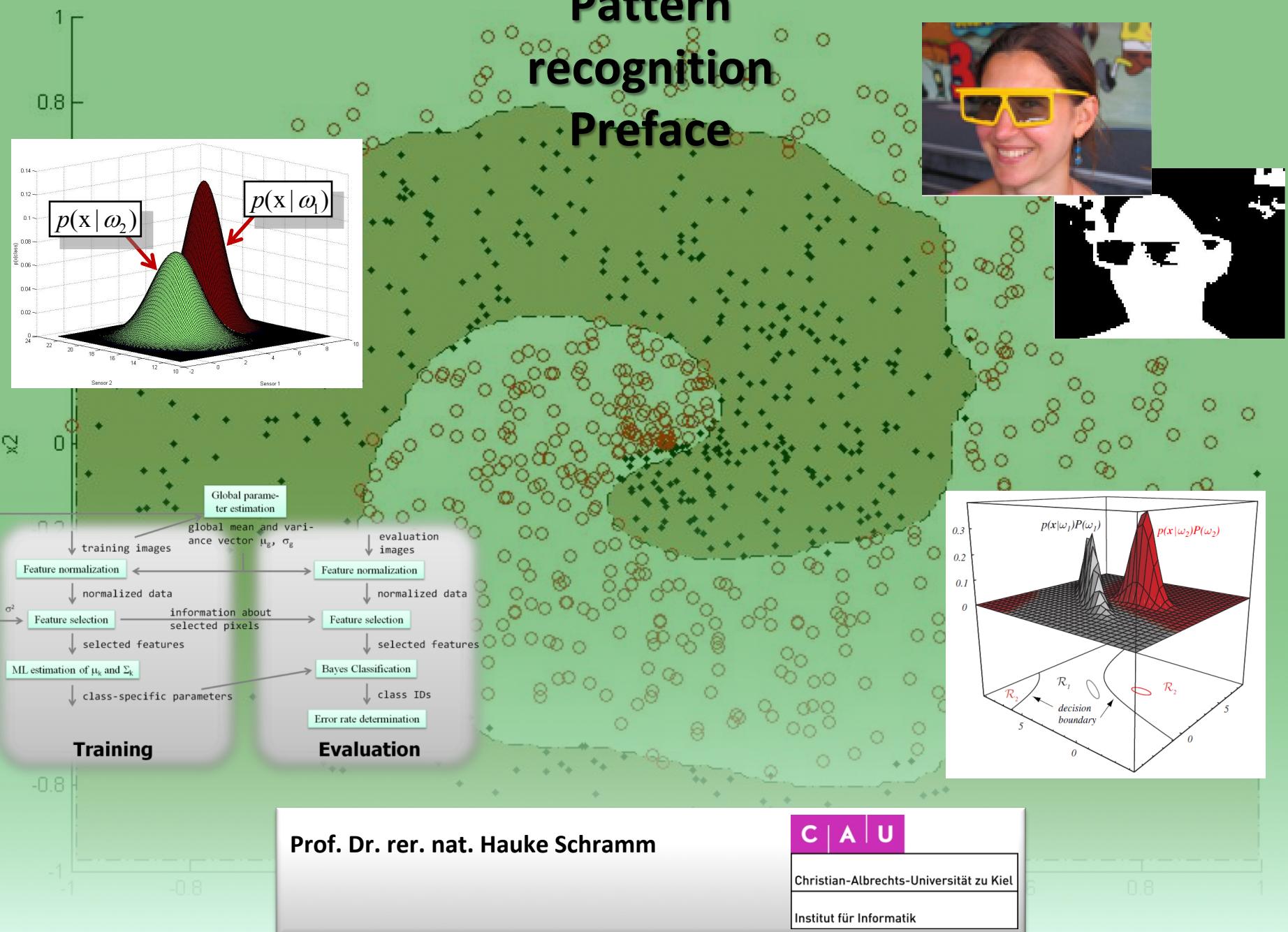


# Pattern recognition

## Preface



**Prof. Dr. rer. nat. Hauke Schramm**

[hsc@informatik.uni-kiel.de](mailto:hsc@informatik.uni-kiel.de)

Office hours: by arrangement

Farmer ..... Apprenticeship

Dipl.-Ing. (Electrical Engineer) ..... Technische Fakultät der CAU Kiel 

PhD in Computer Science ..... RWTH Aachen   
(avocational)

Senior Scientist ..... Philips Research Aachen   
und Projektleiter



## **Group Man-Machine Interfaces: 6 years**

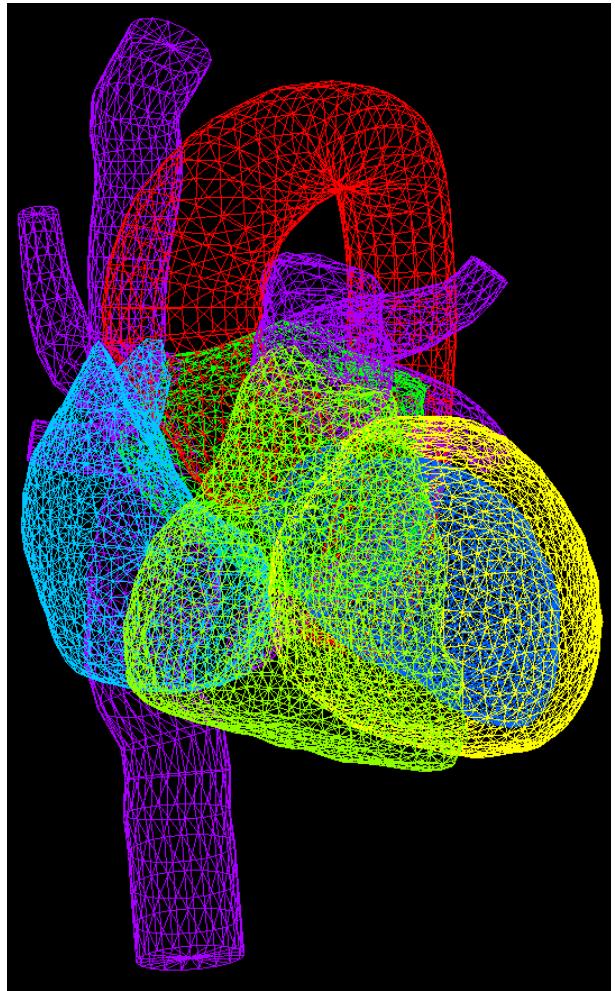
One of the world-wide leading research groups in automatic speech recogn.

- 2 years project "Automatic Inquiry Systems"  
World-wide first prototype for fully automated directory assistance for large city
- 2 years project "Fundamental Research and International Evaluation"  
High performance large vocabulary speech recognizer, „ASR world championship“
- 2 years project "Medical Dictation"

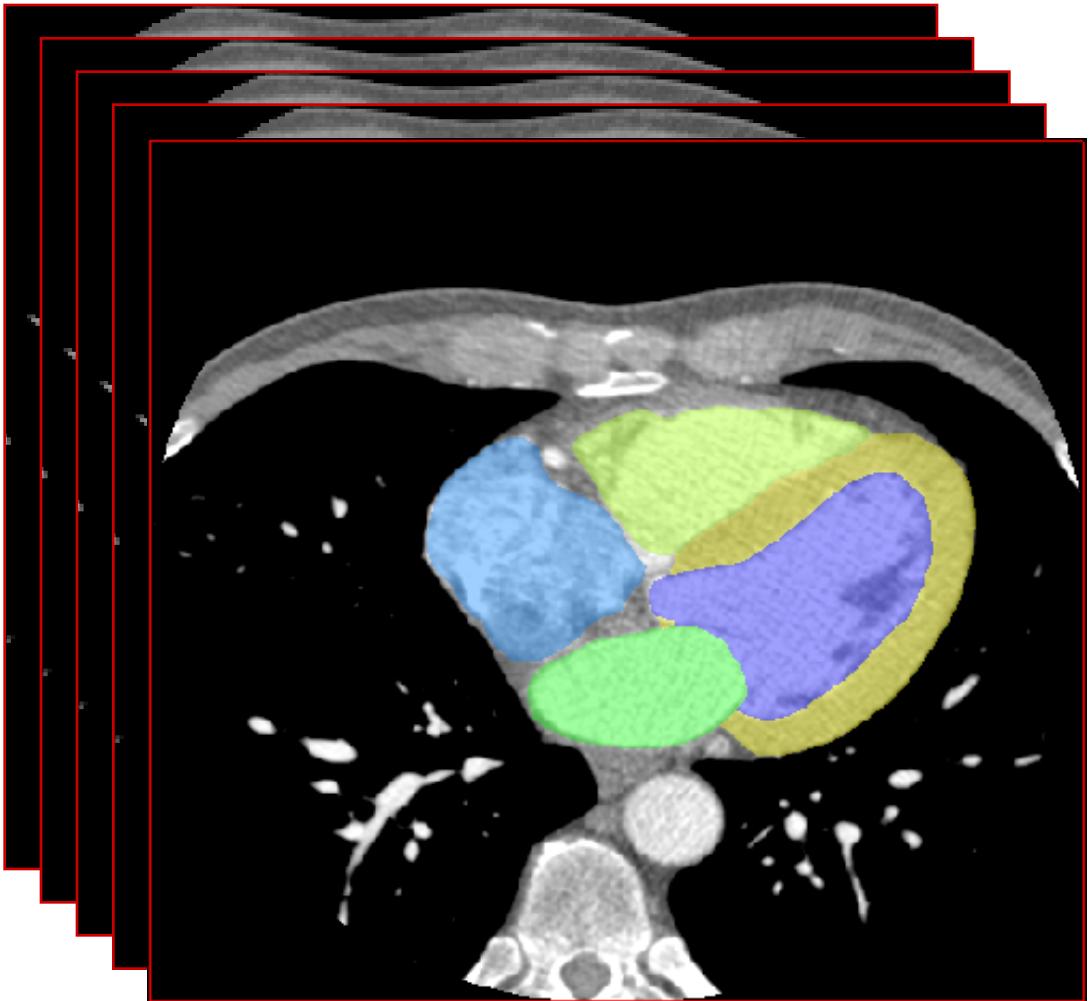
## **Group X-Ray Imaging Systems: 4 years**

Research for X-ray detectors (CT) and medical images processing

- Project leader for 2 projects in the field of automatic image analysis  
World-wide first system for fully automated heart segmentation



Triangulated mesh of human heart



Segmented CT volume data set

**Prof. Dr. rer. nat. Hauke Schramm**

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und Projektleiter

Lecturer & Project leader ..... Fachhochschule Kiel 

- Image and video analysis
- 3D printing

Lecturer and Second Member ..... Institute for Computer  
Science Kiel University

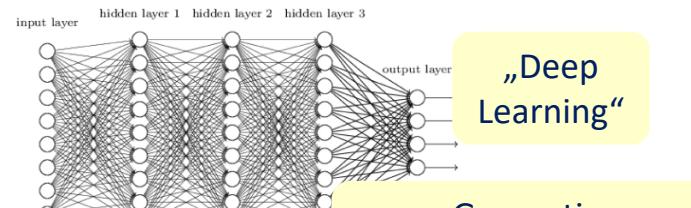
# Research Group Pattern Recognition & Machine Learning

Statistical Learning Techniques

Hidden Markov Models

„Support Vector Machines“

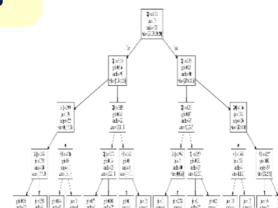
Discriminative  
Generalized Hough Transform



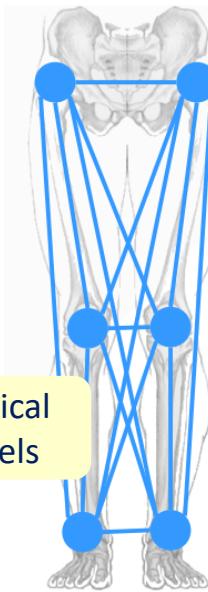
„Deep Learning“

Neural Networks

„Generative Adversarial Networks“



Decision Trees  
„Random Forests“



Graphical Models

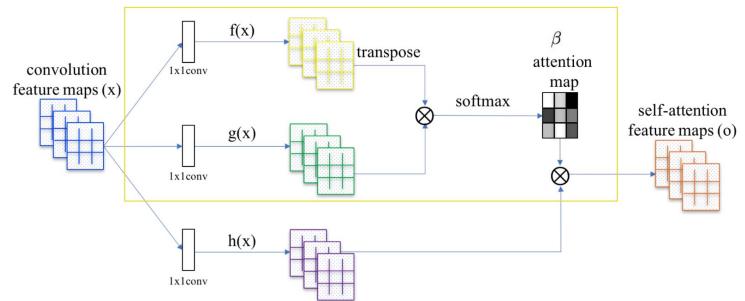
Image Processing

Signal Processing

Speech Processing

- 36 international **papers and journal articles** since 2010
- 2 finished and 3 ongoing **dissertations**
- **Poster Award** (Florida, USA, 2011), **Best Paper Award** (Quebec, Kanada, 2017)
- Latest journal articles
  - **Journal of Electronic Imaging (Sept 2018)**
  - **Journal Computer Vision and Image Understanding (Dez 2018)**
- **Acquired third party funding:** > 2 Mio. €

# Artificial Art



Ongoing Master Project

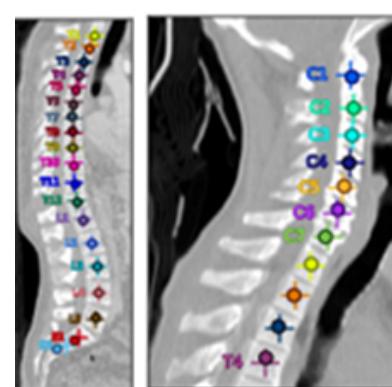
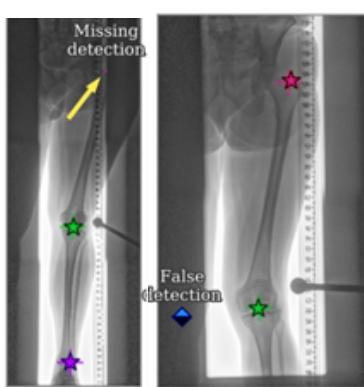
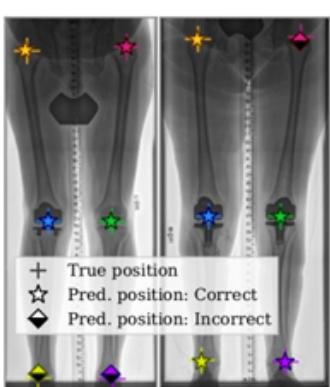
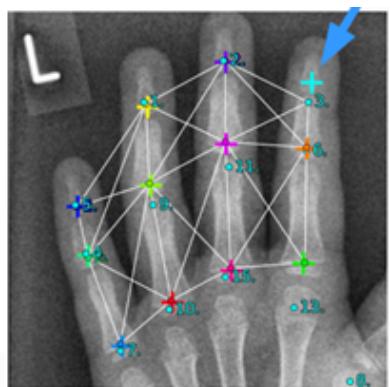
# Medical Image Processing

Graphical Models  
(Conditional Random Fields)

Decision Trees  
„Random Forests“

Neural Networks  
and „Deep Learning“

Learning Techniques,  
Optimization



UNIVERSITÄT ZU LÜBECK

PHILIPS



Christian-Albrechts-Universität zu Kiel

GRAIL, Quebec, Canada, 2017. **Best Paper Award**

A. Mader, H. Schramm, C. Meyer, „Detection and Localization of Landmarks in the Lower Extremities Using an Automatically Learned Conditional Random Field“,

**Journal Computer Vision and Image Understanding**, Volumes 176–177, Pages 45-53, November–December 2018.

A. O. Mader, C. Lorenz, M. Bergtholdt, J. von Berg, H. Schramm, J. Modersitzky, C. Meyer,

“Detection and localization of spatially correlated point landmarks in medical images using an automatically learned conditional random field”,

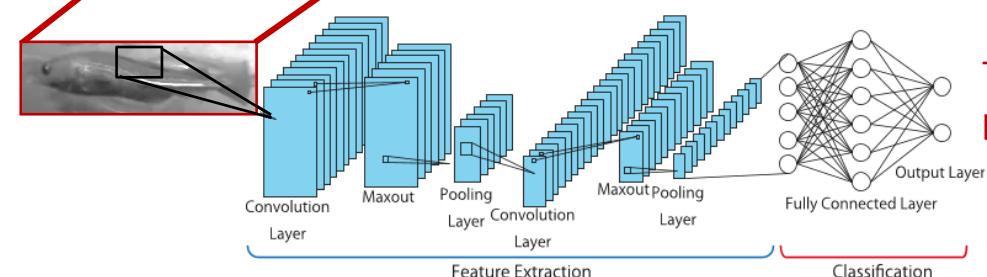
Ongoing Thesis

# Fish Detection and Classification in Combined Video/Sonar Data



Neuronal Networks  
and „Deep Learning“

Tracking  
Techniques



Trachurus trachurus  
background

Ongoing Thesis

# Working Group 3D Printing

## Carving Starch

- Novel 3D printing method developed
- Completely based on **edible** materials:
  - potato starch, vegetable oil and edible ink
- Highly machineable (very similar to wood)



Carving sculptures



[www.carving-colors.com](http://www.carving-colors.com)



Anatomical models

## Arbeitsgruppe 3D-Druck

### Sculpting by Colors

- Novel 3D printing method developed
- Completely based on **edible** materials:  
→ potato starch, vegetable oil and edible ink
- Highly machineable (similar to wood)



[www.carving-colors.com](http://www.carving-colors.com)

## Organization

### Lecture

- Wednesday, 8:30 – 10:00
- Room: Lecture room 1, CAP3
- From 23.10.2019 - 05.02.2020

- 2 h per week: concepts / theory
- Mostly beamer presentation / whiteboard

### Laboratory

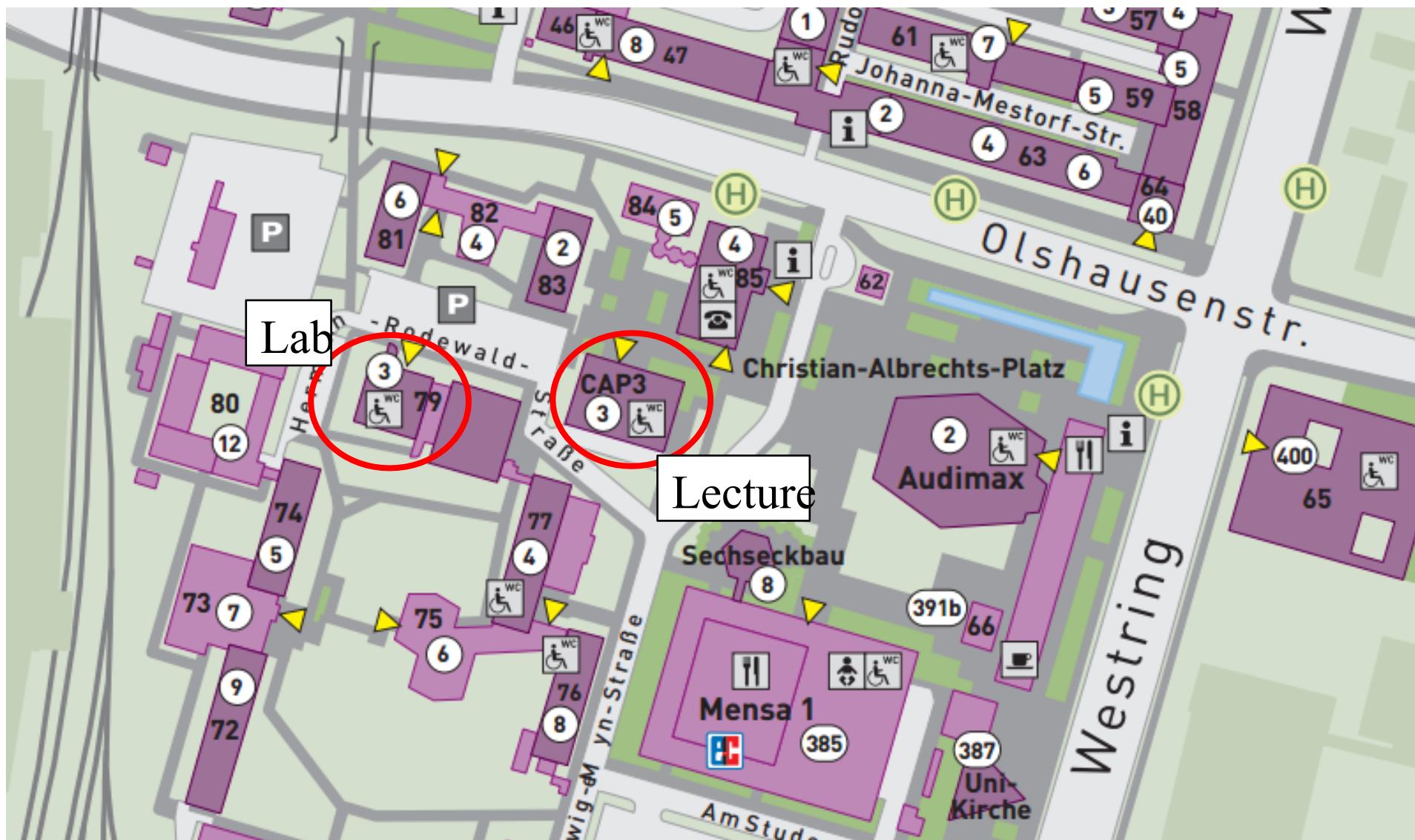


- Required: Gnu Octave (freeware)  
--> [www.gnu.org/software/octave/](http://www.gnu.org/software/octave/)
- From 06.11.2019 - 22.01.2020

- 2 h per week ( + further self-study)
- Theoretical exercises
- Practical exercises to illustrate theory

**Time**        Wednesday, 10:15 – 11:45

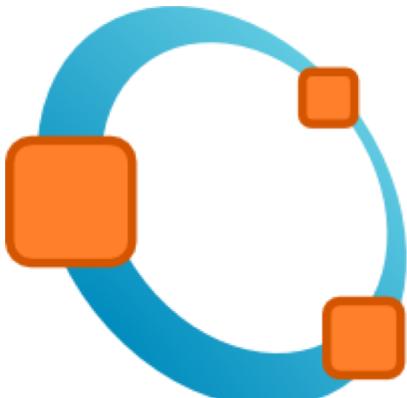
**Room**        HRS3 - R.105b, HRS3 - R.105a



## GNU Octave

### "Homework" for first lab in two weeks:

- Install **Cygwin** and **Octave** on your laptop (if you have one)
- If you are not familiar with Octave: work through tutorial [www-mdp.eng.cam.ac.uk/web/CD/engapps/octave/octavetut.pdf](http://www-mdp.eng.cam.ac.uk/web/CD/engapps/octave/octavetut.pdf) up to page 39.
- Form teams of up to 3 students and inform me via email



GNU Octave is a high-level interpreted language, primarily intended for numerical computations. It provides capabilities for the numerical solution of linear and nonlinear problems, and for performing other numerical experiments. It also provides extensive graphics capabilities for data visualization and manipulation. Octave is normally used through its interactive command line interface, but it can also be used to write non-interactive programs. The Octave language is quite similar to Matlab so that most programs are easily portable.

Source: <http://www.gnu.org/software/octave/>

## Getting Octave

[www.gnu.org/software/octave/download.html](http://www.gnu.org/software/octave/download.html)

GNU Octave

About    Donate    Download    Get Involved    News    Support/Help    Docs

## Download

Source    GNU/Linux    macOS    BSD    **Windows**

**Note:** All installers below bundle several **Octave Forge packages** so they don't have to be installed separately. After installation type `pkg list` to list them. [Read more.](#)

- Windows-64 (recommended)
  - [octave-5.1.0-w64-installer.exe \(~ 286 MB\) \[signature\]](#)
  - [octave-5.1.0-w64.7z \(~ 279 MB\) \[signature\]](#)
  - [octave-5.1.0-w64.zip \(~ 490 MB\) \[signature\]](#)

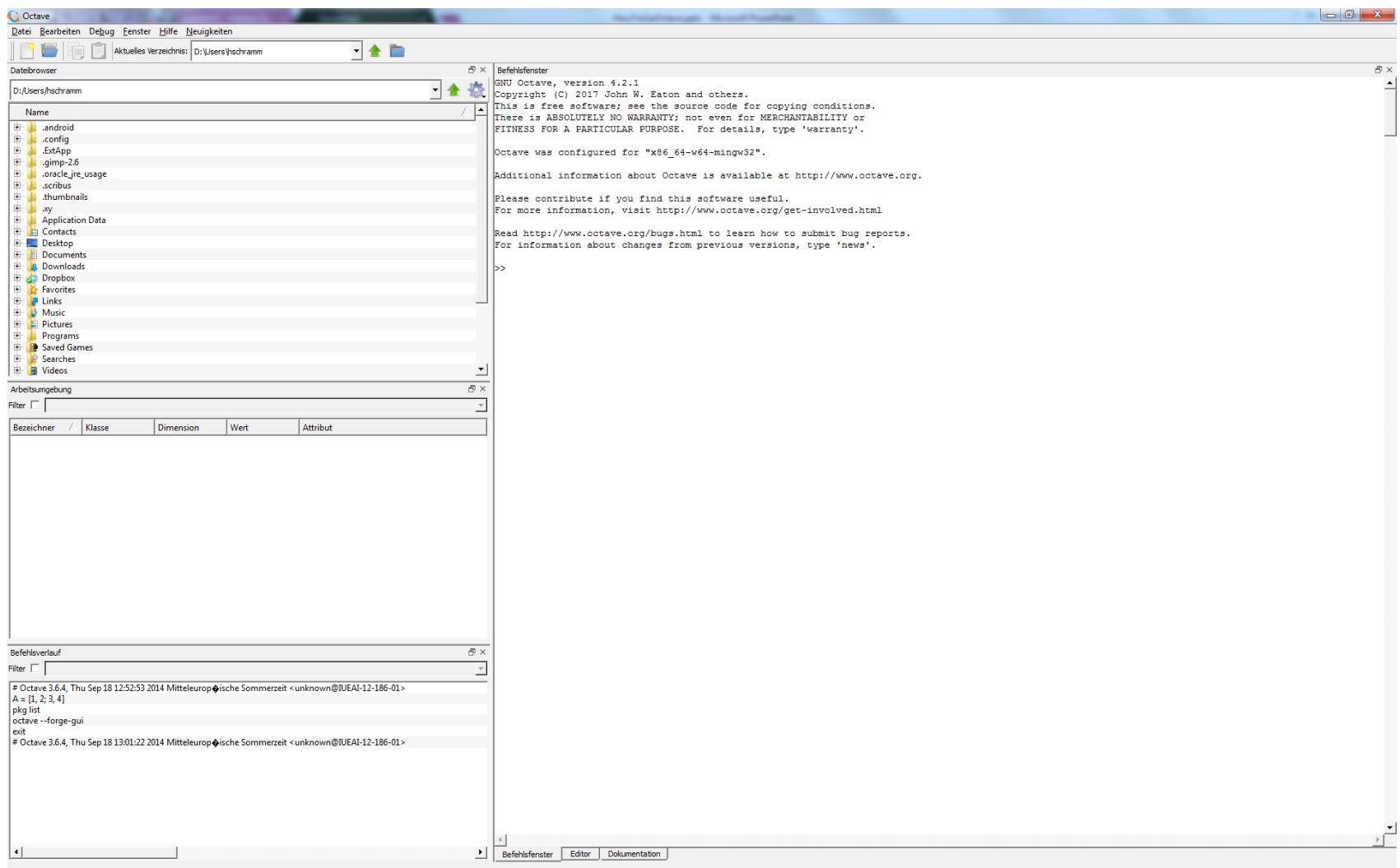


## Working with Octave:

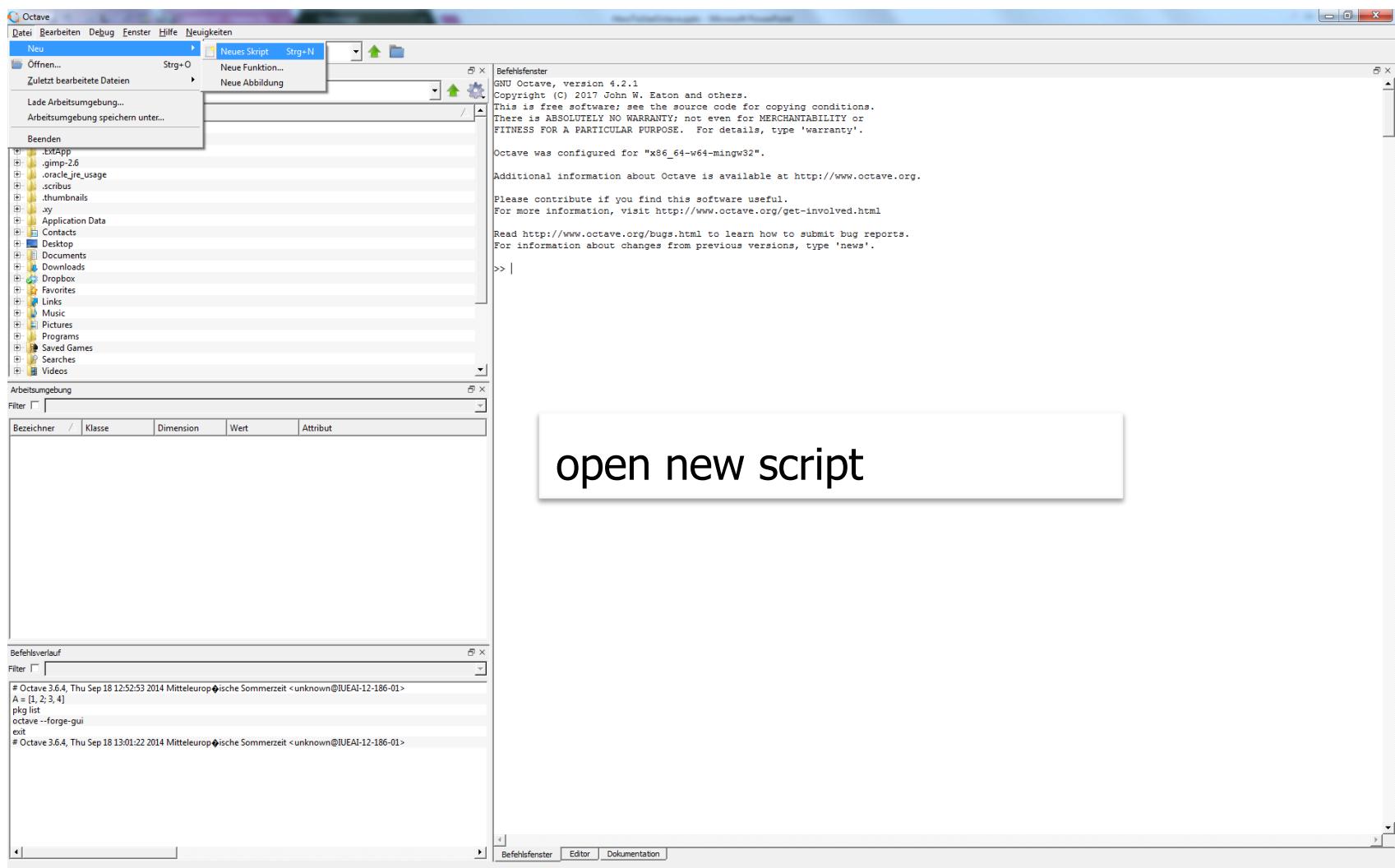
On unix machines (lab):

- start terminal
- type: "octave --force-gui"
- will start the GUI of Octave

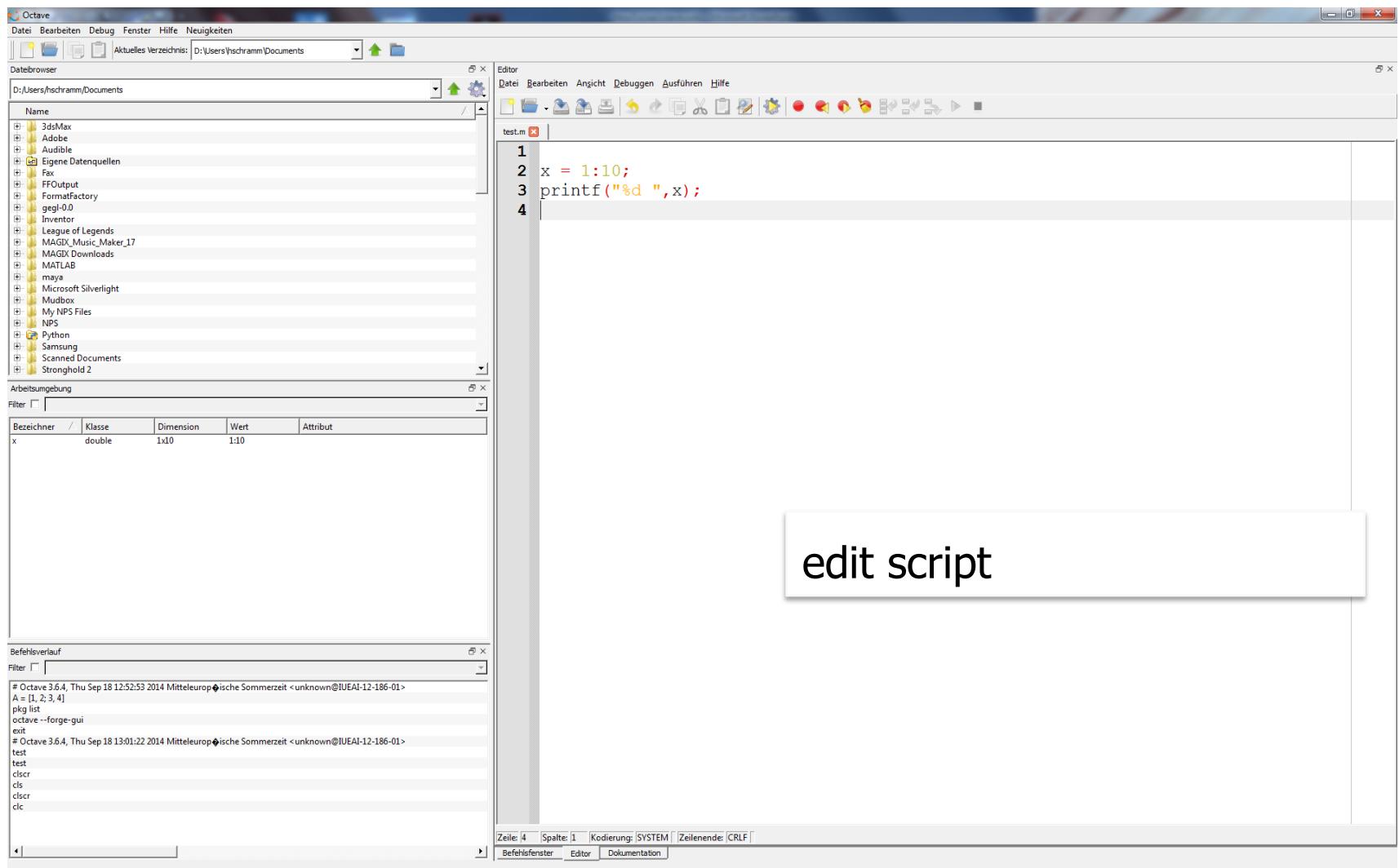
## Working with Octave:



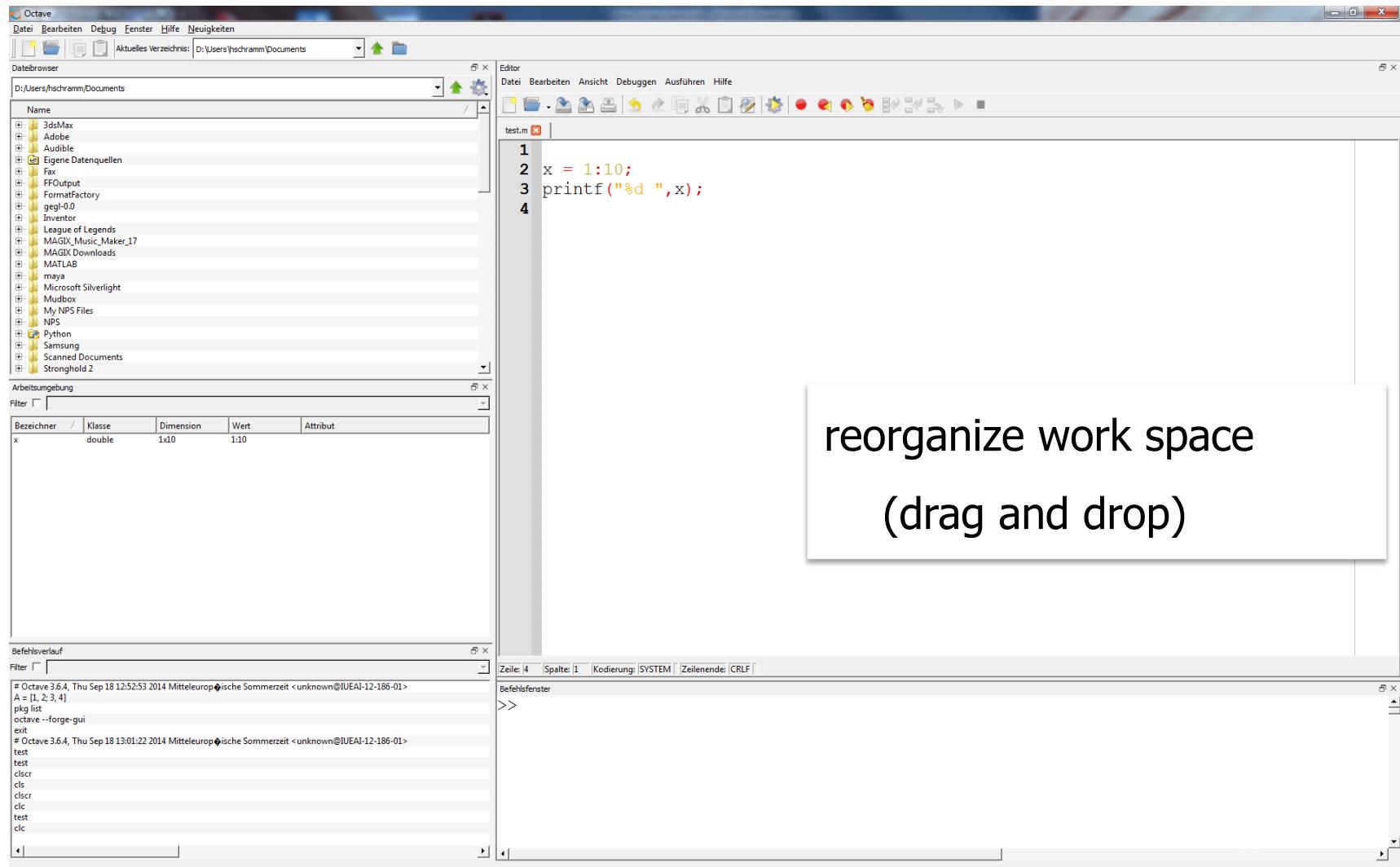
## Working with Octave:



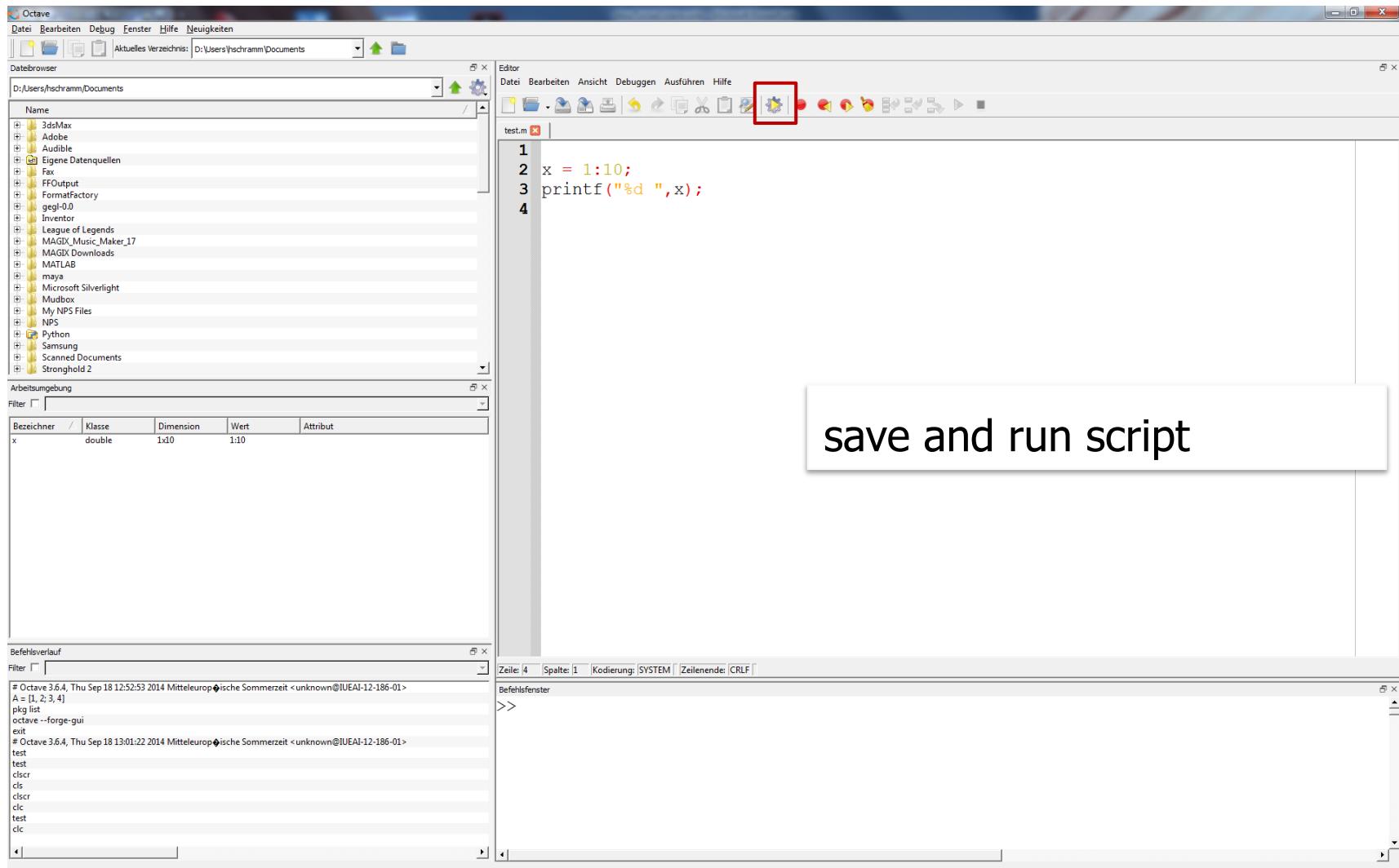
## Working with Octave:



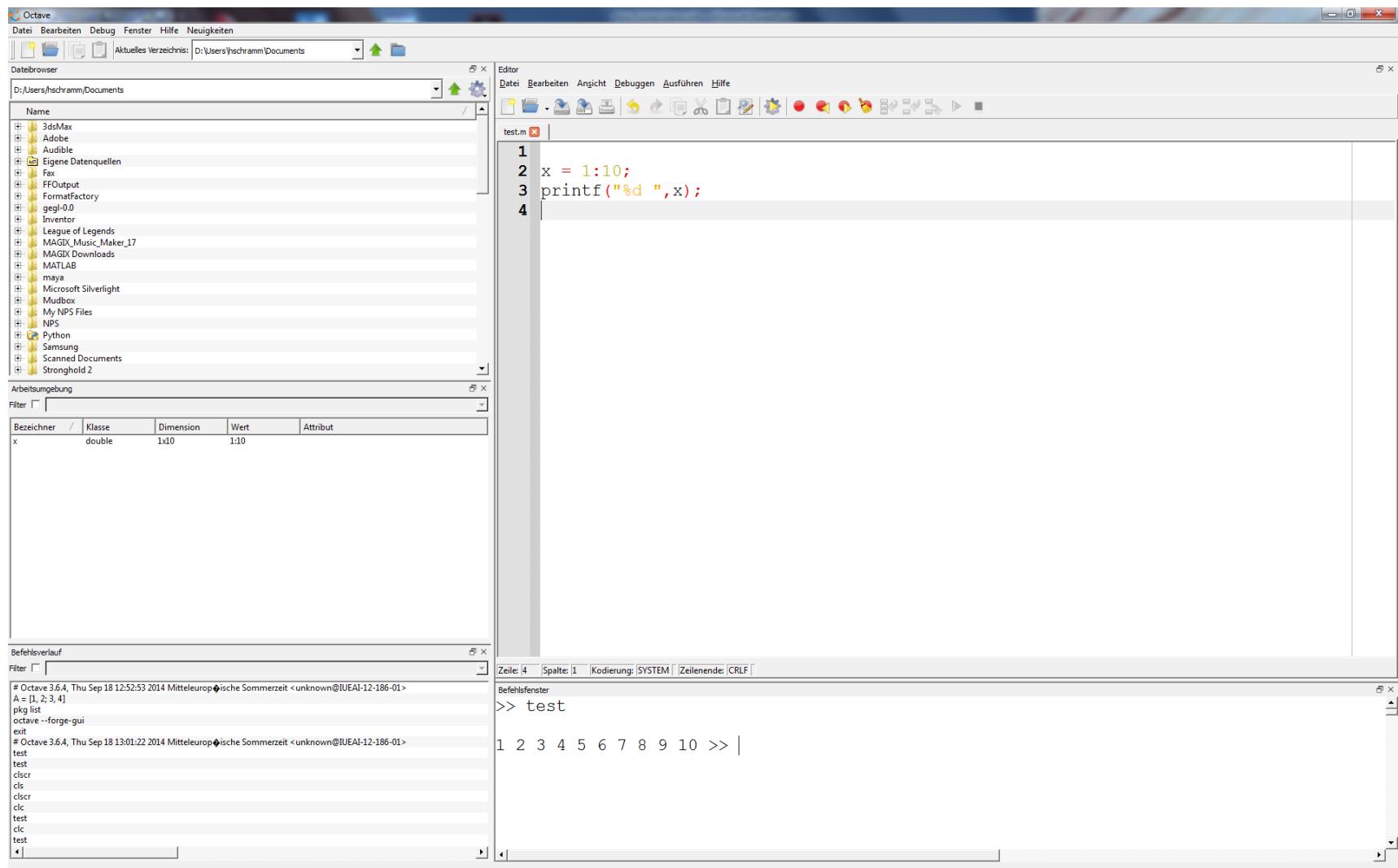
## Working with Octave:



## Working with Octave:



## Working with Octave:

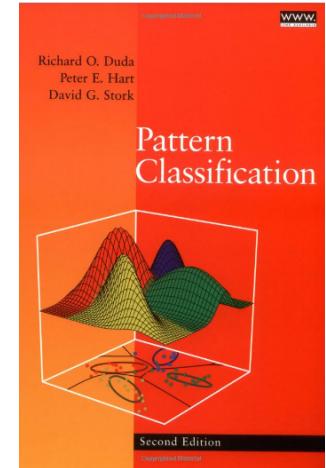


## Literature

1. Richard O. Duda, Peter E. Hart, David G. Stork:

Pattern classification. Wiley, New York 2001, ISBN 0471056693

**Recommendation:** Appendix A "Mathematical Foundations"



2. K. Fukunaga: Statistical Pattern Recognition. Academic Press, New York 1991.

ISBN 0122698517

3. T. Hastie, R. Tibshirani, and J. Friedman: The Elements of Statistical Learning - Springer Series in Statistics - Springer Science 2001

## **Topics of the lecture**

### Introduction

#### 1. Fundamentals of probability theory

Probability distribution, expectation, covariance matrix, marginal, multivariate Gaussian, ...

#### 2. Bayesian decision theory

Bayes theorem, prior-/a-priori-/a-posteriori-probabilities, Bayes risk, decision boundaries, ...

#### 3. Parameter estimation

Maximum-likelihood, Bayes learning, Distances in  $\mathbb{R}^D$

#### 4. Non-parametric techniques

Density estimation, Parzen windows, nearest neighbor classification

 Pattern Recognition 2018
 Information Page
 Material Folder
►  Laboratory Exercises

Neu konfigurieren

Information zur Vorschau dieses Kursbausteines	
Kurzer Titel	
Langer Titel	
Typ Teilnehmer	Registrierte OLAT-Benutzer
Sichtbarkeitsregel	
Zeitpunkt der Vorschau	24.10.18 16:18
Gruppen	
Lernbereiche	

## Pattern Recognition 2018

▼ Beschreibung ausblenden

The field of Pattern Recognition deals with the problem of classifying complex data into pre-specified categories to enable automatic decisions. Most state-of-the-art classification frameworks utilize large amounts of data to develop robust statistical representations of the considered patterns and enhance class discrimination by sophisticated learning algorithms. This course explains the theoretical and practical aspects of fundamental pattern recognition techniques and enables the independent development and enhancement of classification systems

Content:

1. Basics of probability calculus  
Random variables, marginal distribution, conditional probability, Bayes rule, multivariate normal density, ...
2. Bayesian decision theory  
Discriminant functions, Bayes theorem, Bayes risk, decision boundaries
3. Maximum-likelihood parameter estimation  
Theory and practical applications
4. Non-parametric techniques

Ausblenden

### Information Page

In this message board, you will find latest information about the course, like time and place of the exam or lecture cancellation due to illness.

### Material Folder

In this folder you may find course material like lecture slides, exercise sheets, additional reading etc.

 parzenWindow\_demo.m

Alle Dokumente >

**Password: patws19\_hs**

**Registration must be done before 14.11.19**