Introduction to Machine Learning

Objectives

Define machine learning

Illustrate key elements of machine learning

What is Machine Learning?

Many different definitions for "machine learning"

- All involve *learning* by a machine (computer)

Definition of *learning* in a typical dictionary: "the acquisition of knowledge or skills through experience, study, or by being taught"

- Can machines be enabled to learn, without being explicitly programed?

Learning and adaption

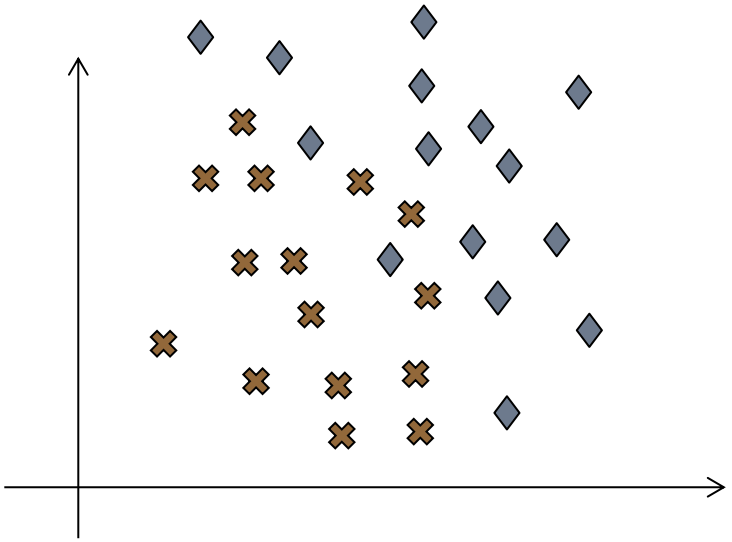
An Illustrative Example

Given some example pictures, how a computer can learn to differentiate dogs from cats?

Data Representation – Feature Extraction

Raw data: Images

Features



Different Types of Data Representations

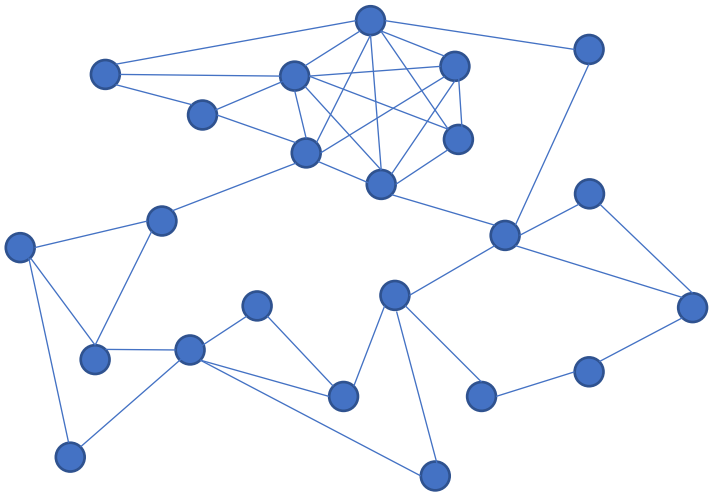
Numerical; Categorical; Ordinal

- Univariate or multivariate

➔ **All could be represented by numbers.**

Graphical representations in terms of nodes & edges

- **E.g., Social network analysis**



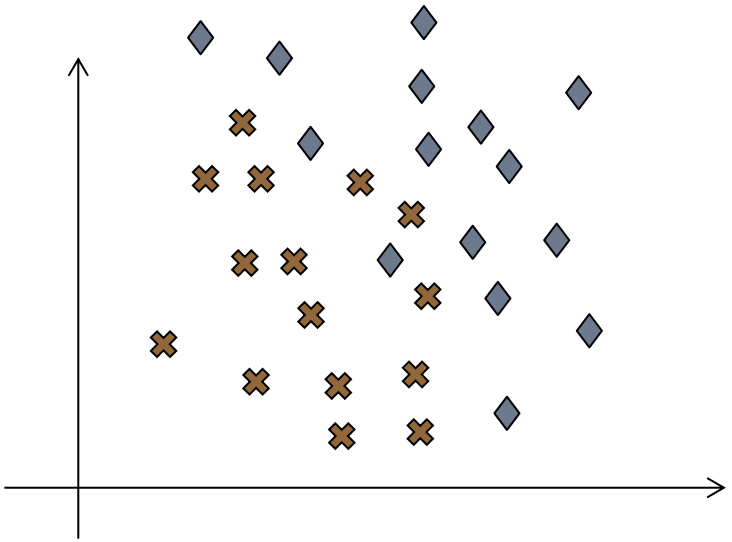
Preprocessing for Feature Extraction

- **Segmentation**
- **Filtering**
- **Various transformations**

➔ **All intended for facilitating feature extraction**

- **Good features should be *invariant* in some sense.**

Mathematical Models for Classification



Importance of Statistical Modeling

Why we often reply on statistical methods in machine learning?

Data is noisy (measurement noise) ➔ Features are often represented random variables/vectors.

Inaccuracy of the assumed model

Inherent ambiguity of many real-world problems

Basic Machine Learning Paradigms

- **Supervised learning:** the training samples have labels.

- **Unsupervised learning:** the training set is not labeled.

- **Reinforcement learning:**
  - Learning to take actions to maximize some notion of *reward*.