Adaptive Media Processing

1. Introduction

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About myself

- Keisuke Kameyama（亀山　啓輔）
  email : keisuke@cs.tsukuba.ac.jp
- Professor, Faculty of Engineering, Information and Systems, University of Tsukuba
- In Univ. Tsukuba since 2000
- Adaptive Information Processing Group
  (http://adapt.cs.tsukuba.ac.jp)
- Pattern recognition, Signal processing and Neural networks
- Application to processing, recognition and retrieval of media contents (especially images).

About this lecture

Term Spring AB

Period/Room ~~Mon2 / 3B303~~

Anytime / **Online video**.

Might try real-time schooling later.

Keywords

Signal Processing, Image Processing, Pattern Recognition, Adaptation, Feature Extraction

Outline

Adaptive techniques in processing, recognition and retrieval of media information will be discussed.

Prerequisites

Basic understanding of Linear Algebra, Analysis, Probability and Statistics of undergraduate level.

Knowledge of basic signal processing would be a plus.

About this lecture

Part of Computer Science English Program

http://www.cs.tsukuba.ac.jp/cse/

– All assignments must be submitted in English

Evaluation

– Some homework and a final term paper (report)

- No checking of real-time attendance
- View video lecture anytime. Try avoiding system congestion.

About this lecture

Webpages etc

Manaba for notices, Q&A and assignment submission

https://manaba.tsukuba.ac.jp

Moodle for course materials (guest access)

http://adapt.cs.tsukuba.ac.jp/moodle

MS stream for lecture videos (sign in by @u mail address)

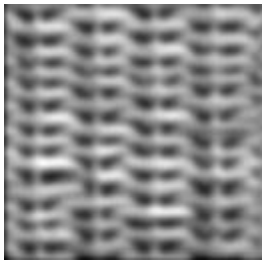
https://stream.microsoft.com

MS teams for grouping people (sign in by @u mail address)

https://teams.microsoft.com or the Teams app.

Media Processing

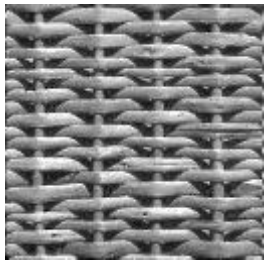
Media signal $\boldsymbol{x}$



Transformation $f(\boldsymbol{x}; \theta)$

(e.g. Deblurring)

Media signal $\boldsymbol{y} = f(\boldsymbol{x})$

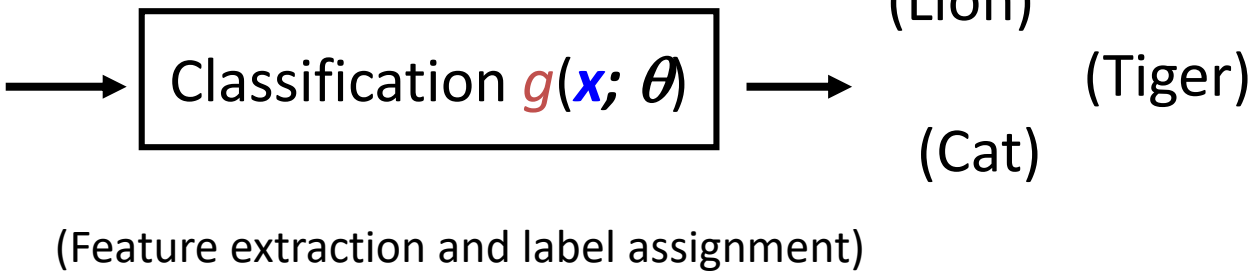


Components and tools

- Linear/nonlinear mapping (f) of vectorized signals ($\boldsymbol{x}$, $\boldsymbol{y}$).
- Means of signal vector description (space and basis).
- Tuning (adaptation) of mapping by selection (optimization) of parameter vector (θ).

Media Categorization (classification)

Media signal ***x***



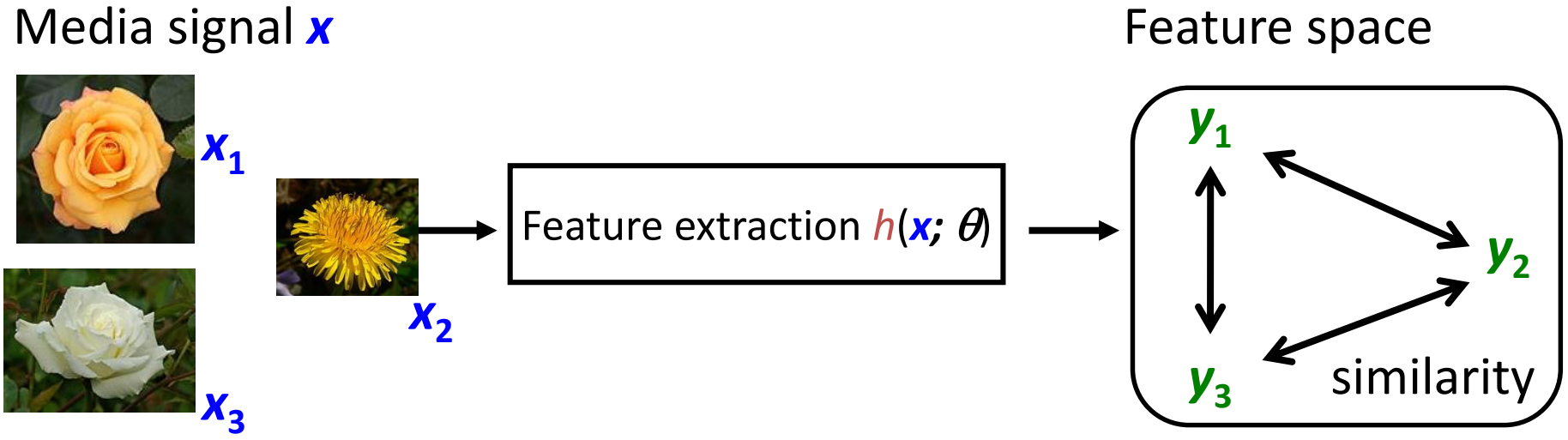
Class label ***y***

(Feature extraction and label assignment)

Components and tools

- (A more drastic) mapping (g) of vectors (***x***) to labels (***y***).
- Extraction (filtering) of signal features to simplify labeling.
- Flexible label assignment within feature space (segmentation).
- Strategy (rule) to support decision making for label assignment

Relevance (similarity) evaluation



Components and tools

- Variety of features to represent the nature of signal ***x***.
- Similarity (distance) measure to rate relevance.

Topics and schedule

Weeks 1-2

Introduction and reviews on math used in this course.

Weeks 3-7

Theories and techniques for adaptation, recognition and retrieval

- –Basic Pattern Recognition and the Bayes Rule
- –Linear Discrimination and Adaptive Filters
- –Neural Networks and Support Vector Machines
- –Clustering
- –Nearest Neighbor and Subspace Methods

Weeks 8-10

Applications

- –Content-Based Image Retrieval (CBIR)
- –Biometric Authentication

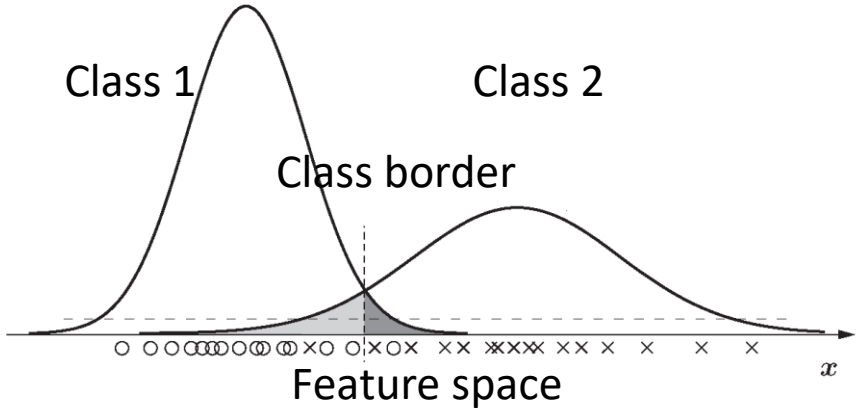
Math

- Linear maps and approximate solutions of matrix-vector equations
- Projection for dimensionality reduction
- Gradient-based optimization methods
- Lagrange theorems for optimization
- Statistics for pattern recognition
- Fourier transform and signal space
- Convolution and linear filters
- Autocorrelation and other signal features

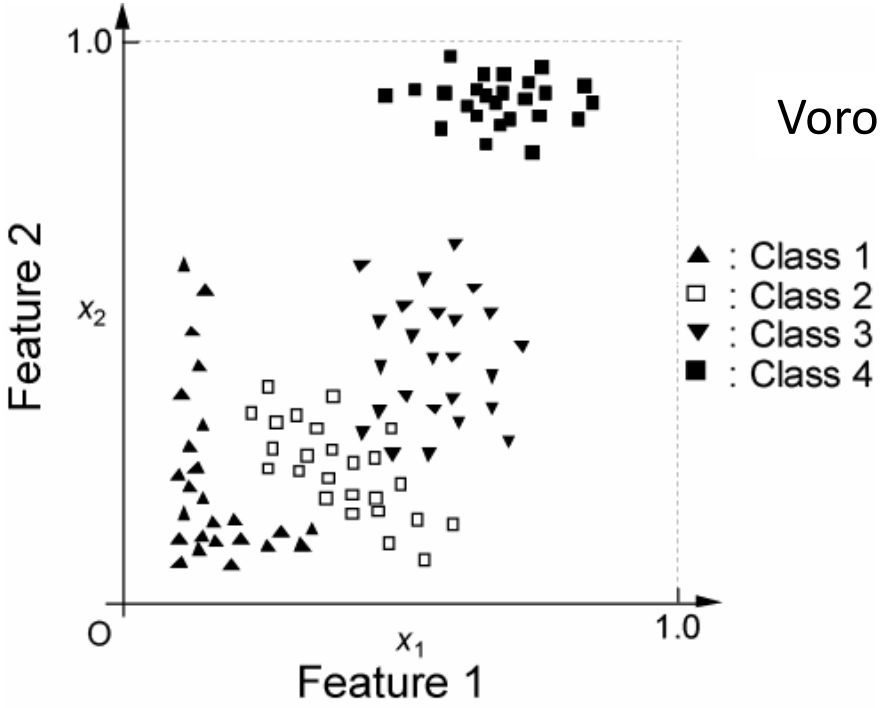
Fundamentals of pattern recognition

Bayes theorem

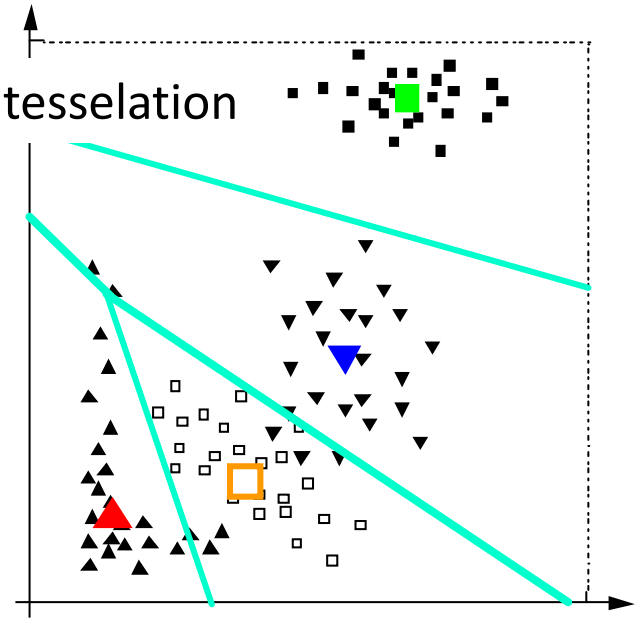
Rule for decision making by observation of examples



Segmentation of feature space



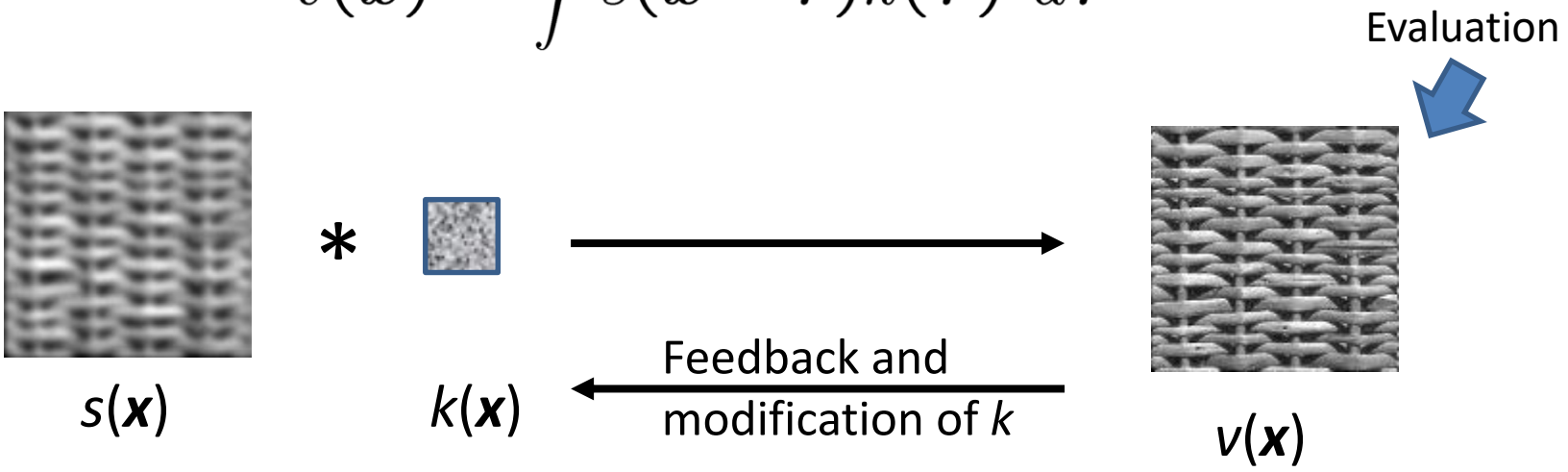
Voronoi tesselation



Adaptive Linear Filters

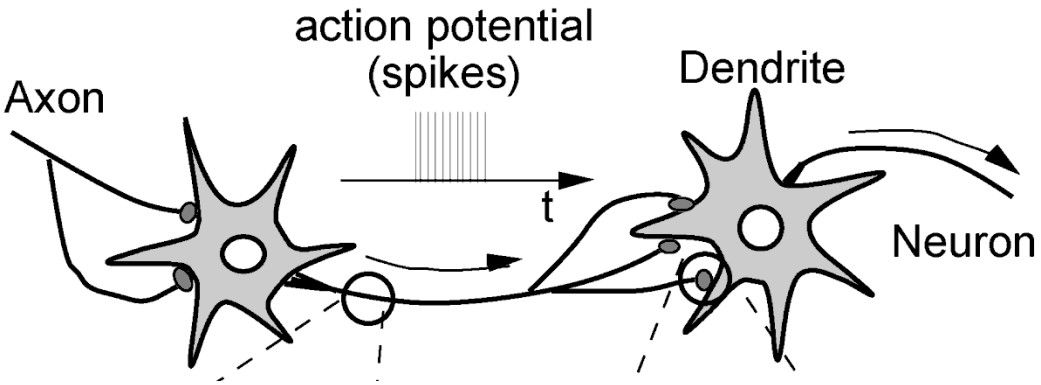
- Signal processing by linear transformation
- Convolution of signal s and filter kernel k
- Modification (adaptation) of kernel weights

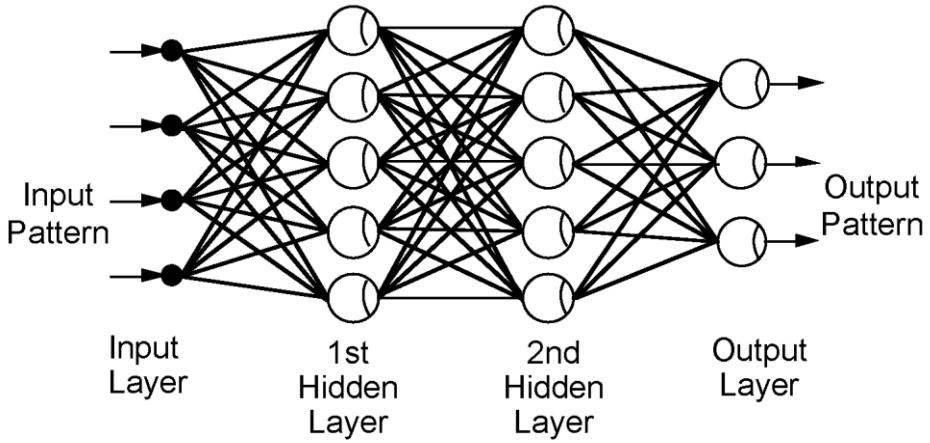
$$v(x) = \int s(x - \tau)k(\tau)\ d\tau$$



Neural networks

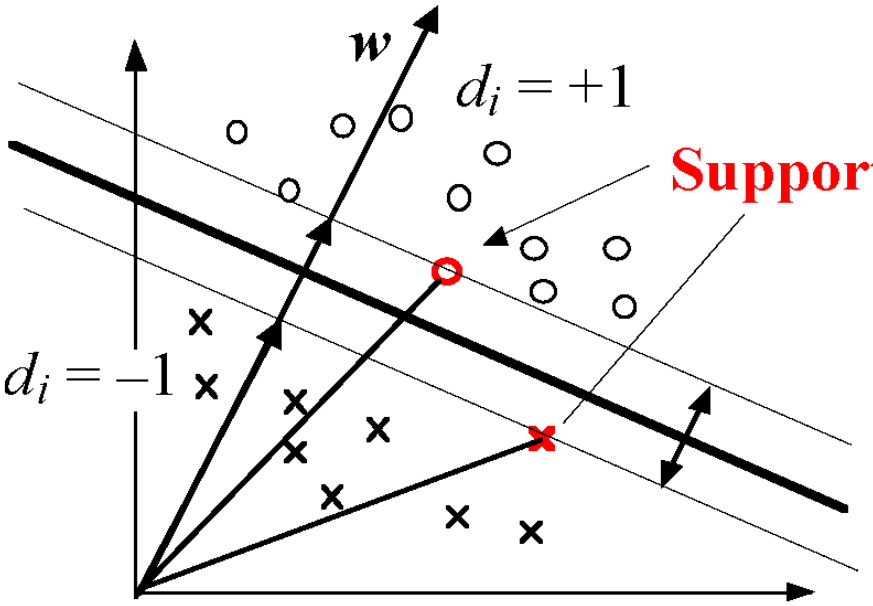
- Nonlinear mapping which can be trained using examples
- Models of biological neurons connected in a network

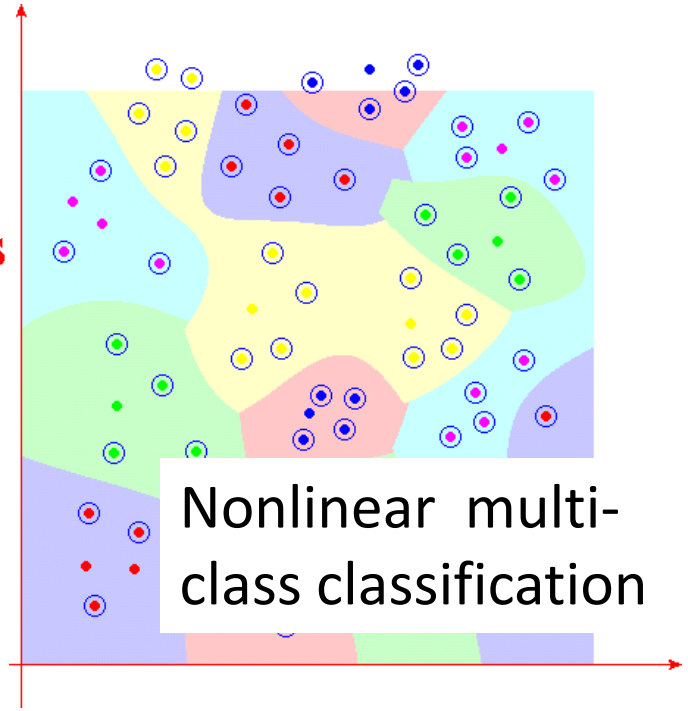




Support Vector Machines

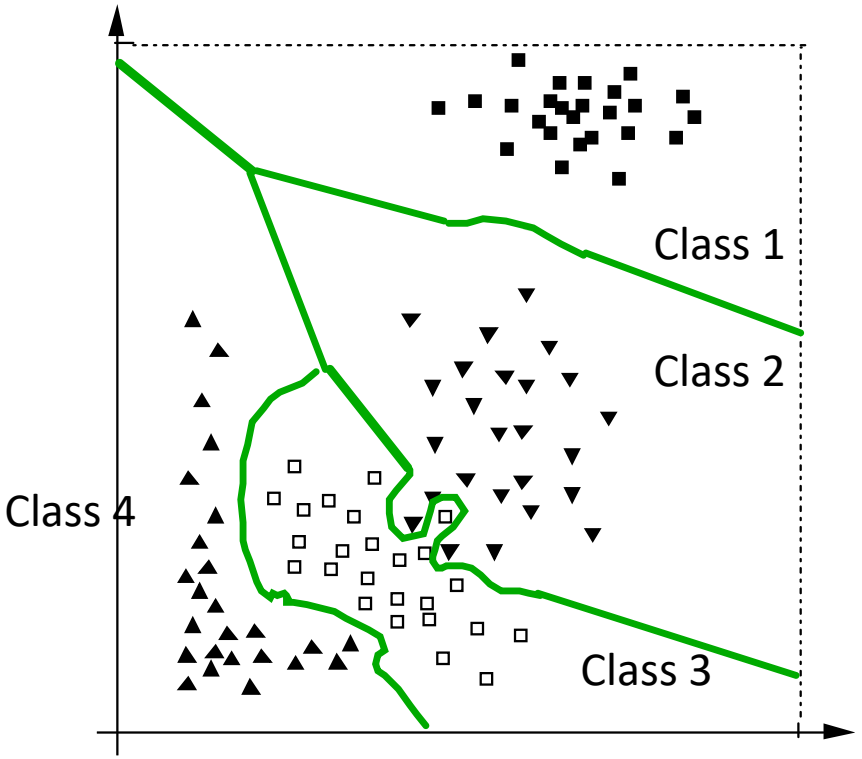
- Linear classifier achieving maximized margins
- Use of kernels for nonlinear classification borders

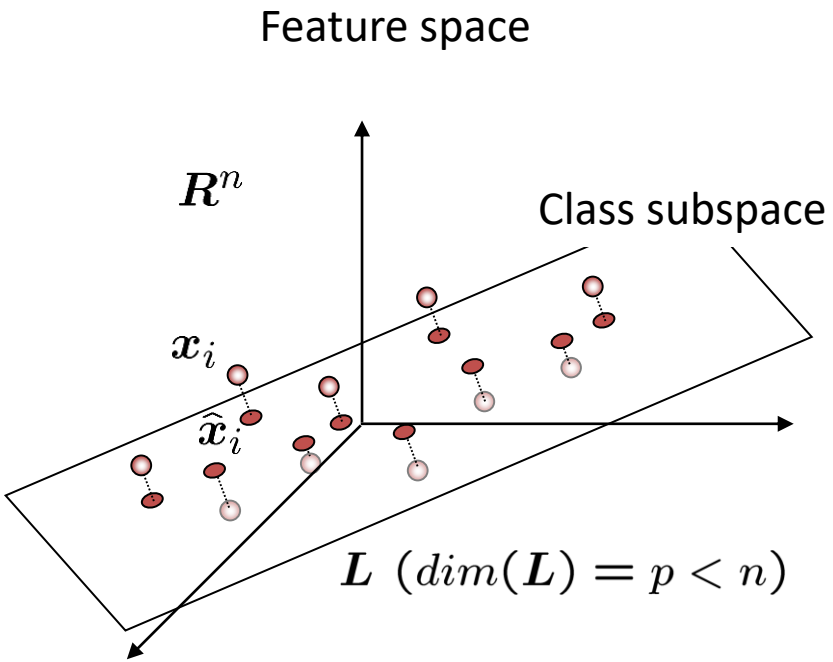




Nearest neighbor and Subspace Methods

- Decision by distance to template sample or a class-exemplar subspace

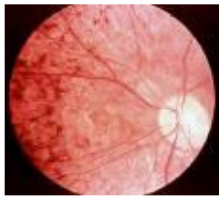
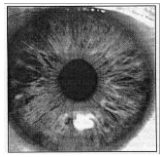


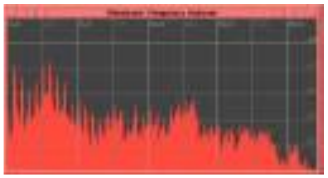


Biometric Authentication

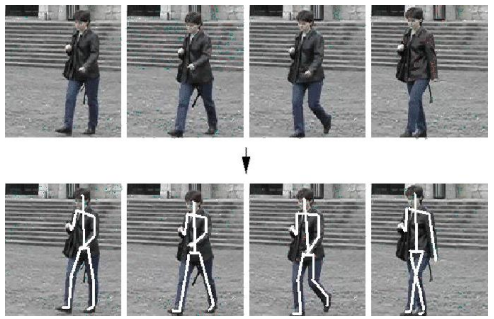
- Identification of individuals using physiological and behavioral features
- face, fingerprint, vein, iris, DNA, signature, voice, gait, key input

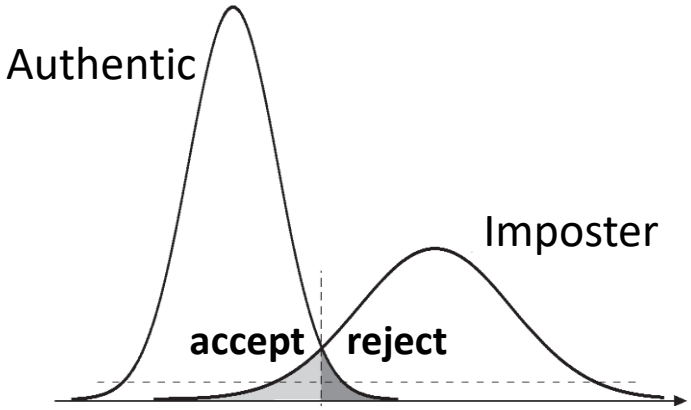




- Verification and Recognition
- False acceptance and False rejection





http://sp.newsclip.be/sp/hitachi/009706.php

Content-Based Media Retrieval

- Media retrieval by relevance (similarity) of the media (not by keyword matching).
- Need for adapting the similarity evaluation according to the requested relevance (relevance feedback)