Bachelor Thesis
@
Neural Engineering

Bachelor Thesis

Prerequisites Bachelor Thesis

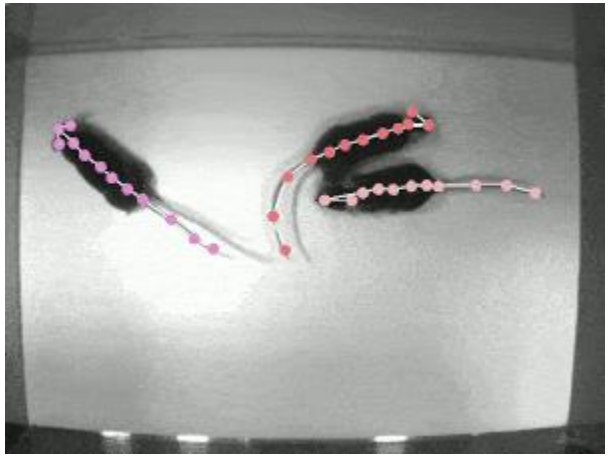
- ✓ 2 dates/per year to register: SS March/ WS October
- ✓ Duration max. 6 months
- ✓ Lectures (Curriculum):
  - ✓ Modul A: Medizin und Naturwissenschaften (A1-A3)
  - ✓ Modul B: Mathematik (B1, B2)
  - ✓ Modul C (C1: Grundlagen der Elektrotechnik)
  - ✓ Modul E: Computer Science (E1-E3)
  - ✓ Modul F: Biomedical Engineering (F1, F2)
  - ✓ Modul G2: Verfassen wissenschaftlicher Arbeiten
  - ✓ Signalverarbeitung

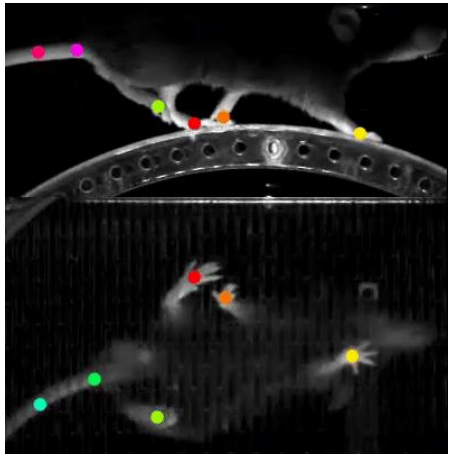
- ✓ Register to students.bci@mlist.tugraz.at
- ✓ Science Club: Tuesday 10:15 s.t. via webex
- ✓ 2 times a presentation (begin, end)

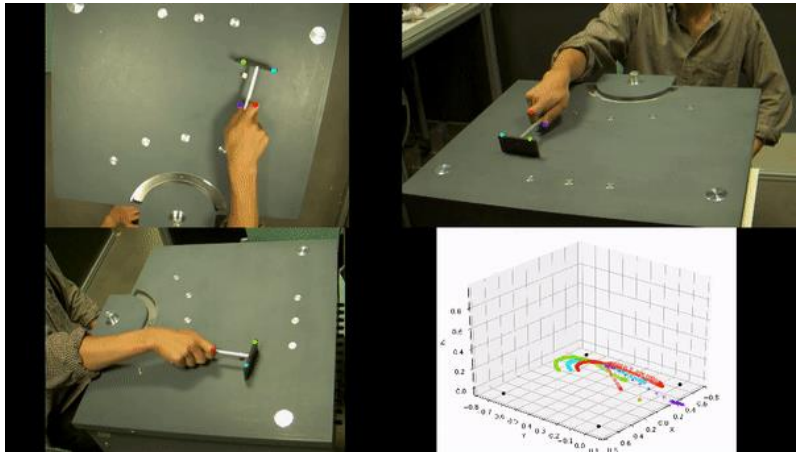
- ✓ kkostoglou@tugraz.at
- ✓ Kerstin.lenk@tugraz.at
- ✓ S.wriessnegger@tugraz.at
- ✓ Gernot.Mueller@tugraz.at

- ✓ Send email until Sunday (9.10.2022) night!

GRMP1: DeepLabCut - Software

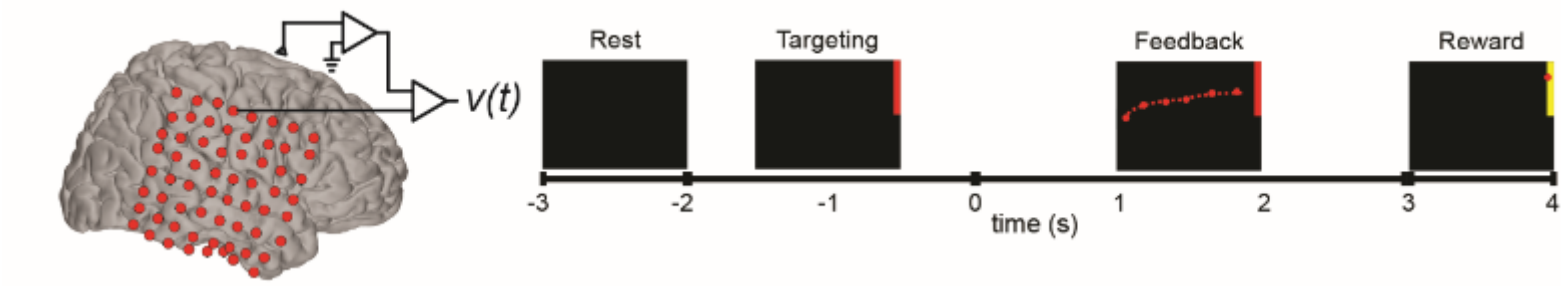






Research it, install it!
Suitable for humans in EEG research?
Setup of an EEG-experiment including movement task.
Perform experiment
Analyse Data with EEG toolboxes and DeepLabCut

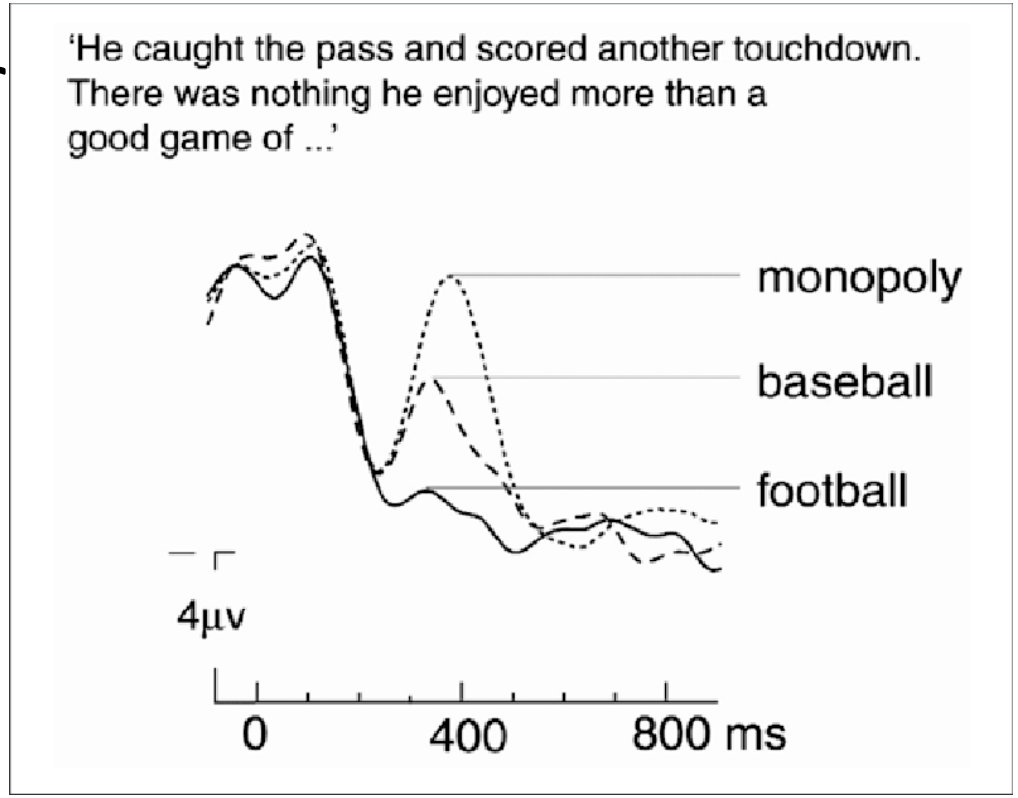
GRMP2: Analysis of ECoG Data



Look at data, separate into classes
Analyze for each class:
- Trials average (-2.0 – +4.5 [s])
- Spectra for some time points
- ERD-maps from 1-200 Hz

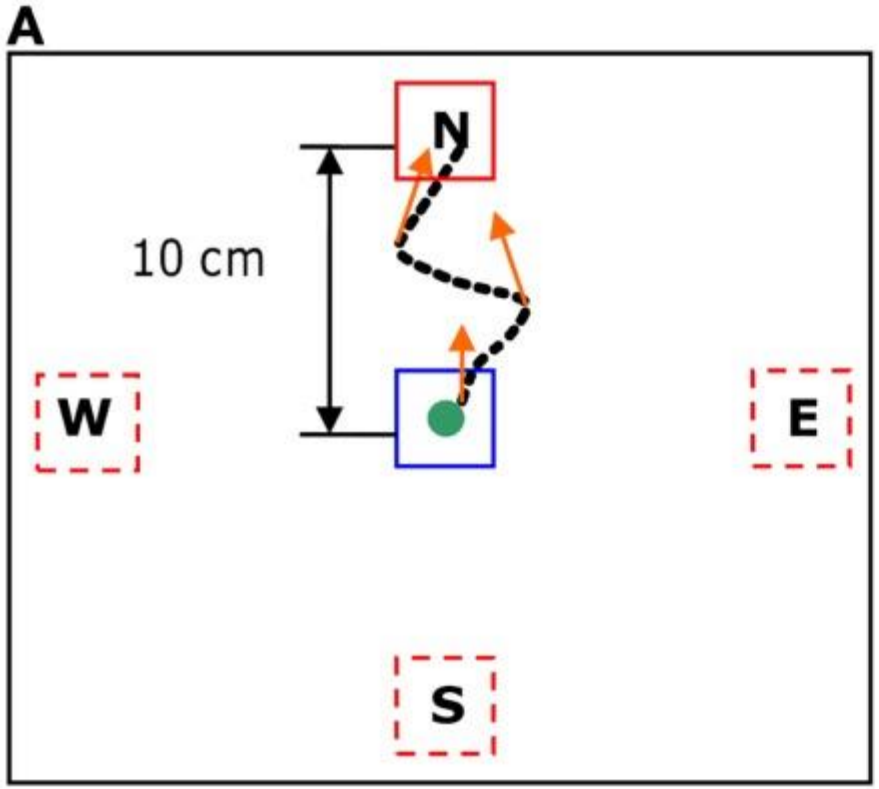
Find features for separation/classification
Try classification with best features

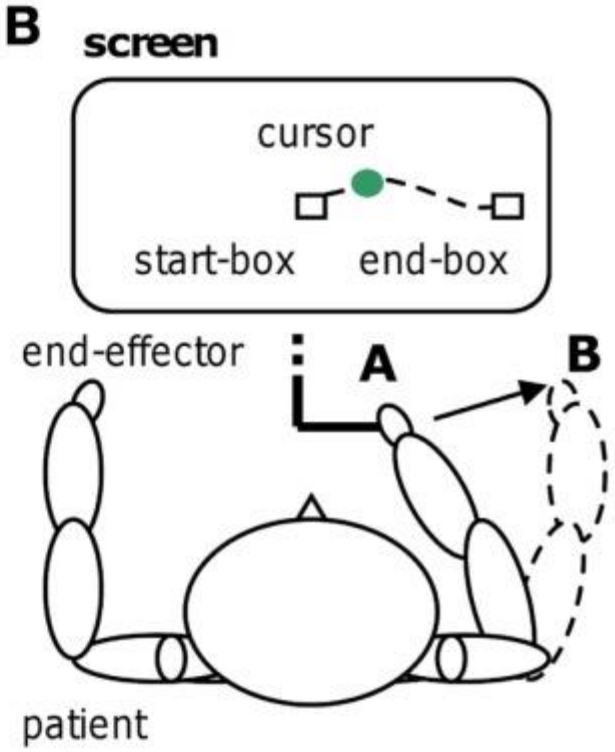
GRMP3: Semantic Networ



- Understand the concept
- Design two networks: semantic / non-semantic
- Design an experiment to test, whether the networks show an N400-effect
- Test the networks in detail on nN400

GRMP4: Movement Decoding: Center-out task

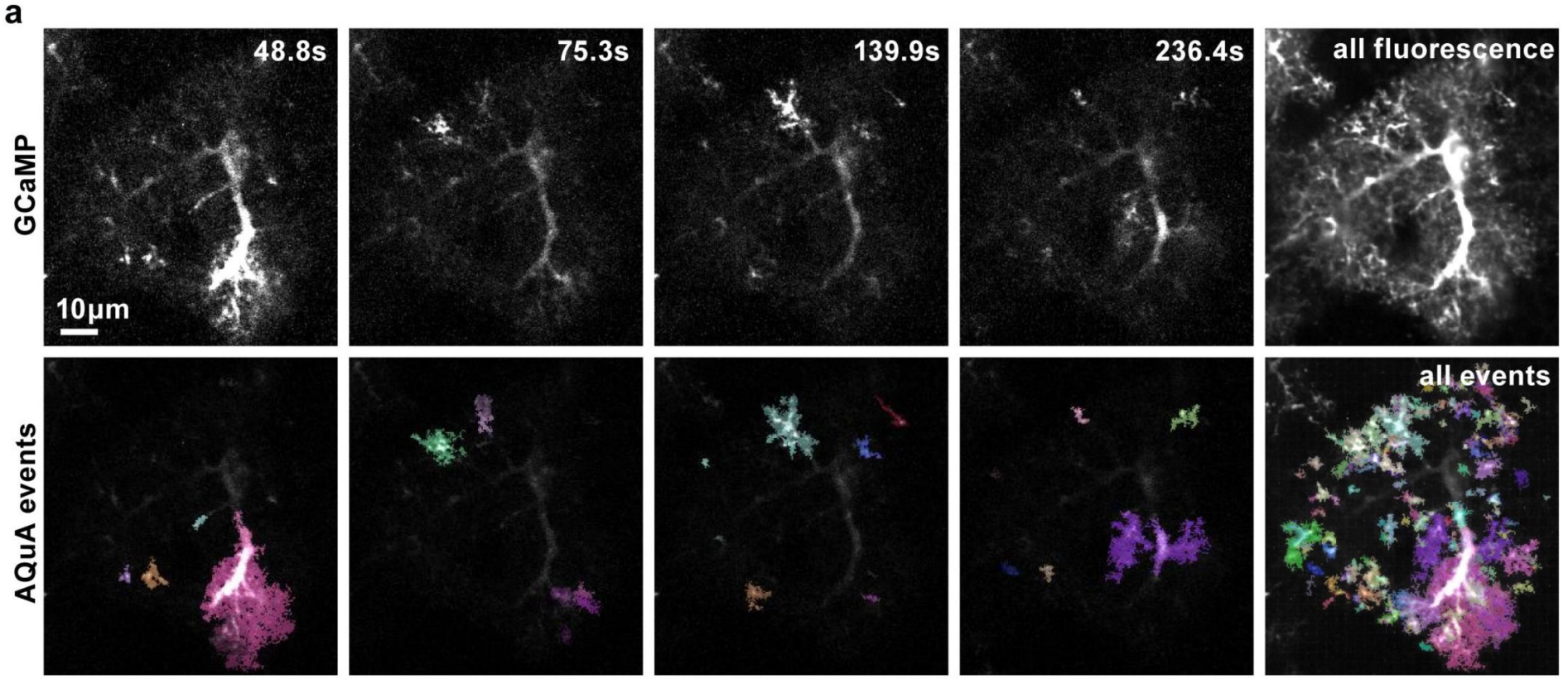




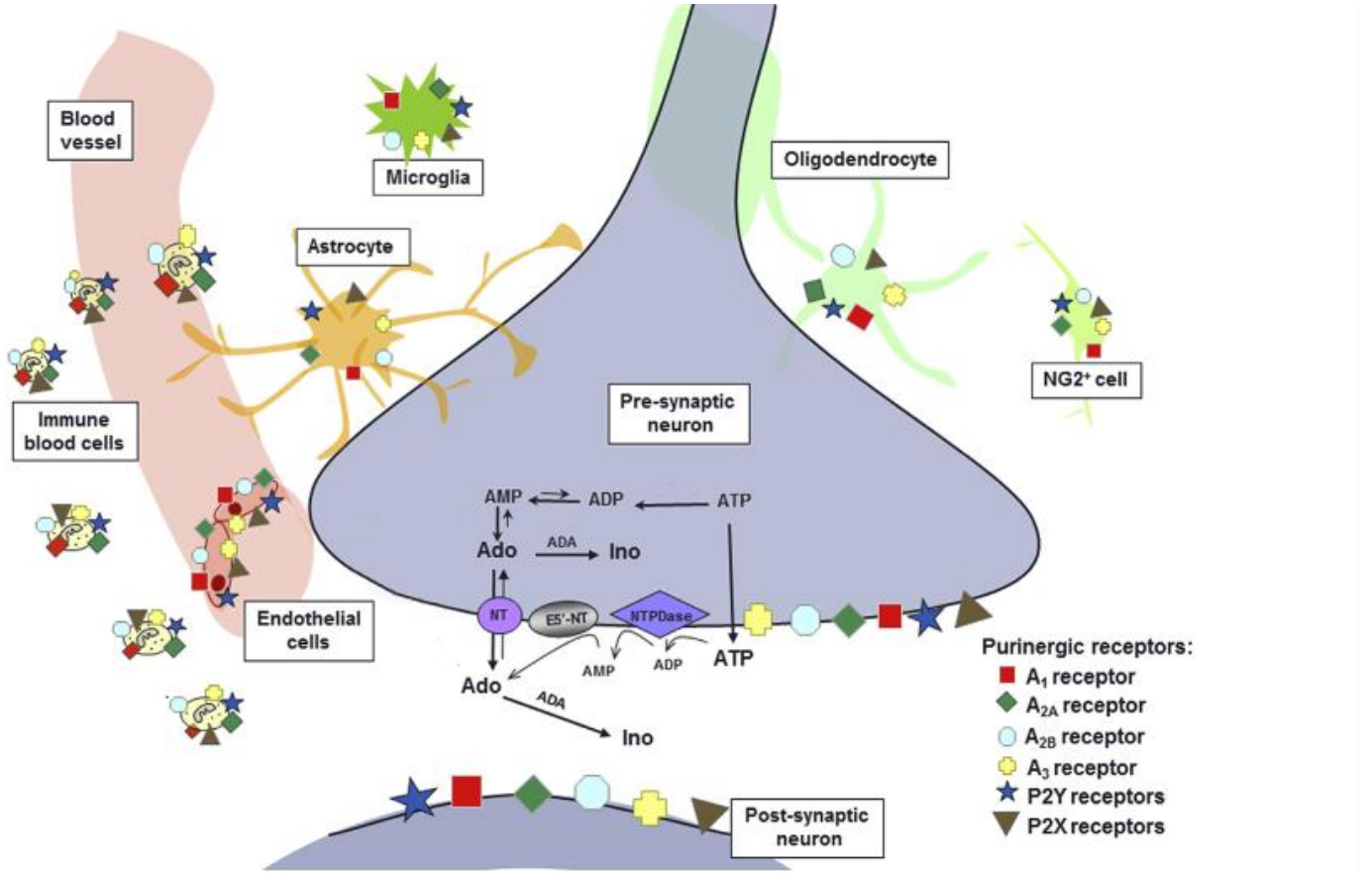
- Build a setup including tracking system
- Design a paradigm
- Perform a study
- Anaylze EEG signals

Lenk – Topic 1: Calcium event decoding

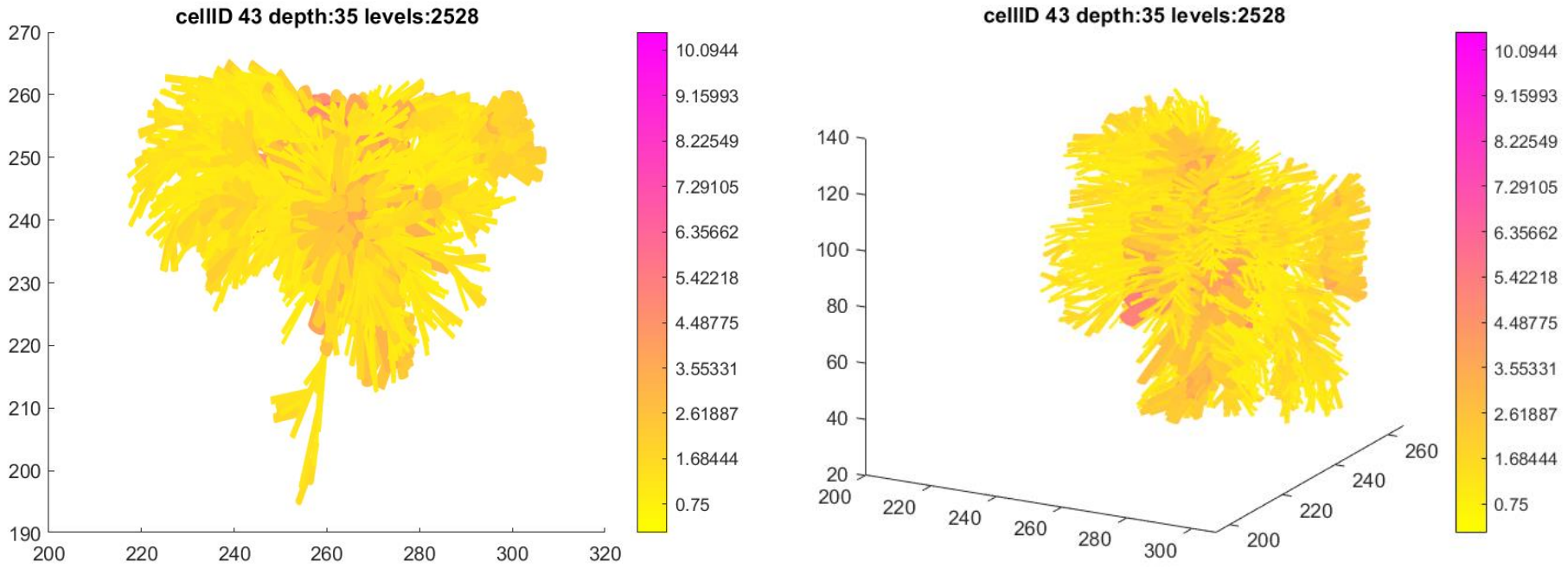
Focus: inter-lab comparability, different spatial scales



Lenk – Topic 2: Adenosine receptor at the postsynapse



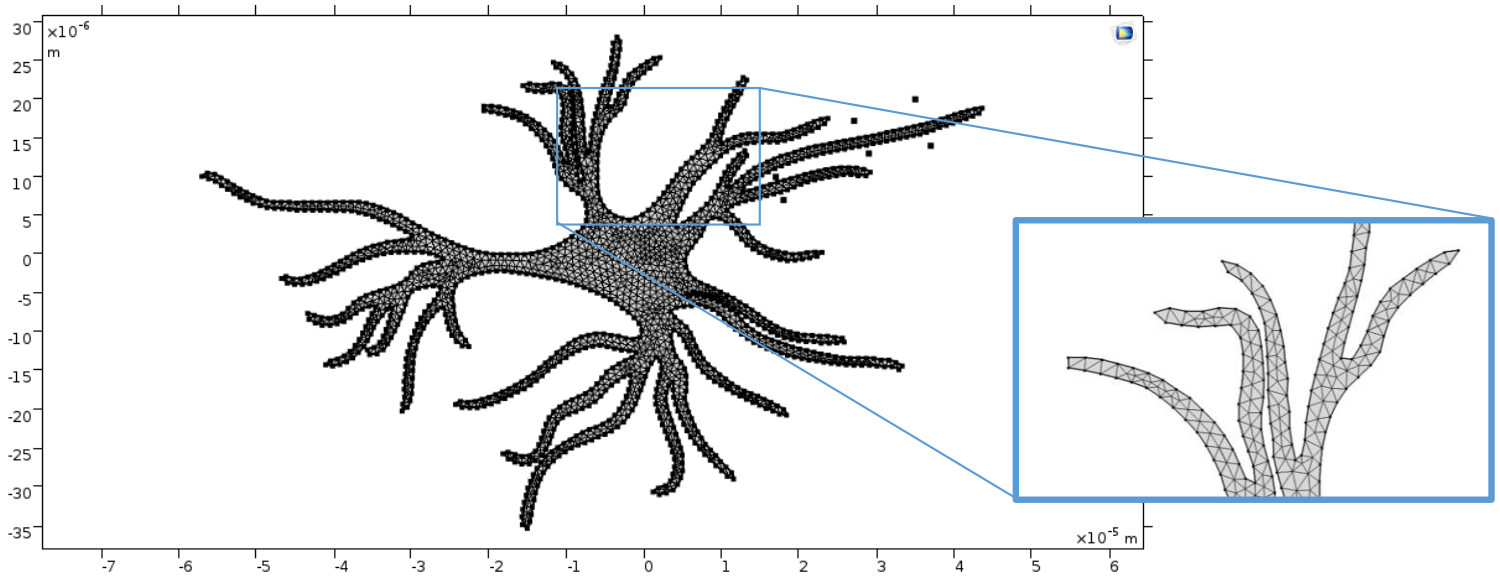
Lenk – Topic 3: Quantification of rat hippocampal astrocytes



Figures by Anna Freund

Topic already reserved

Lenk – Topic 4: Meshing an astrocyte



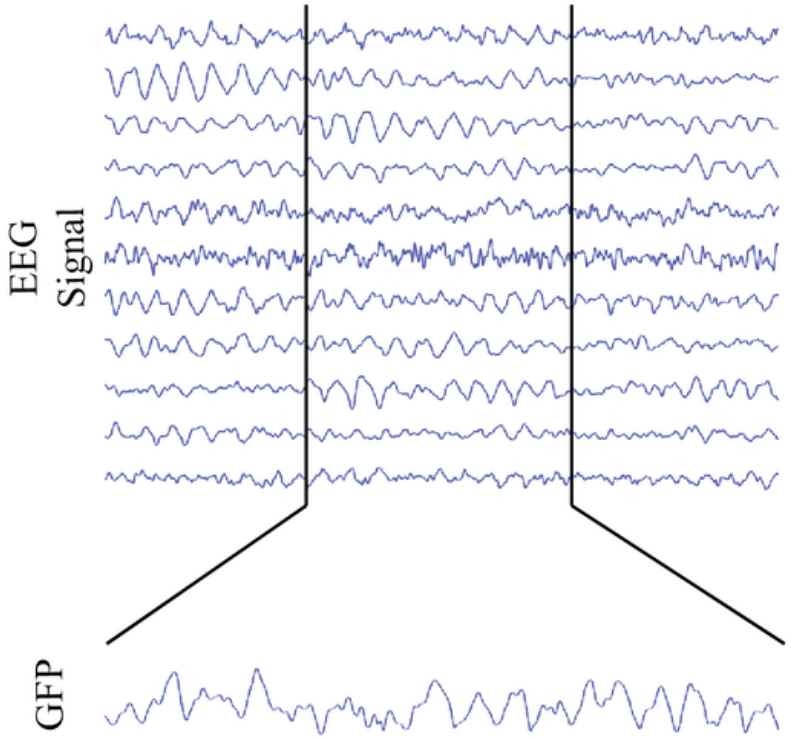
Investigating EEG microstates during rest and motor execution/attempt

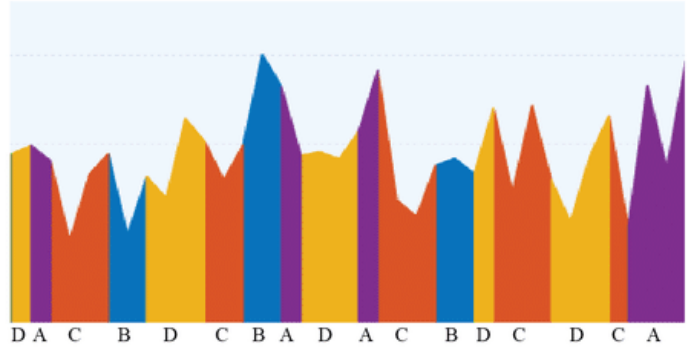
EEG microstates represent brain states with distinctive scalp topographies characterized by periods of synchronized neural activity. This thesis provides the opportunity to investigate and compare EEG microstates during rest and during motor execution or attempt.

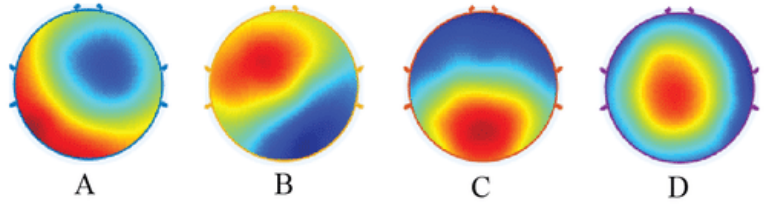
Thesis content:

- ❑ Literature review on EEG microstate functional significance and analysis techniques.
- ❑ Application on real EEG data during rest and motor execution/attempt.

Techniques: Signal processing, Unsupervised clustering







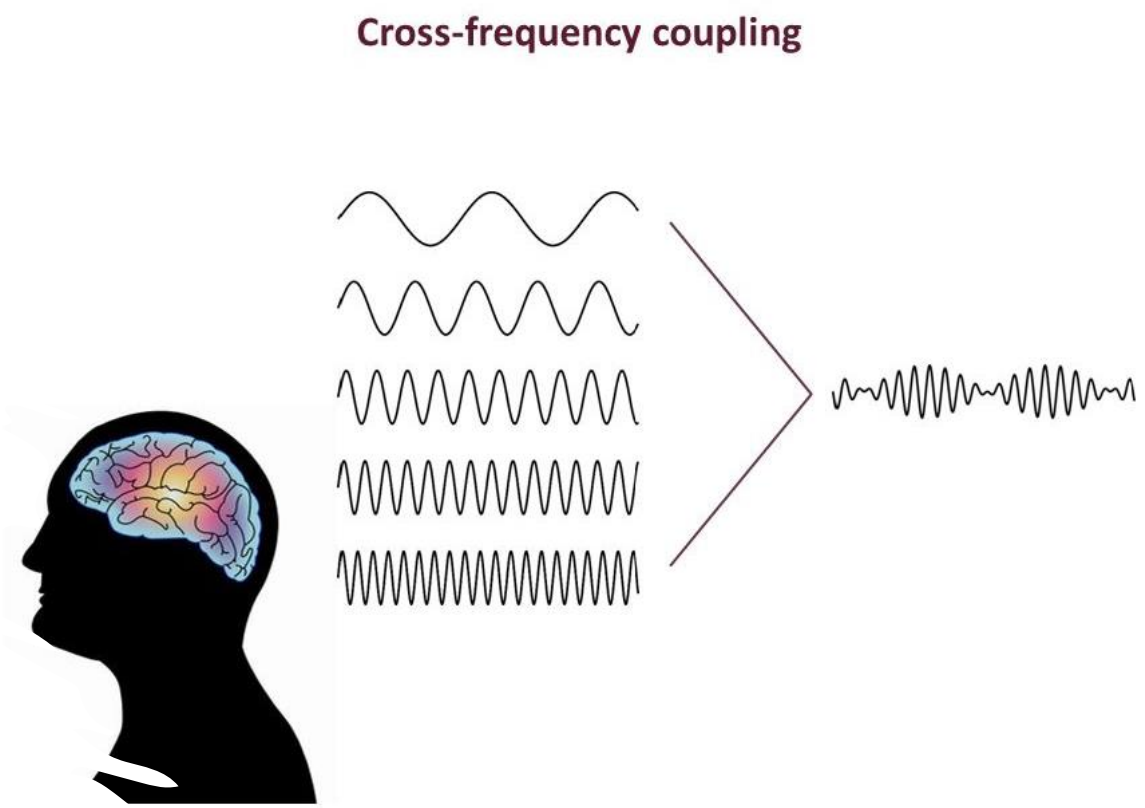
EEG-based cross-frequency couplings

Cross-frequency couplings (CFC) refer to interactions between oscillations at different frequency bands. It has been suggested that in the brain CFC serves as a mechanism that facilitates communication and information transfer between local and spatially separated neuronal populations. This thesis focuses on investigating different types of CFC using resting and task-related EEG data.

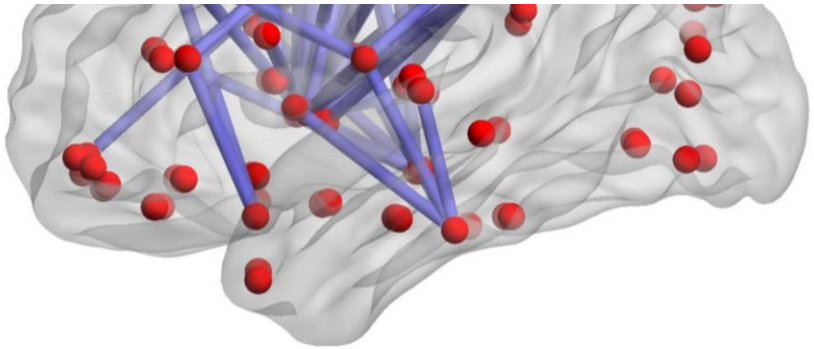
Thesis content:

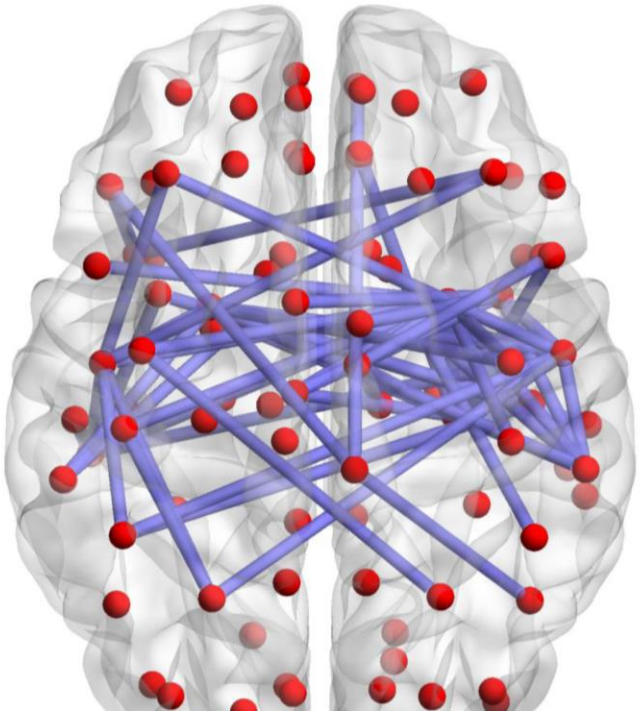
- ❑ Literature review on different type of EEG CFC analysis techniques.
- ❑ Application on real EEG.

Techniques: Signal processing, time-series analysis



Measuring brain networks – Methods and challenges





The brain is a huge network of interconnected pathways that communicate through synchronized electric activity. This thesis focuses on exploring functional connections across the brain using EEG signals.

Thesis content:

- ❑ Literature review on various brain connectivity measures (e.g., coherence, mutual information, granger causality).
- ❑ Application and comparison of some of these measures on real EEG data.

Techniques: Time series analysis, time-frequency analysis, signal processing

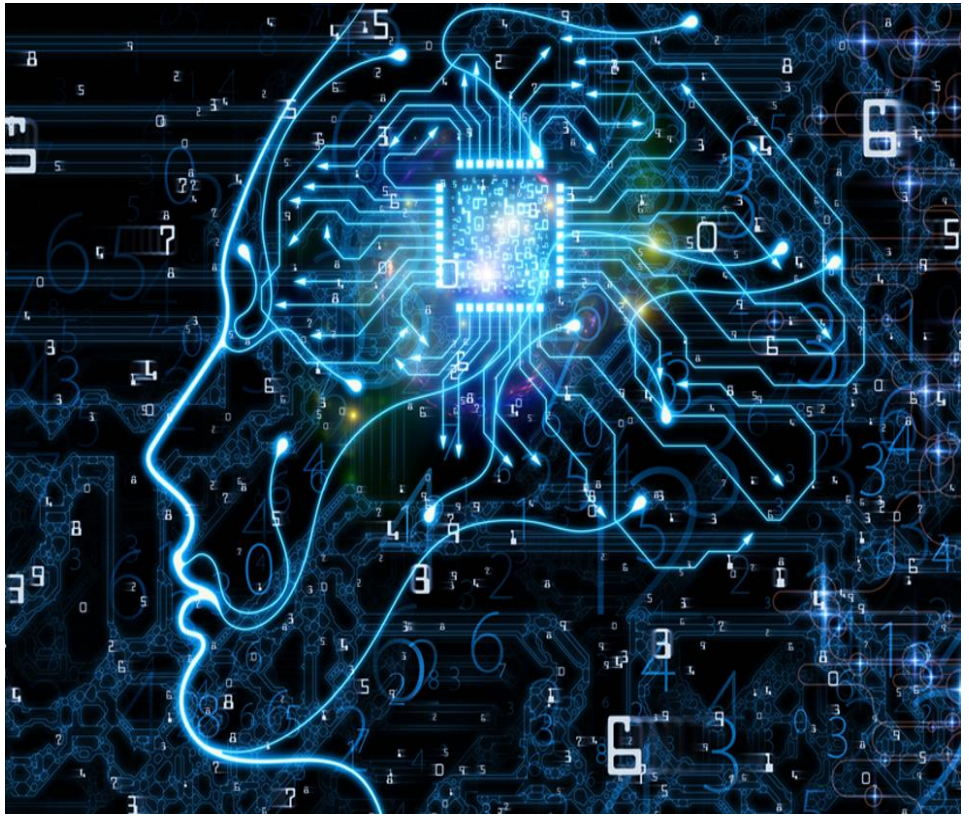
Feature engineering for EEG classification during motor attempts

Feature engineering refers to the process of developing new data features from raw data. The goal of this thesis is to investigate and compare various time and frequency domain EEG features for motor attempt classification.

Thesis content:

- ❑ Literature review on EEG features for motor attempt classification.
- ❑ Compare various features based on the final classification results in motor attempt data.

Techniques: Signal processing, machine learning



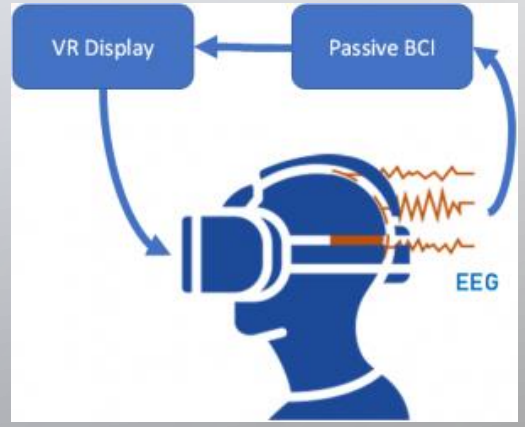
INVESTIGATING EEG CORRELATES OF ACROPHOBIA IN A VR SCENARIO

Hardware

Live AMP Brain Vision

Oculus Quest 2

VR scenario



4 height levels

13th floor
8th floor
3rd floor
Ground floor

Bachelor Thesis I:
„EEG CORRELATES OF ACROPHOBIA IN A VR SCENARIO„

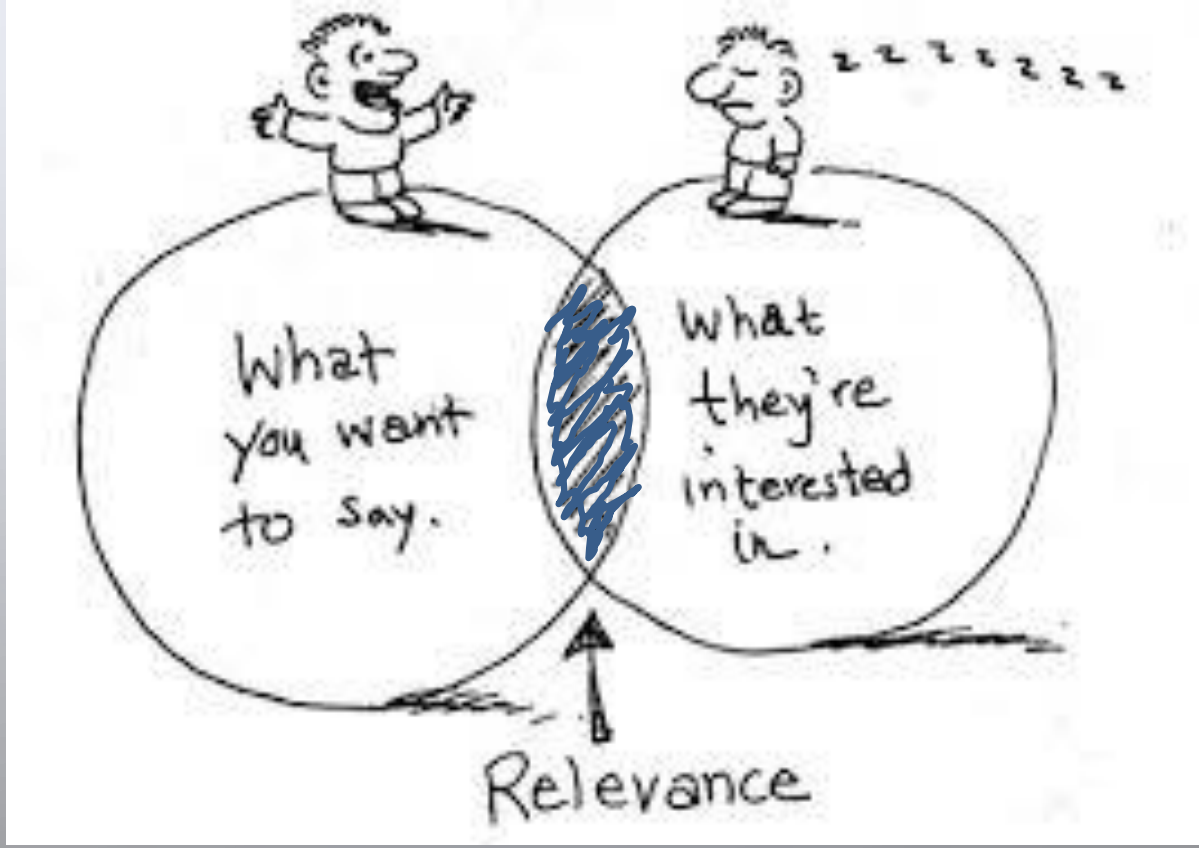
- Perform EEG Study with 10 Participants
- VR scenario: existing Acrophobia App
- Preprocessing of EEG and quantitative (questionnaires) data
- Feature engineering of EEG data, statistical analysis

Bachelor Thesis II
„EEG correlates of Acrophobia in a 2D enivronment“

- EEG Study with 10 Participants
- Development of Experimental paradigm in 2D (based on VR scenario)
- Signal processing and feature extraction of EEG data

Bachelor Thesis III
„Emotion detection (acrophobia) in VR“

- VR Study with 20 Participants
- VR scenario: existing Acrophobia A
- Signal processing of VR-integrated features (face detection, heart rate, eye-tracking) related to acrophobia



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