

Pattern Recognition

Introduction

Course Information

Instructor

Reza Hassanpour

Office: L 214

Phone: 2331338

Email: reza@cankaya.edu.tr

Course Webpage: <http://ceng509.cankaya.edu.tr>

Lecture time/place : Tuesdays 17:40 at INT3

Reference Books

- Pattern Classification, Richard O. Duda, Peter E. Hart, and David G Stork, Wiley-Interscience, ISBN-10: 0471056693
- Pattern recognition, 4th edition, by S. Theodoridis and K. Koutroumbas, Academic Press, 2009, ISBN 978-0-12-374486-9

Syllabus

- Pattern Recognition Systems
 - Basic Structure of Pattern Recognition Systems
 - Design of Pattern Recognition Systems
 - Supervised and Unsupervised Learning and Classification
- Bayesian Decision Theory and Optimal Classifiers
- Discriminant Functions and Decision Surfaces
- Supervised Learning of the Bayes Classifier
 - Parametric Estimation
 - Non-Parametric Estimation of Density Functions
 - Parzen Windows
 - k-Nearest Neighbors Classifier
 - Linear Discriminant Functions and Classifiers
 - Classifier Evaluation

Syllabus (cont.)

– Unsupervised Learning and Clustering

- K-means Clustering
- K-means
- K-means Algorithm
- Properties of the K-means
- Finite Mixture
- EM Algorithm

– Neural Networks

- Perceptron Criterion and Algorithm in 2-Class Case
- Perceptron Criterion
- Perceptron Algorithm
- Back-propagation Neural Networks

Tools and Materials

- MATLAB
 - Image Processing
 - Speech
 - Neural Networks
- Review Papers
- Reference Books

Evaluation

- Programming Assignments 40%
- Term Project + Presentation 40%
- Research Assignments 20%

Basic Definitions

- **Pattern Recognition** is the task of placing some object to a correct class based on the measurements about the object.
- A system that makes measurements about certain objects and thereafter classifies these objects is called a **pattern recognition system**.

Example Applications

- A bottle recycling machine.
- A spam (junk-mail) filter.
- A speech-based control system.
- Optical character recognition (OCR).
- Vehicle type detection.
- Fruit sorting.
- Identification using finger print.

The Basic Structure of a Pattern Recognition System

1. Sensing (measurement);
2. Pre-processing and segmentation;
3. Feature extraction;
4. Classification;
5. Post-processing;

Pre-processing and Segmentation

- Pre-processing refers to filtering the raw data for noise suppression and other operations performed on the raw data to improve its quality.
- In segmentation, the measurement data is partitioned so that each part represents exactly one object to be classified.
- For example in address recognition, an image of the whole address needs to be divided into images representing just one character.

Features

- **Features** are properties that best characterize the data for classification.
- The process of choosing the best subset of properties for classification is called **feature selection**.
- Measuring the value of each feature is called **feature extraction**.
- The result of the feature extraction stage is called a **feature vector**.
- The space of all possible feature vectors is called the **feature space**.

Classification

- The classification can be thought as a mapping from the feature space to the set of possible classes.
- The classifier cannot distinguish between two objects with the same feature vector.

Post-processing

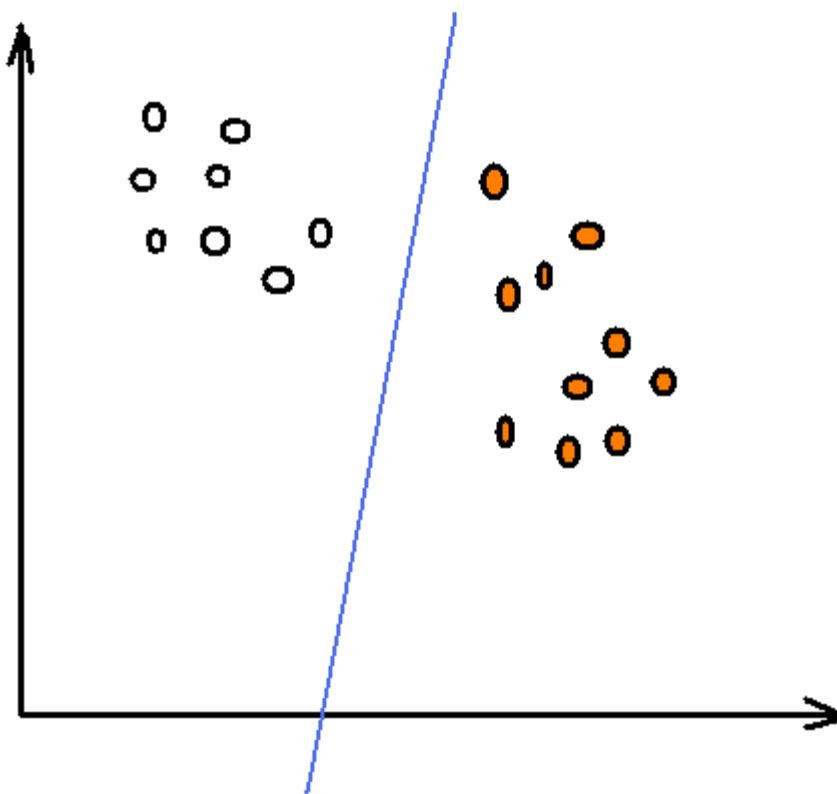
- It is possible to use the context to correct a possible misclassification.
- It is possible to optimize classifier parameters.

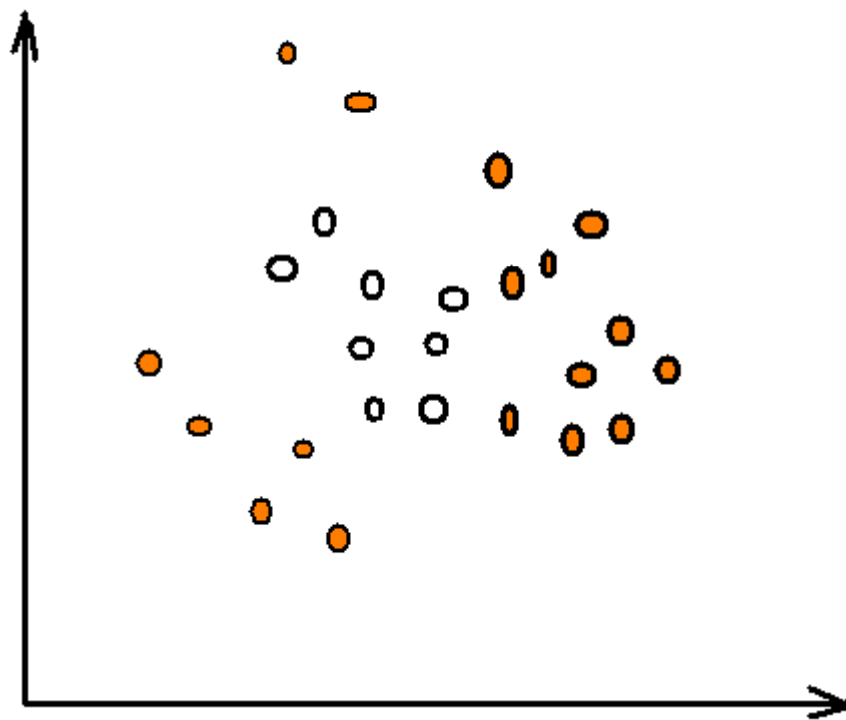
Design of Pattern Recognition Systems

- Pattern recognition system design is an iterative process.
- Important issues are:
 - Feature selection
 - Using too many features can reduce the correct classification rate (Curse of dimensionality)
 - Features have different importance
 - Improving classifier
 - Evaluate the performance of the system
 - Include the impact of misclassification

Linear/Nonlinear Classifiers

- A linear classifier makes a classification decision based on the value of a linear combination of the features.

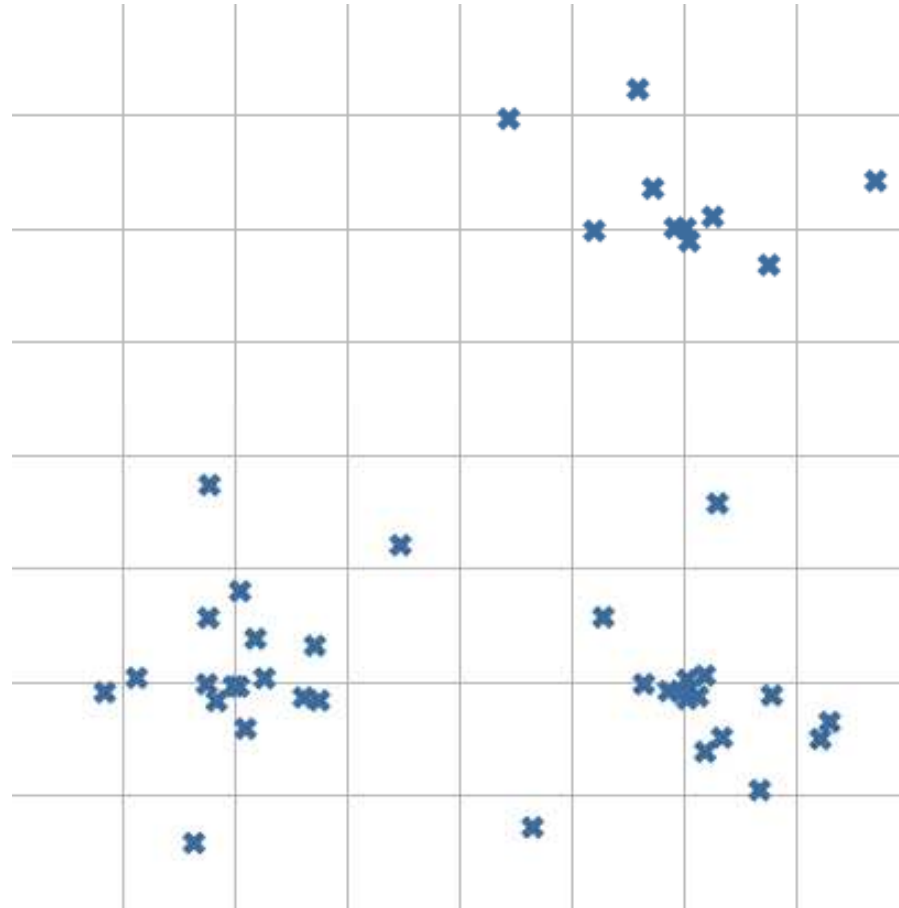




Supervised and Unsupervised Learning/Classifications

- In supervised learning a set of correctly labeled training samples are available for training the classifier.
- In unsupervised classification (that is also termed as clustering), we do not use labeled training data.
- Instead, a collection of unlabeled samples, and we try to classify them based only on the features in data.

Unsupervised Learning



Questions?