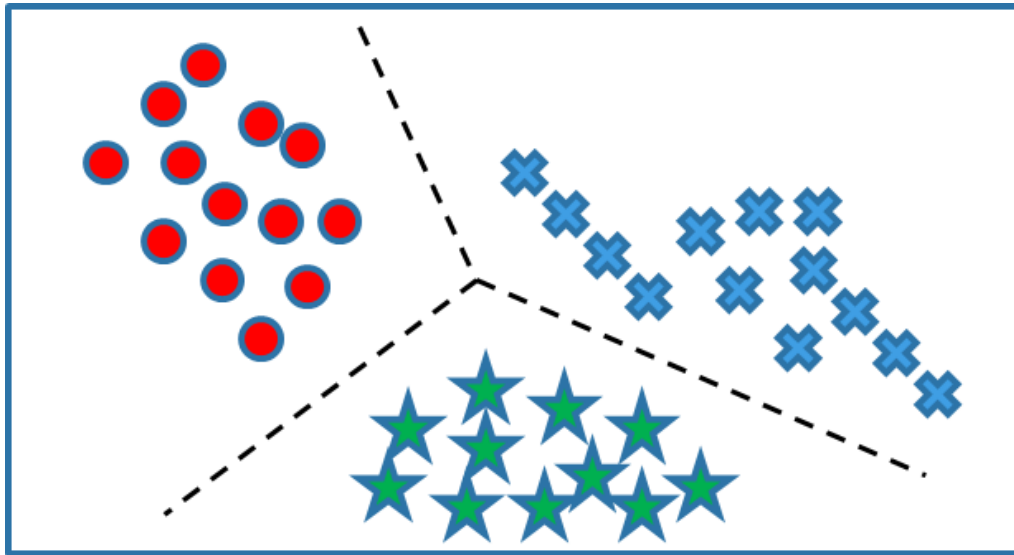
Classification identifies and differentiates objects based on the training data

Supervised Learning vs. Unsupervised Learning

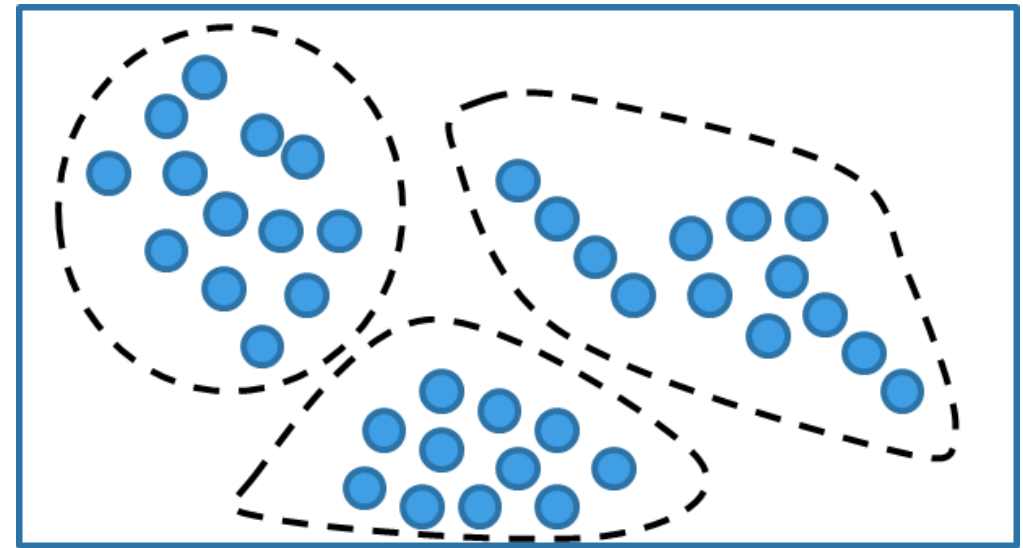
Classification is referred to as supervised learning where the training data is tagged

Clustering only considers the proximity of object in feature space for categorization

Supervised Learning vs. Unsupervised Learning

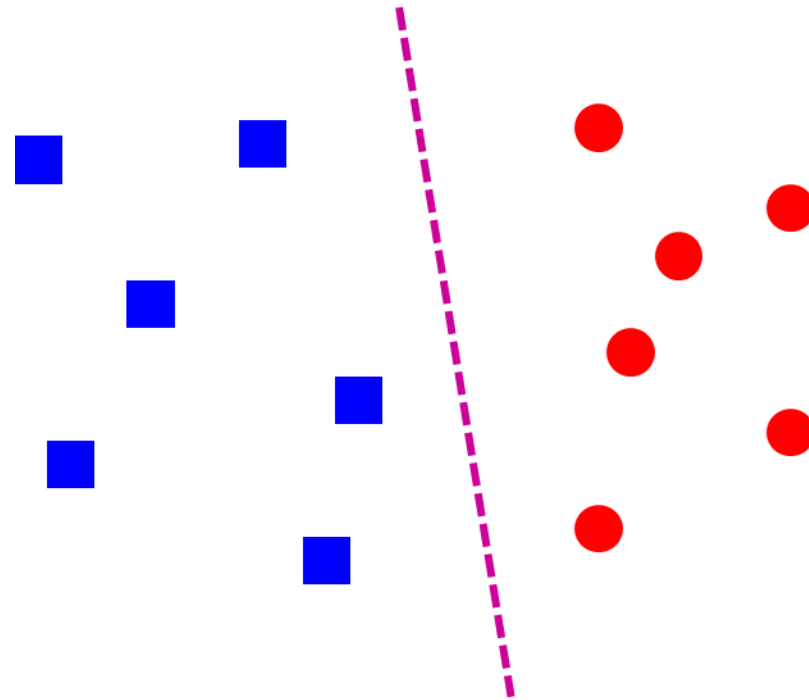


Classification

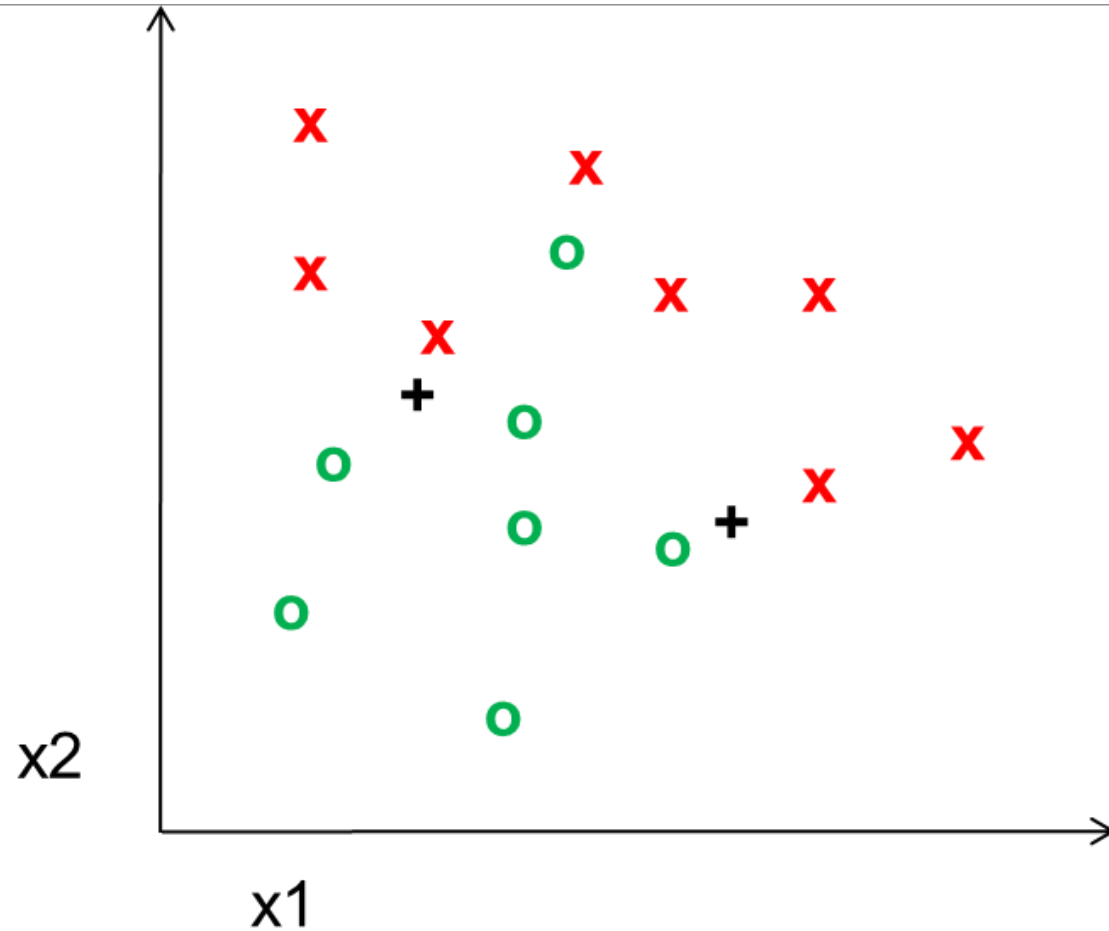


Clustering

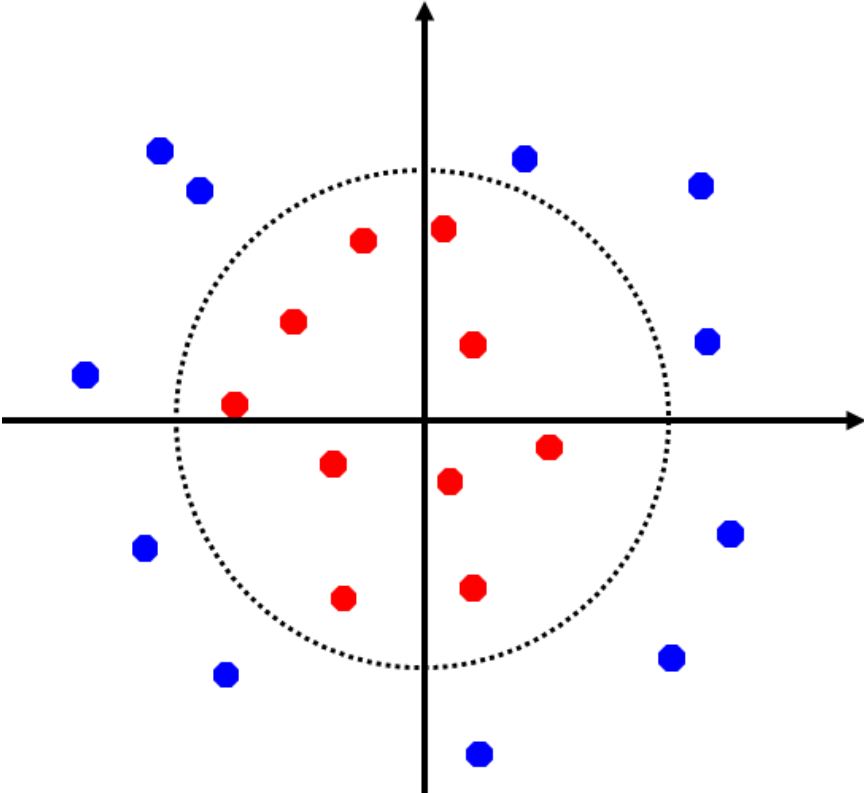
Linear Classifiers



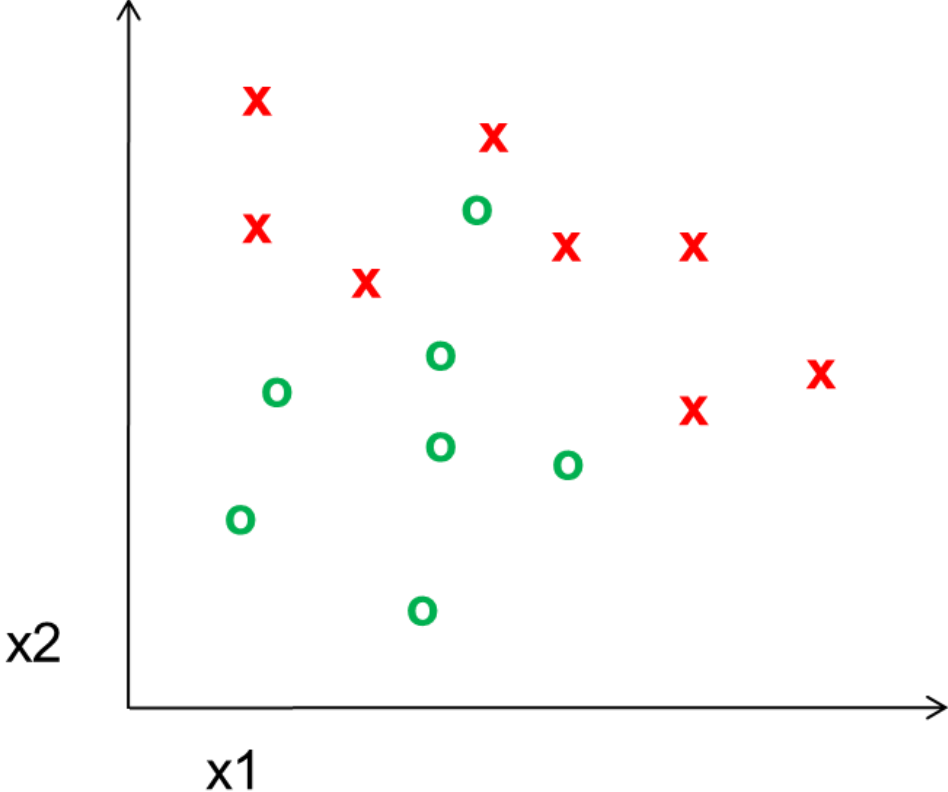
Linear Classifiers



Non-Linear Classifiers



K-Nearest Neighbors



Clustering

K-means

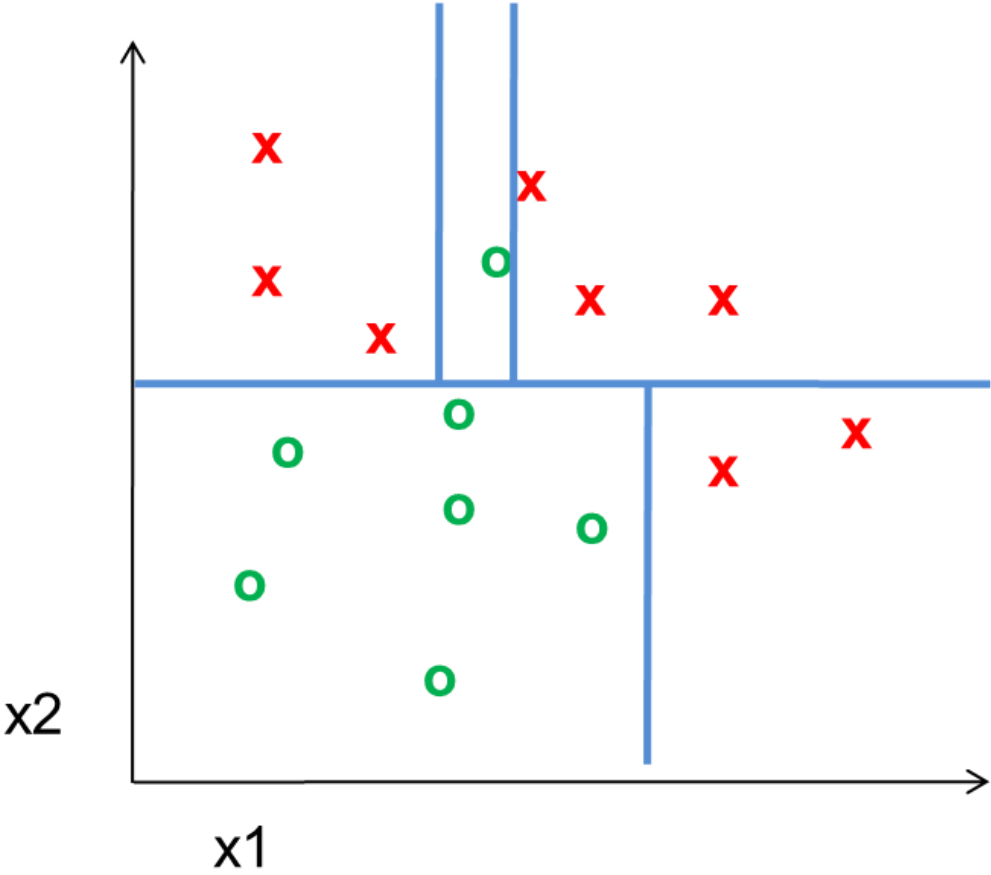
Iteratively re-assign points to the nearest cluster center

Update cluster center (mean)

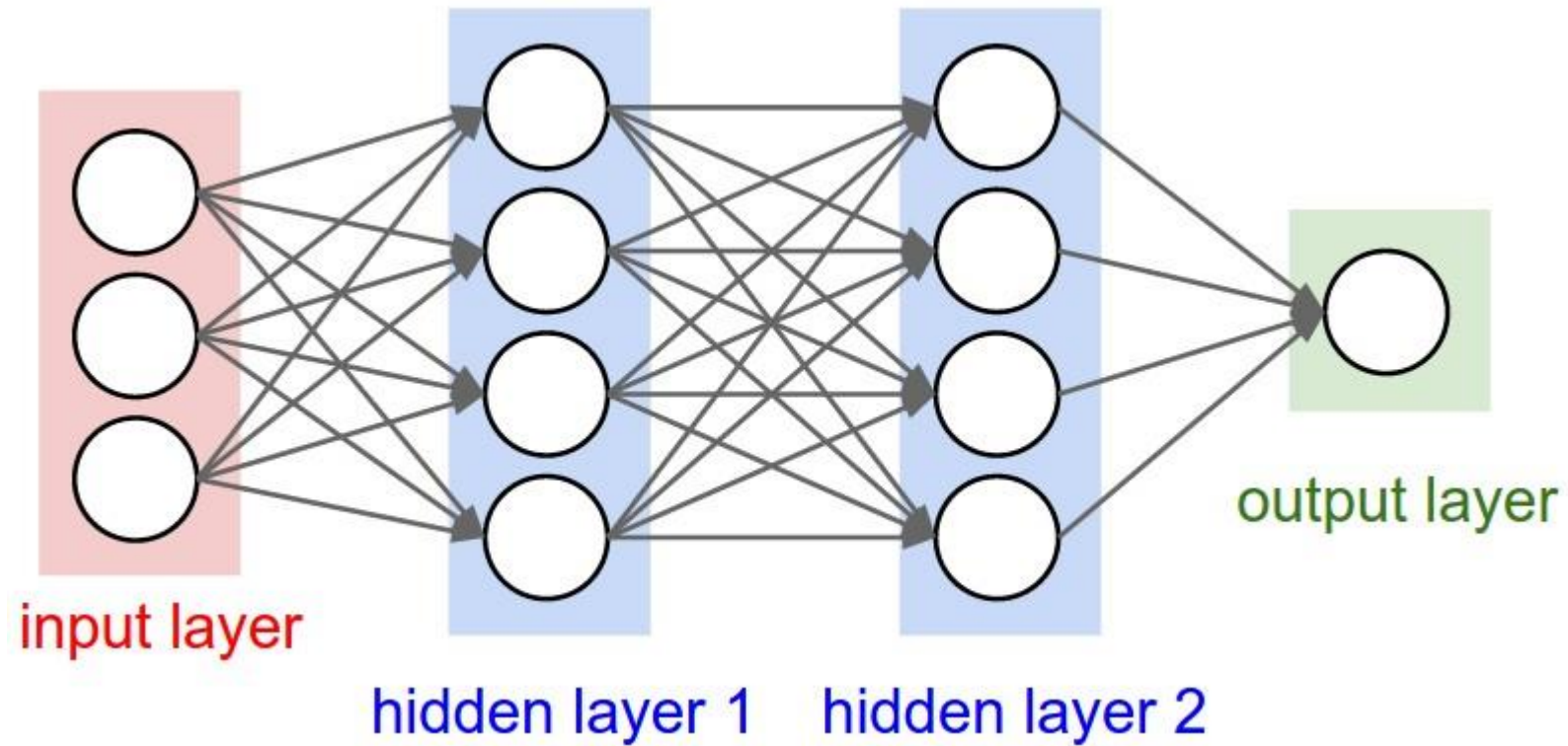
Problem:

Number of clusters should be given

Decision Trees



Neural Networks



Verification and Validation

Supervised: Error term is defined as the difference between actual output and true output.

Unsupervised: Different metrics such as Minimum distance, MLE(maximum likelihood estimation) are used

What next?

Features, Feature Selection, Reducing the Dimensionality of the Feature Space

Designing classifiers:

- Parametric and Non-parametric classifiers

Questions?

