Authentication

Prof. Dr. Helene Dörksen

helene.doerksen@th-owl.de

What is it about?

Conventional Pattern Recognition and Classification

pattern recognition and classification is fundamental to many of the **automated systems** in use

applications range:

from **military** defense to **medical diagnosis**
from **biometrics** to **machine vision**
from **bioinformatics** to **home entertainment**, and more

Conventional Pattern Recognition and Classification

Humans are good at recognizing objects (using size, shape, color, and other visual clues)

it is generally easy to distinguish:

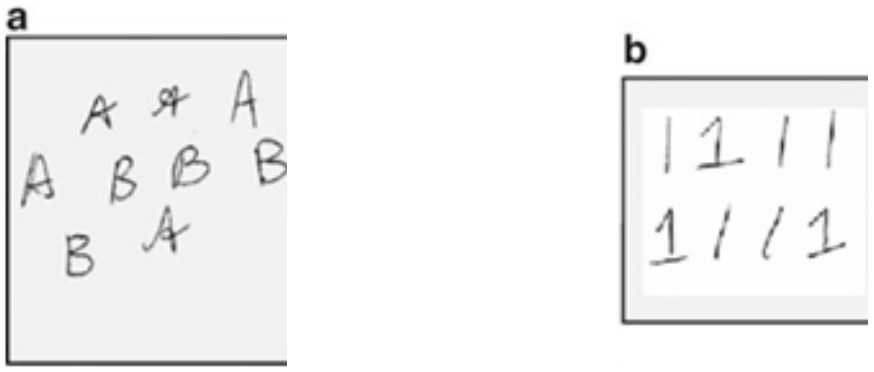
- the sound of a **human voice**, from that of a **violin**;
- a handwritten numeral "**3**," from an "**8**";
- and the aroma of a **rose**, from that of an **onion**

Humans do it unconsciously and because we cannot explain our expertise, we find it difficult to write a **computer program** to do the same

Conventional Pattern Recognition and Classification

In pattern recognition, the term **pattern** is interpreted widely and does not necessarily imply a repetition; it is used to include all objects that we might want to **classify**

A **class** is a collection of objects that are similar, but not necessarily identical, and which is distinguishable from other classes.



Are you able to classify pattern without computer?

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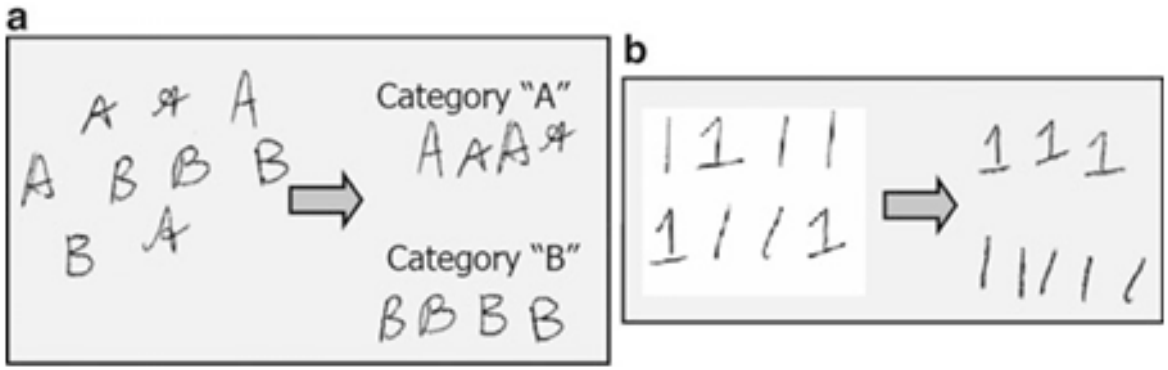
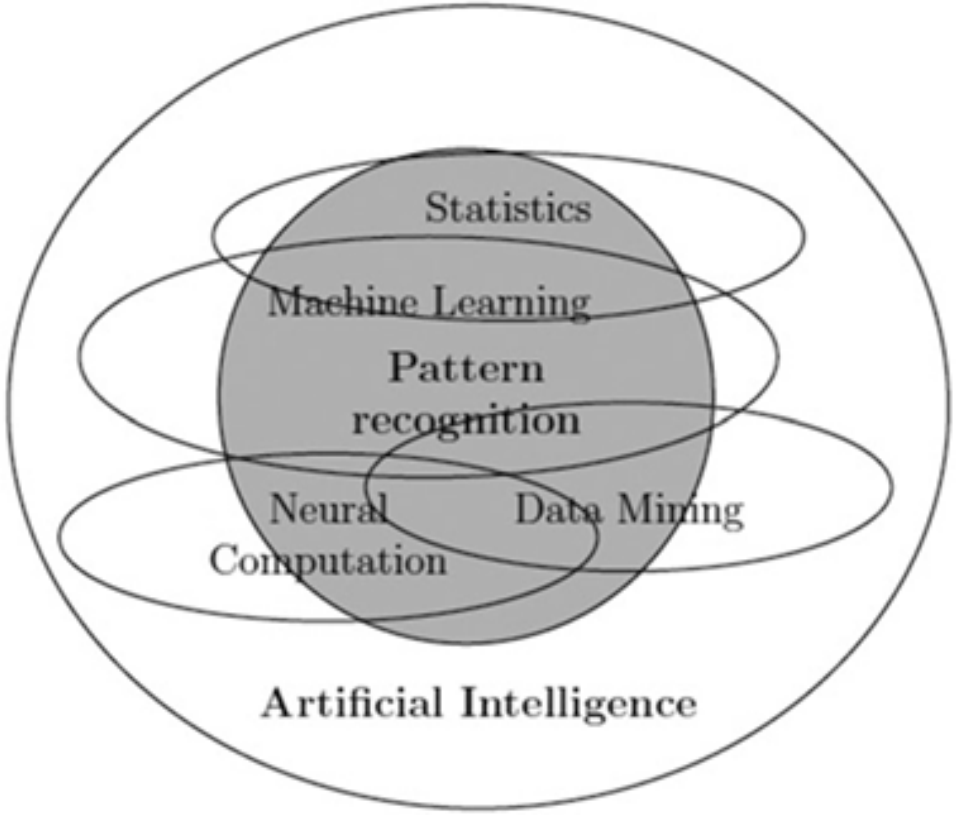
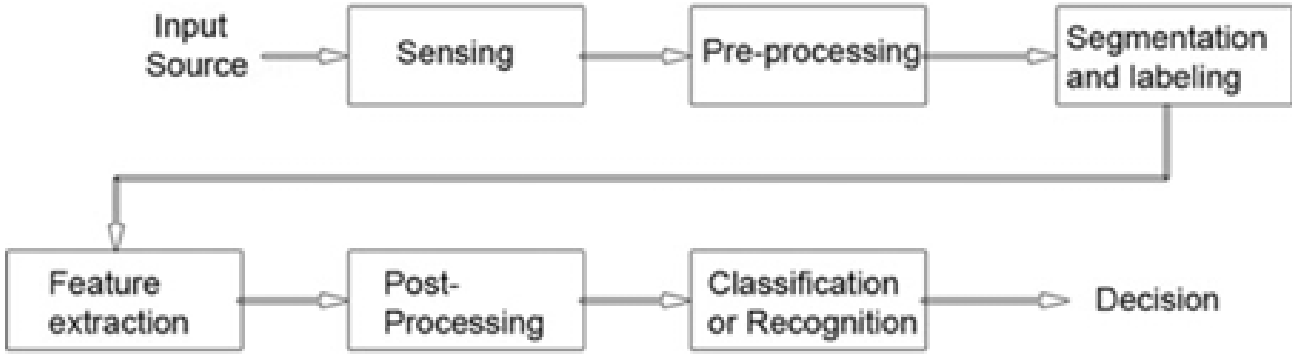


Conventional Pattern Recognition

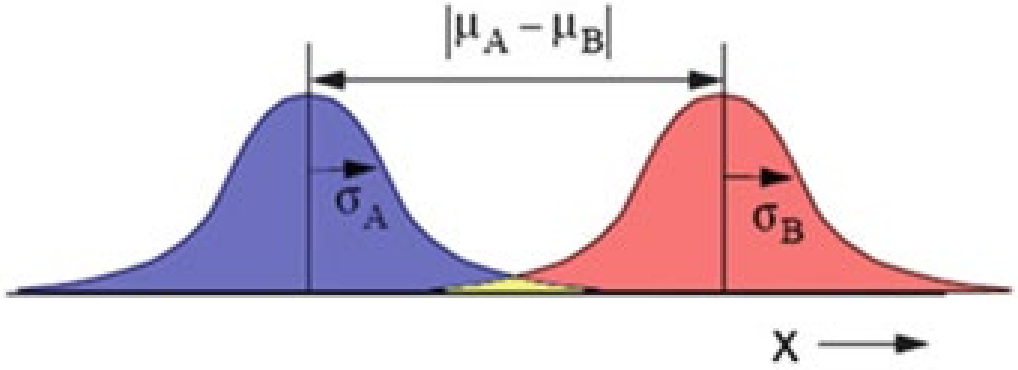


Pattern recognition and related fields

Conventional Classification



conventional classification system

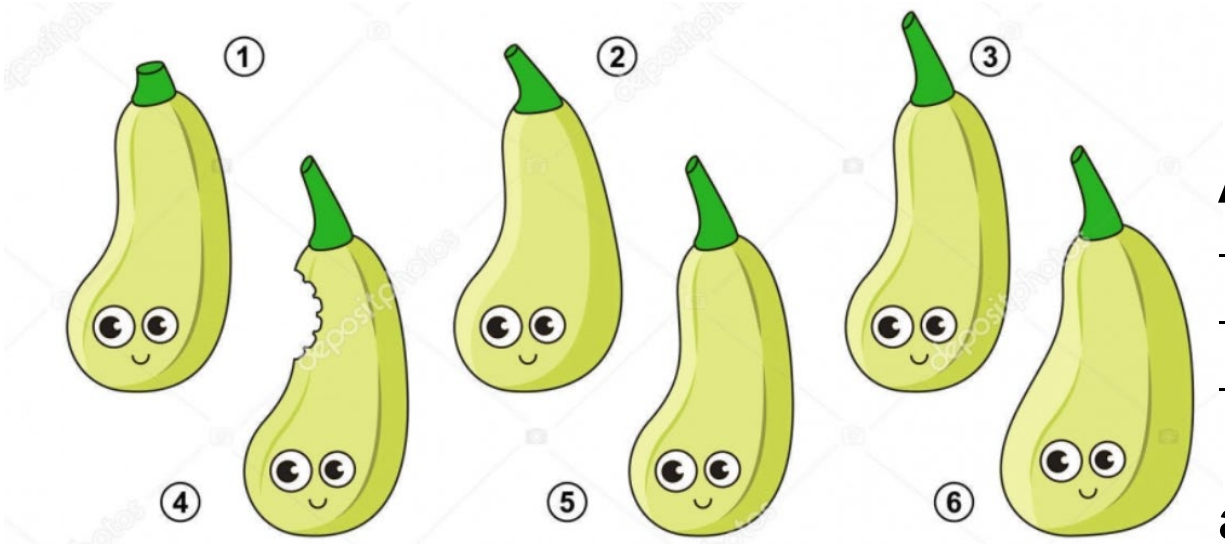


good one feature, **x** , should have small intra-class variations and large inter-class variations

But

- does such feature exists?
- how to find it?

Non conventional: Authentication Methods



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Are you able to

- find
- recognize
- authenticate

absolutely identical objects?

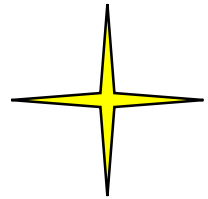
Are you able to classify pattern without computer?
How long does it take now?

- Conventional methods help, but there are many limitations
- Conventional methods profit from authentication methods

Main outlines of this lecture

authentication = special feald of conventional „pattern recognition + classification“

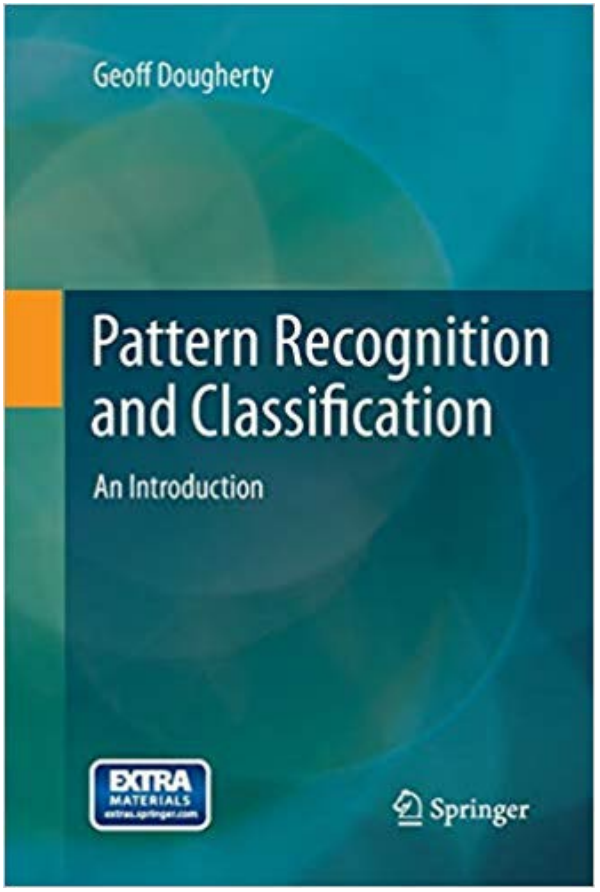
- classification
- nonmetric methods
- statistical pattern recognition
- some topics of supervised learning
- feature extraction and selection
- estimating and comparing classifiers
- application projects



- modern authentication methods
- lot of applications

Literature

eBooks:
on demand



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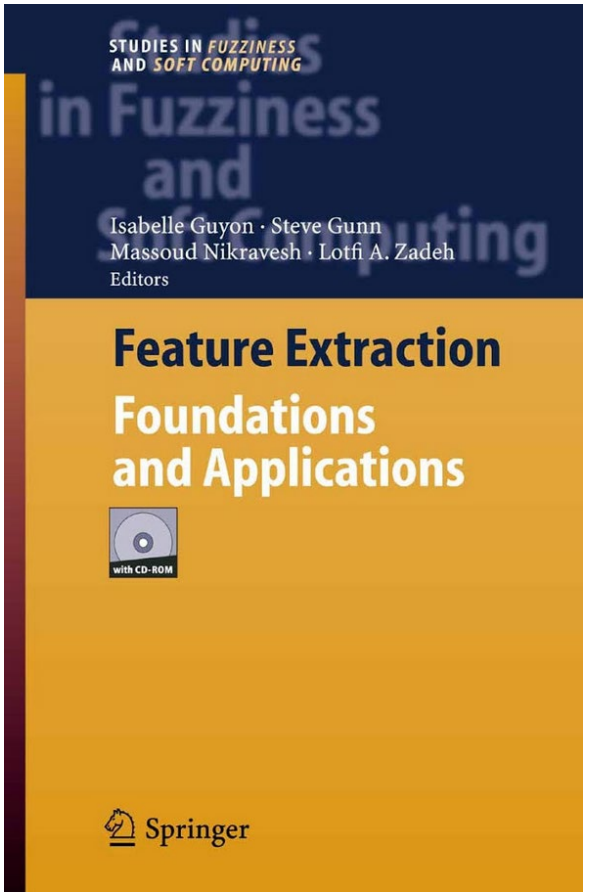
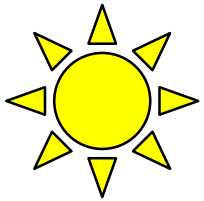


2006

Additional literature is found in modul description

Exercises and labs



Exercises and labs uploaded one week in advance
For successful work-flow, the preparations are essential

- **first week**: MATLAB Introduction; **Exercises Lec 1** for this lecture is uploaded

- from **second week**:
  - **solutions** of exercises from previous week will be discussed;
  - new exercises will be uploaded

- **Examination Term Paper:** please read uploaded informtion carrifully!
  Submission until **31.08 of running semester**

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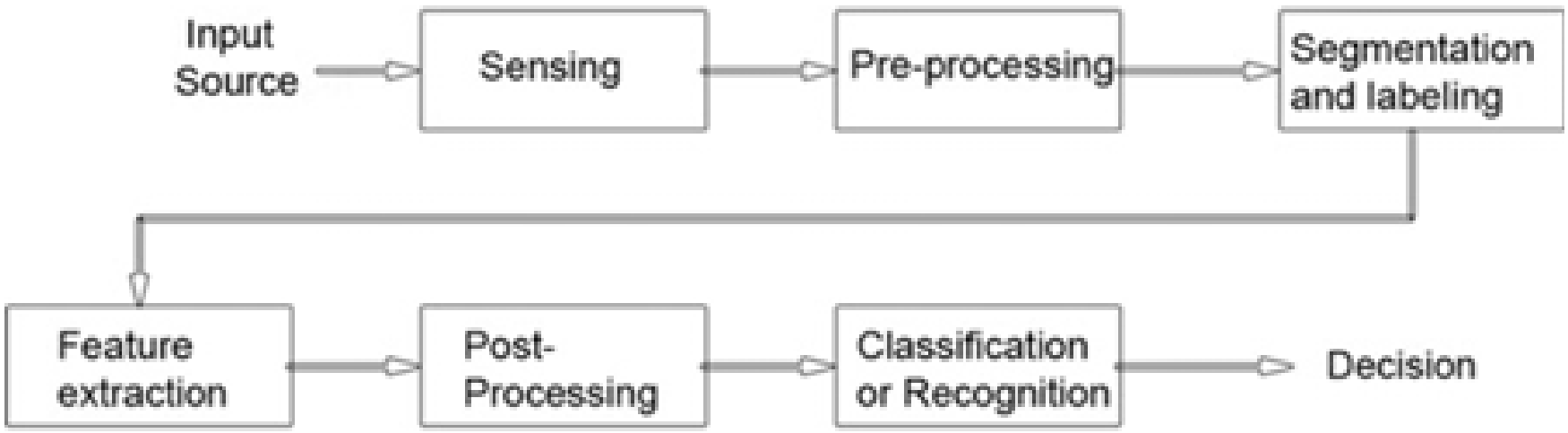
Lecture 1:

Classification Principles

Classification Principles

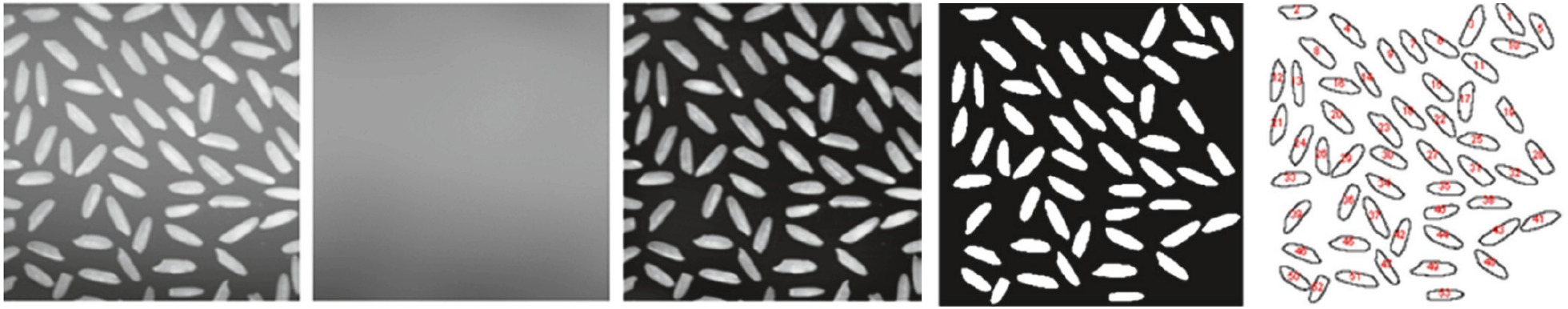
Classification system



1. What do the single parts of the system mean?
2. Why do we start from the end?

Classification Principles

- **sensing/acquisition** stage uses a transducer such as a camera or a microphone
- **pre-processing** might be smoothing of the image, noise reduction, removal of background, etc.
- **segmentation** partitions an image into regions that are meaningful for a particular task



original (roh)

3 x pre-processing

segmentation

Classification Principles

feature extraction: features are characteristic properties of the objects whose value should be similar for objects in a particular class, and different from the values for objects in another class

features may be **continuous** (i.e., with numerical values) or **categorical**

> **categorical** features are either **ordinal** [where the order is meaningful (e.g., class standing, military rank, level of satisfaction)] or **nominal** [where the ordering is not meaningful (e.g., name, zip code, department)]

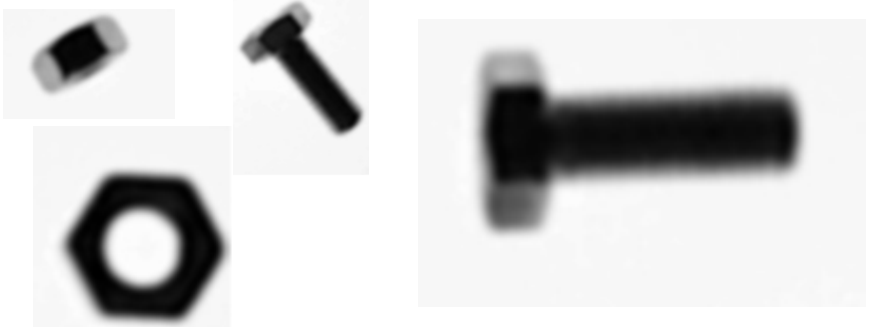
features are higher level representations of structure, shape or other properties of objects

Classification Principles

Example
recognition of nuts and bolts from the image

– segmentation of single objects
  do we need a standardisation (scaling)?

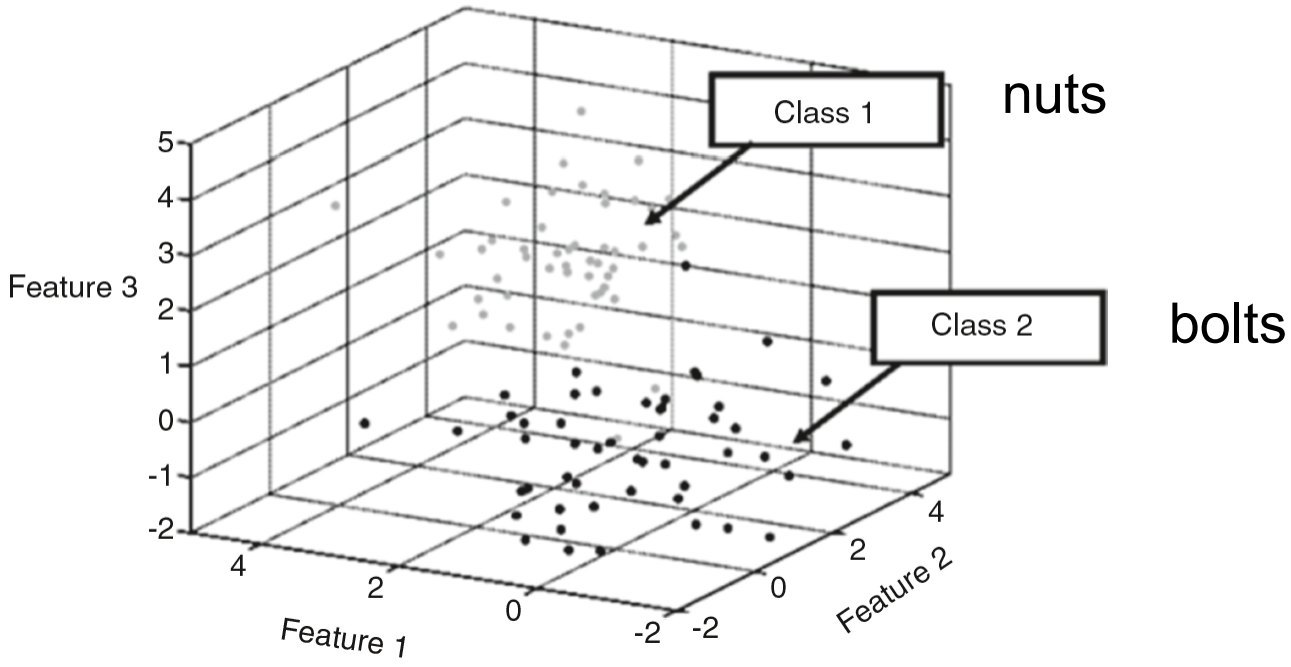
– feature extraction:
  size features (area, perimeter, length)
  shape features (round, elongated)



standardisation

Classification Principles

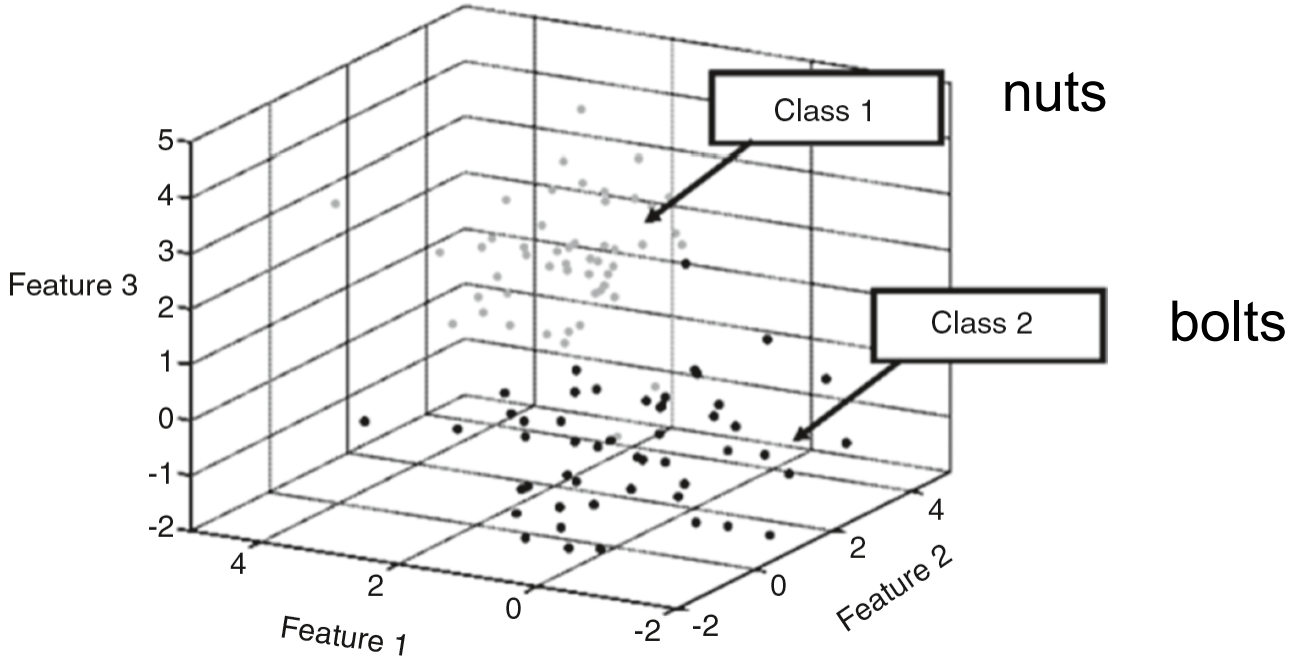
feature vector $\boldsymbol{x} = (\boldsymbol{x_1}, \boldsymbol{x_2}, \cdots, \boldsymbol{x_n})$, is a vector containing the measured features, e.g.



feature space

Classification Principles

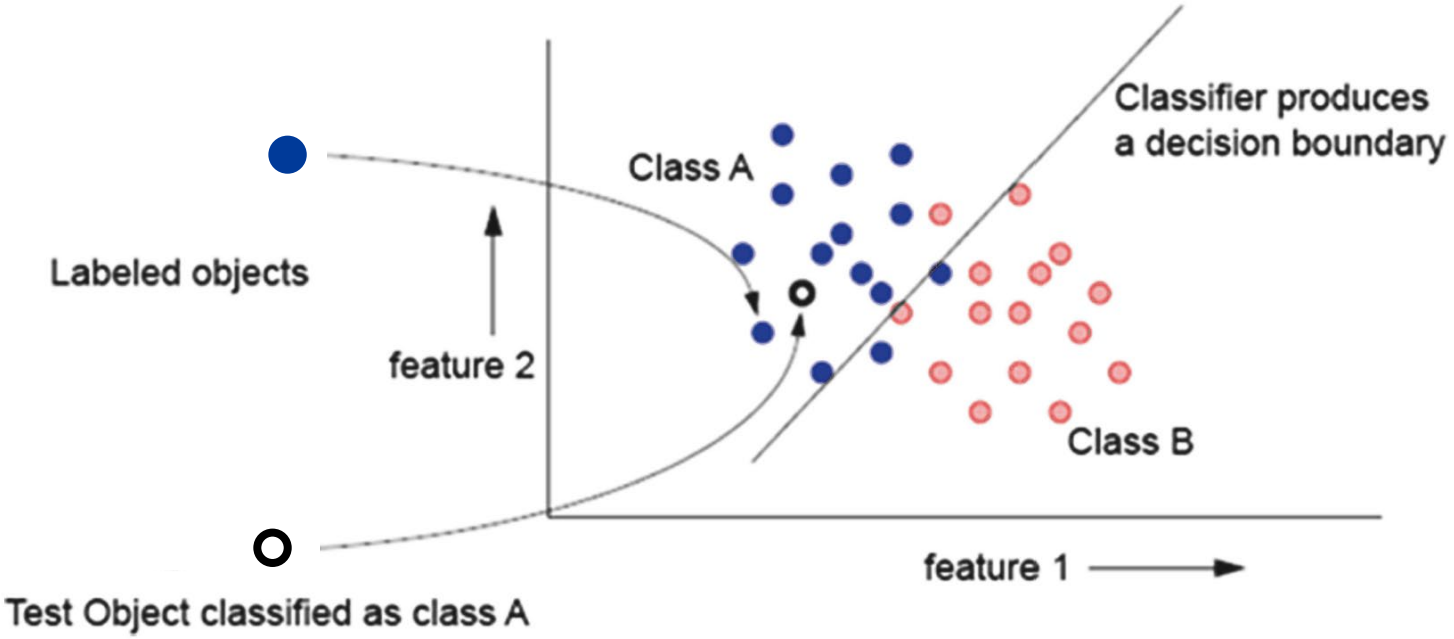
classification stage assigns objects to certain categories (or classes) based on the feature information



feature space

Classification Principles

Example for two features



Classification Principles

- how many features should we measure
- which are the best
- the more we measure the higher is the dimension of feature space, and the more complicated the classification will become

  → "**curse of dimensionality**"

search for a simple, efficient classifier we are need minimum number of "good" features

→ heuristic principle known traditionally as **Occam's razor** (simplest solution is the best) or referred as **KISS** (Keep It Simple, Stupid)

Classification Principles

feature selection = choosing the most informative subset of features, and removing as many irrelevant and redundant features as possible

feature extraction = combining the existing feature set into a smaller set of new, more informative features

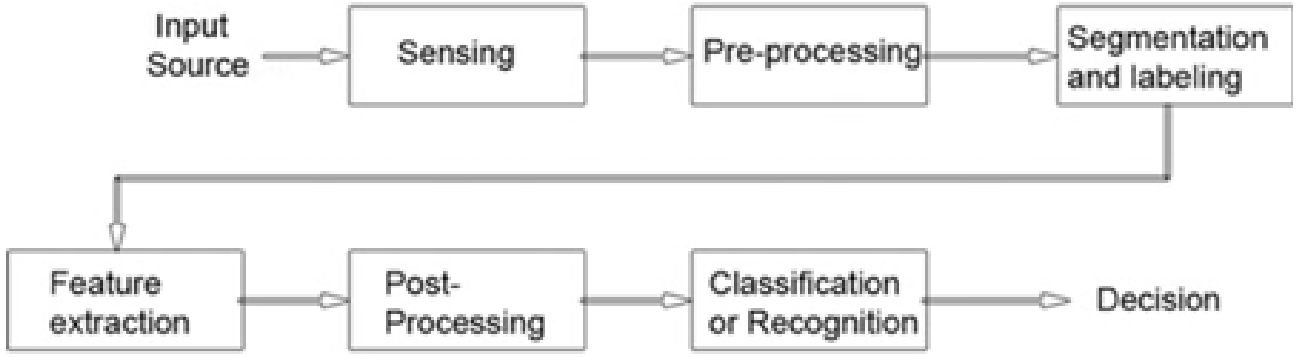
vs.

"**curse of dimensionality**"

Summary

Difference of „conventional“ pattern *recognition* + *classification* from „non conventional“ *authentication*

Classification principles: start from the end



classification system

Homework: Exercises and Labs

theory along is not enough

practice is important!

for the next week:

- solve the practical exercises and labs from **Exercises Lec 1** (you will find it in the download area)
- if you are not familiar with MATLAB, then have a deeper look at **MATLAB Intro**, it is suitable well for the **self-study**