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

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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

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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

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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)

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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?

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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).

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Discovery in Low-data Environments

• **Recommended requirements:**
  – Experience with machine learning and data sparsity

• **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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