Universität Rostock
Traditio et Innovatio

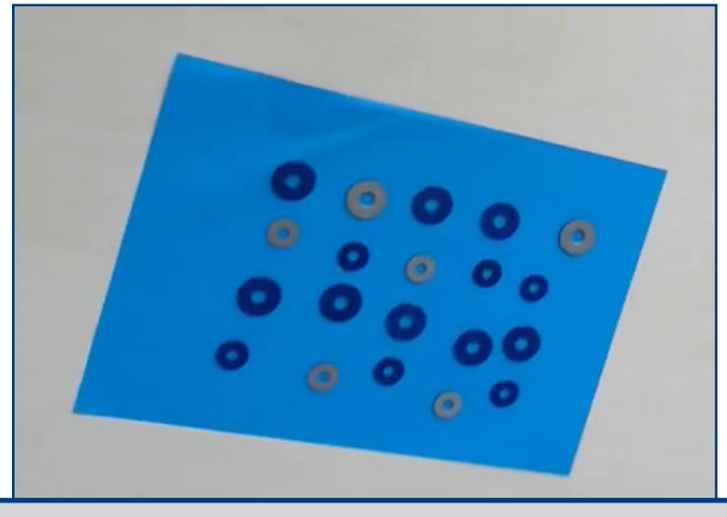
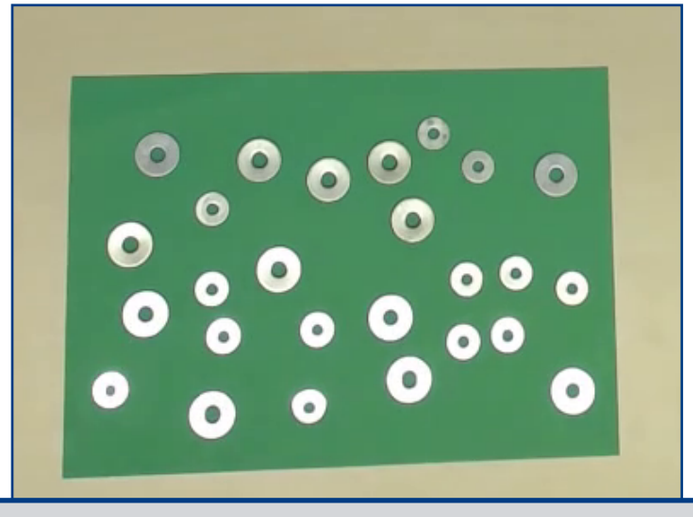
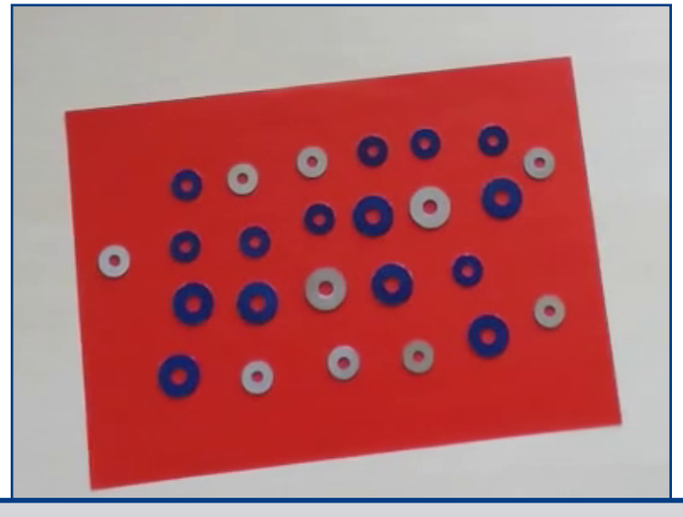
visual & analytic computing

Summer term 2020 – Topics for
NEIDI (MSc),
Project (BSc) &
KSWS (BSc)

Sebastian Bader
Mobile Multimedia Information Systems

How many shims are blue / silver?

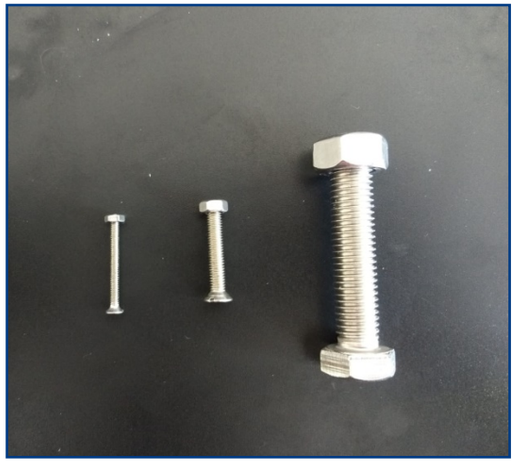
- Recommended Requirements:
  - experience with image / video processing
- Tasks:
  - realise a camera setup and analysis system which recognises the number and state (blue / silver) of multiple shims
  - realtime capable – analysing video streams
  - robust – must work under various background / lighting conditions

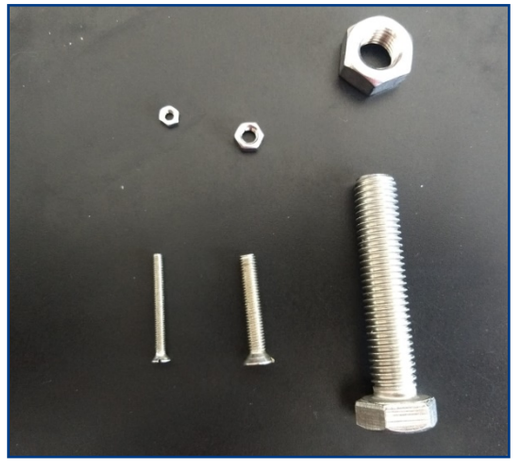




Contact: sebastian.bader@uni-rostock.de

Detection of Screws with and without bolt

- Recommended Requirements:
  - experience with image / video processing
- Tasks:
  - realise a camera setup and analysis system which recognises the number of screws with and without bolt
  - realtime capable – analysing video streams
  - robust – must work under various background / lighting conditions





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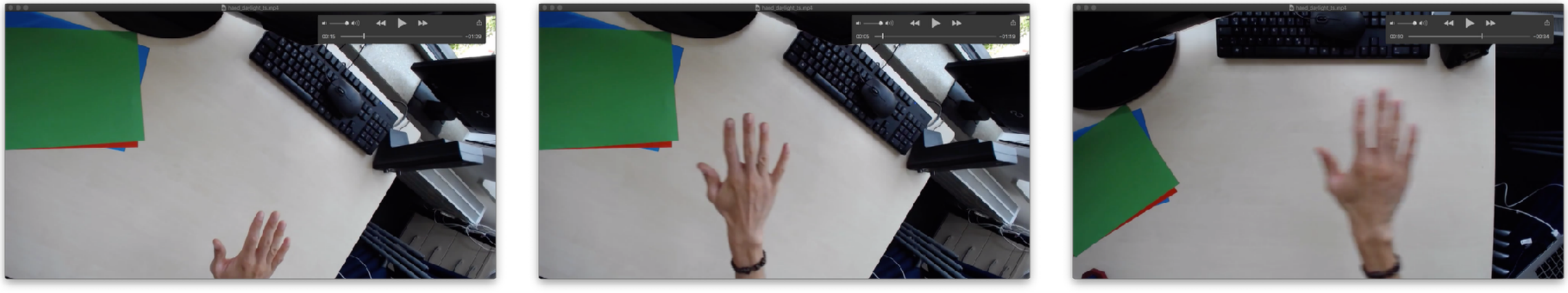
Where are my hands 2.0?

- Recommended Requirements:
  - experience with image / video processing
- Tasks:
  - based on an existing colour-based segmentation, the correct positions of hands shall be detected:
    - multiple hands should be recognised, number, position, number of fingers, …
    - realtime capable – analysing video streams
    - robust – must work under various background / lighting conditions



Contact: sebastian.bader@uni-rostock.de

Gesture Recognition

- Recommended Requirements:
  - experience with image / video processing using convolutional neural networks
- Tasks:
  - Recognition of hand gestures within a video sequence (based on region of interest, color based segmentation, model of a hands)
  - Realise a camera setup
  - Record a training and validation dataset
  - Detecting different gestures occurring in neuro-rehabilitation exercises

Contact: sebastian.bader@uni-rostock.de

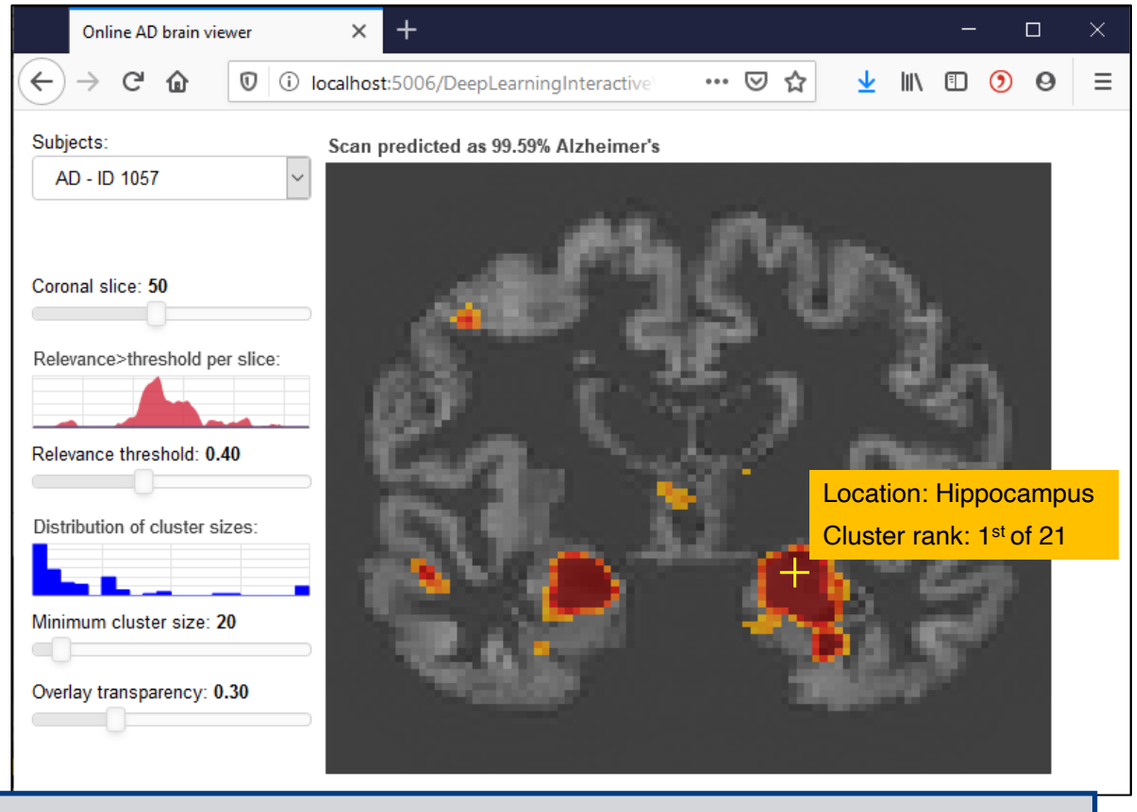
Finger Tapping

- Recommended Requirements:
  - experience with either:
    A. microcontrollers (Arduino / Raspberry Pi), or
    B. 3D-cameras
- Tasks:
  - detection of finger tapping & count the number of tappings per finger
  - realisation, either
    A. a pressure sensor for each finger, or
    B. 3d-camera (leap motion)

Contact: sebastian.bader@uni-rostock.de

Generating textual explanations for heat maps

- Recommended requirements:
  - Experiences in Python and/or image processing
- Tasks:
  - Generate explanations for the output of a given neural network model, capable of detecting Alzheimer's disease in MRI scans
  - Additional information shall be provided for highlighted image areas, e.g. anatomical region
  - Textual descriptions shall be generated and displayed (e.g. as tooltip)
  - Optimization of interactive visualization and exploration of the heatmaps
  - Online capability?
    Can this information be calculated on demand?

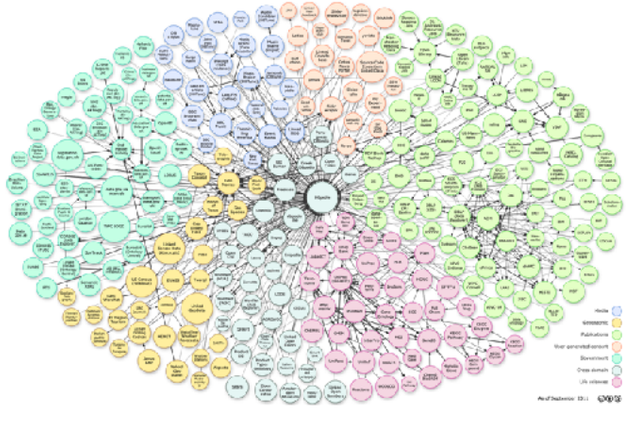


Contact: martin.dyrba@uni-rostock.de

Semantic, Graph-based Representation of Data for Life Science

- Recommended requirements:
  - Experience with handling larger amounts of data
  - Experience with graph based algorithms and databases
- Task:
  - perform an review of the state-of-the-art on graph-based and semantic approaches for life science
  - transform part of an database on mutations into a graph-based database and to investigate benefits and drawbacks of such a solution compared to standards SQL-based representations
    (e.g. automatic consistency checks;
    queries for cohort stratification / study enrolment).

CENTOGENE
THE RARE DISEASE COMPANY



Contact: kristina.yordanova@uni-rostock.de

Discovery in Low-data Environments

- Recommended requirements:
  - Experience with machine learning and data sparcity
- Task:
  - In life science and in rare diseases in particular, very often only limited data is available – limited in amount, or feature rich data, with many irrelevant features
  - Machine learning has come up with various methods that still perform well in these low-data environments (transfer learning, one-shot learning, …).
  - Goal of this project is to
    - perform a review of the-state-of-the-art on methods for discovery in low-data environments, with a focus on life sciences;
    - to build a prototype for data provided by Centogene (either genomic or metabolomic).

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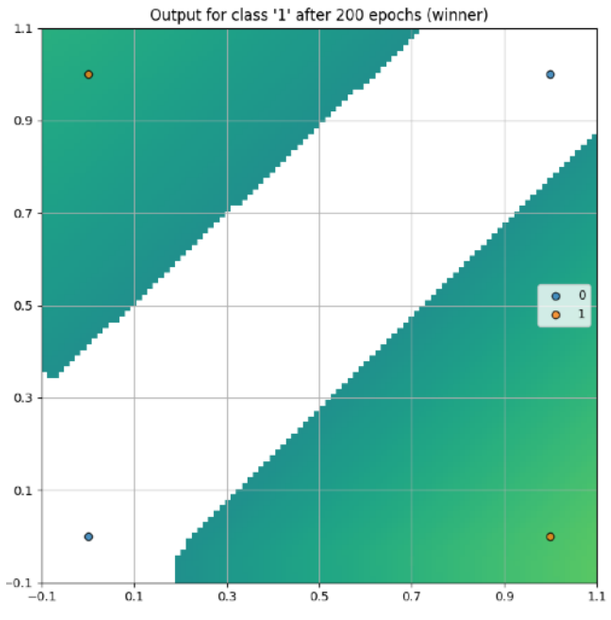
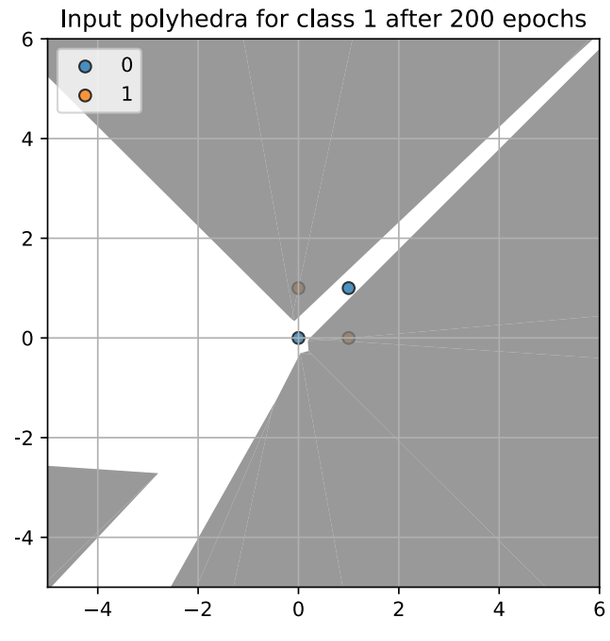
Rule-Extraction from Neural Networks

- Recommended requirements:
  - Experience with training neural networks using Keras

- Task:
  - current validation / self-explanation approaches for neural networks are usually based on visualisations of the input-output-behaviour
  - this might be misleading as exemplified in the figure
  - rule-extraction methods shall be investigated and compared
  - a suitable test-bed shall be defined and existing algorithms be evaluated





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