S C I E N C E ▪ P A S S I O N ▪ T E C H N O L O G Y

Institute of Neural Engineering

Graz Brain-Computer Interface Lab

Ass. Prof.
Kerstin Lenk

Bakk::Mas Day 2024

GRAZ BCI

Institute of Neural Engineering

Graz Brain-Computer Interface Lab

Team Lenk | **Team Müller-Putz** | **Team Wriessnegger**

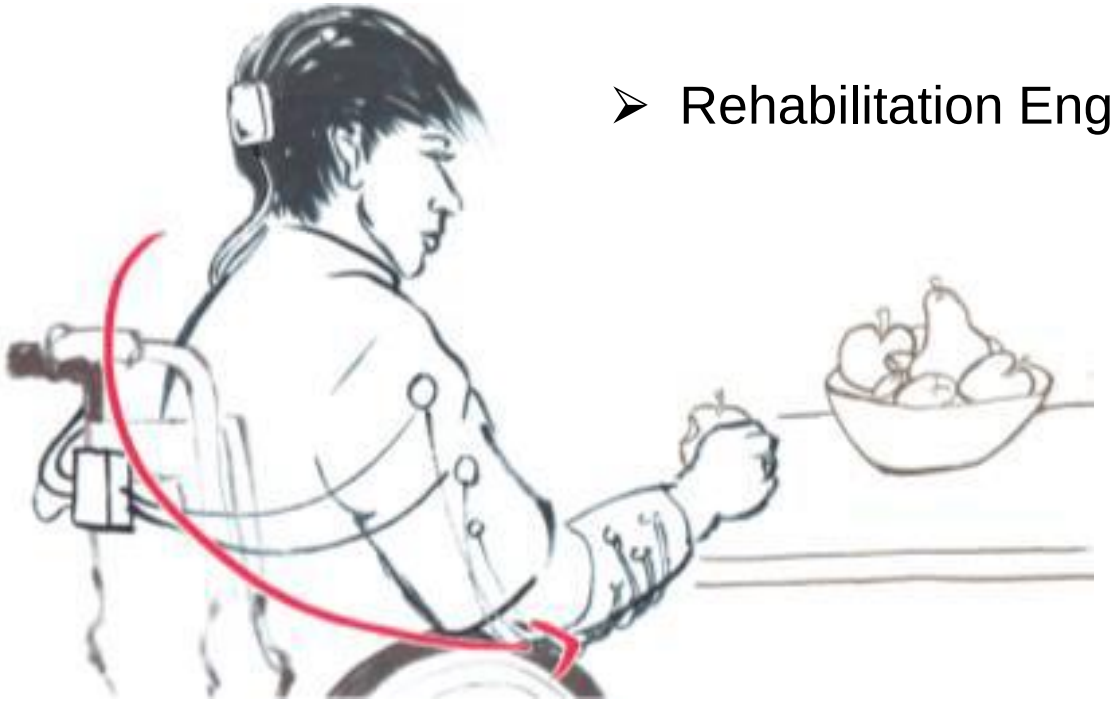
GRAZ BCI

Gernot Müller-Putz

https://www.tugraz.at/institute/ine/people/gernot-mueller-putz/

Main research area: Neurorehabilitation and BCI

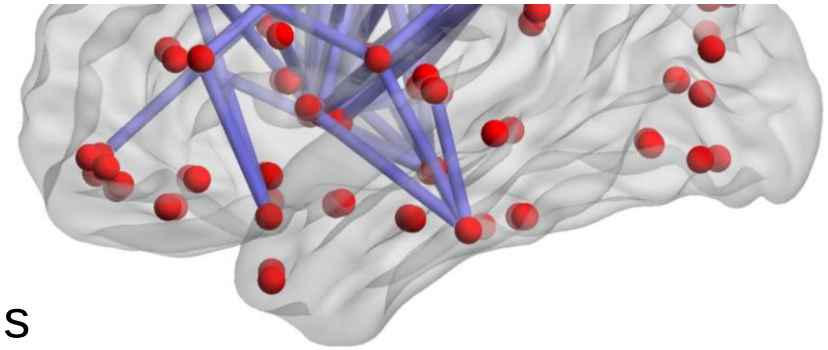
- Brain-Computer Interfacing & EEG Signal Processing (machine learning, task decoding, perturbation detection, error processing, mind wandering, etc.)
- Functional Brain mapping (source localization, MRI segmentation, etc.)
- Rehabilitation Engineering (Neuroprosthetics, FES Bike, etc.)



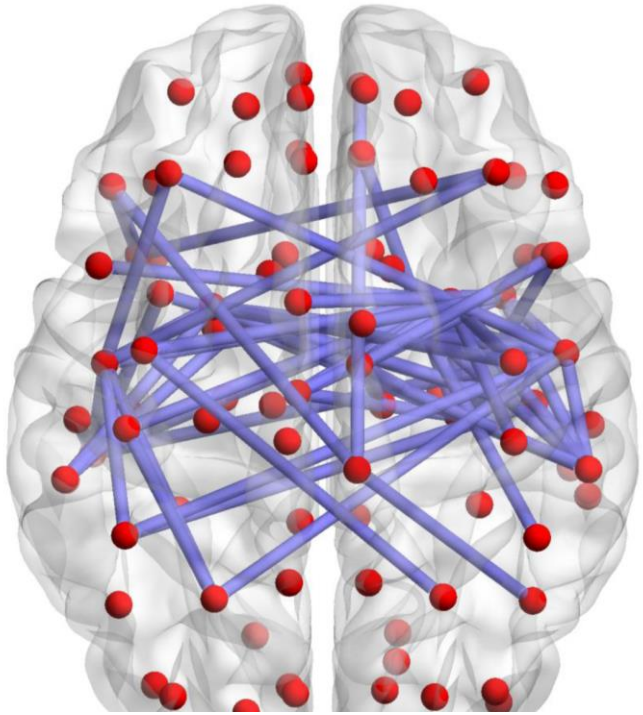
gernot.mueller@tugraz.at

Kyriaki Kostoglou

Measuring brain networks during movement (Bachelor)



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 during movement.



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

kkostoglou@tugraz.at

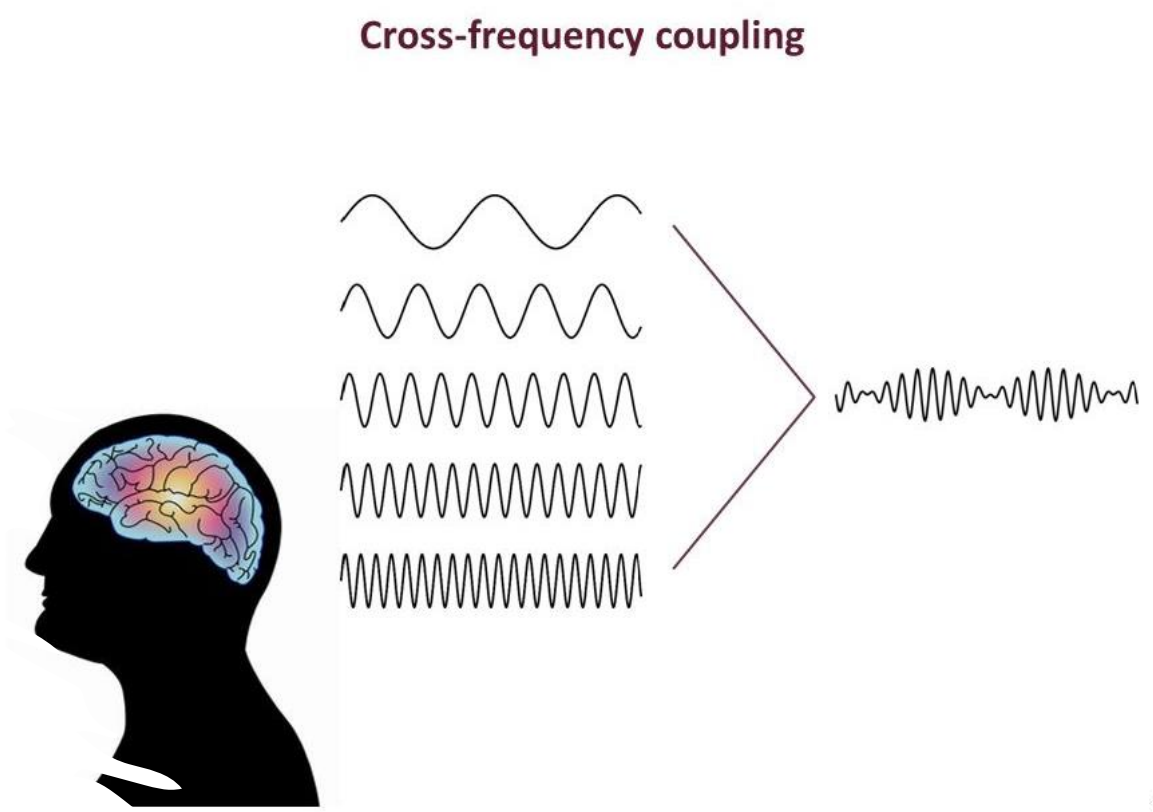
EEG-based cross-frequency couplings

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



kkostoglou@tugraz.at

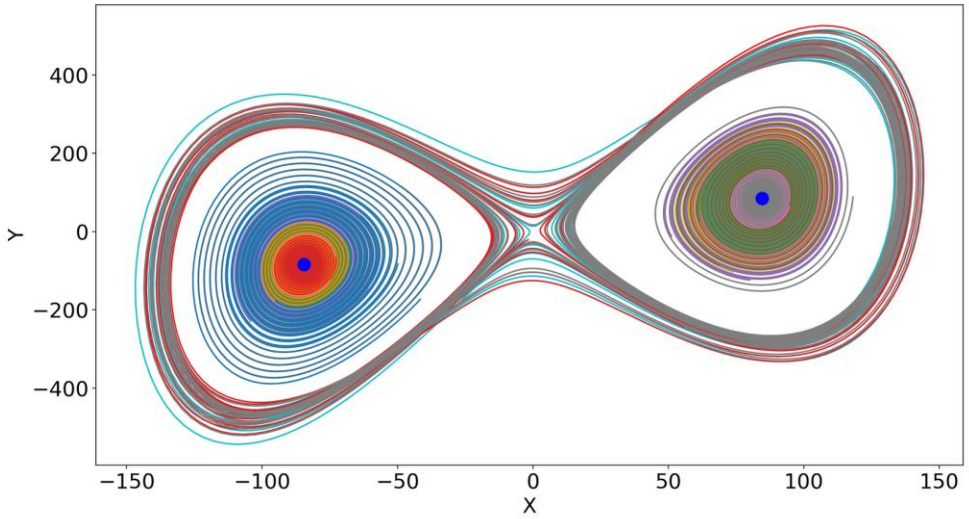
Kyriaki Kostoglou

Exploring EEG and Chaotic Measures during Movement: Complexity of Brain Dynamics

The objective of this thesis is to investigate how EEG and chaotic measures can be combined to reveal the complex patterns of brain activity during movement. Through an analysis of brain oscillations and their non-linear features, we aim to uncover concealed insights into motor control

Thesis content:

- Literature review on chaotic measures and EEG motor-related processes
- Application on real EEG data during movement execution or attempts

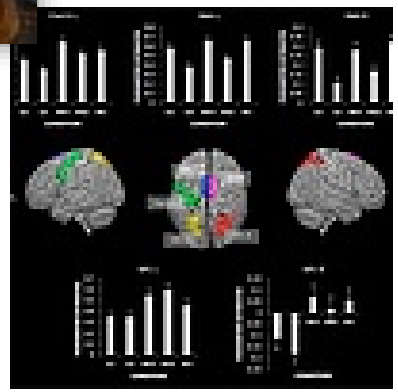


Techniques: Signal processing, nonlinear dynamics

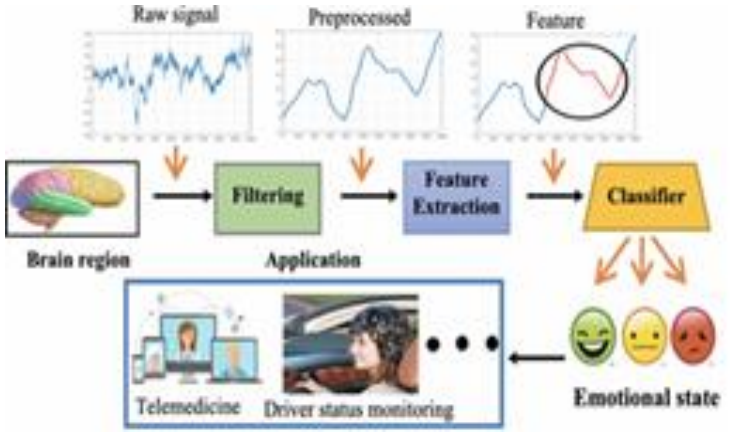
kkostoglou@tugraz.at

Main research area:

Cognitive Neuroscience & Brain-Computer Interfaces



- Mental state detection from EEG
- Fusion of VR and Brain-Computer Interfaces
- Affective Computing



s.wriessnegger@tugraz.at

Methods: EEG, fNIRS, fMRI, physiological signals (ECG, GSR, …)

Topic 1 (Bachelor or Master)

"Decoding emotions based on facial expressions from EEG“

- Explore existing dataset
- Feature engineering and Data Analysis
- Decoding emotions with machine learning and deep learning methods

Topic 2 (Bachelor or Master)

„Physiological markers of affective states“

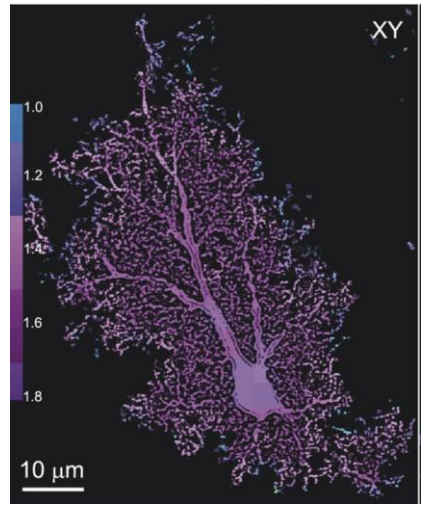
- Perform VR study with existing paradigm (20 participants)
- Data analysis of:
  - eye-tracking data
  - heart rate
  - facial expression data

s.wriessnegger@tugraz.at

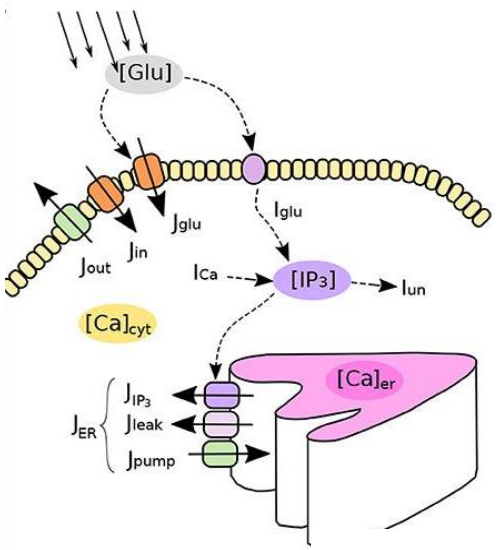
GRAZ BCI

Simulation of neurons and astrocytes

Main research area: Computational Neuroscience



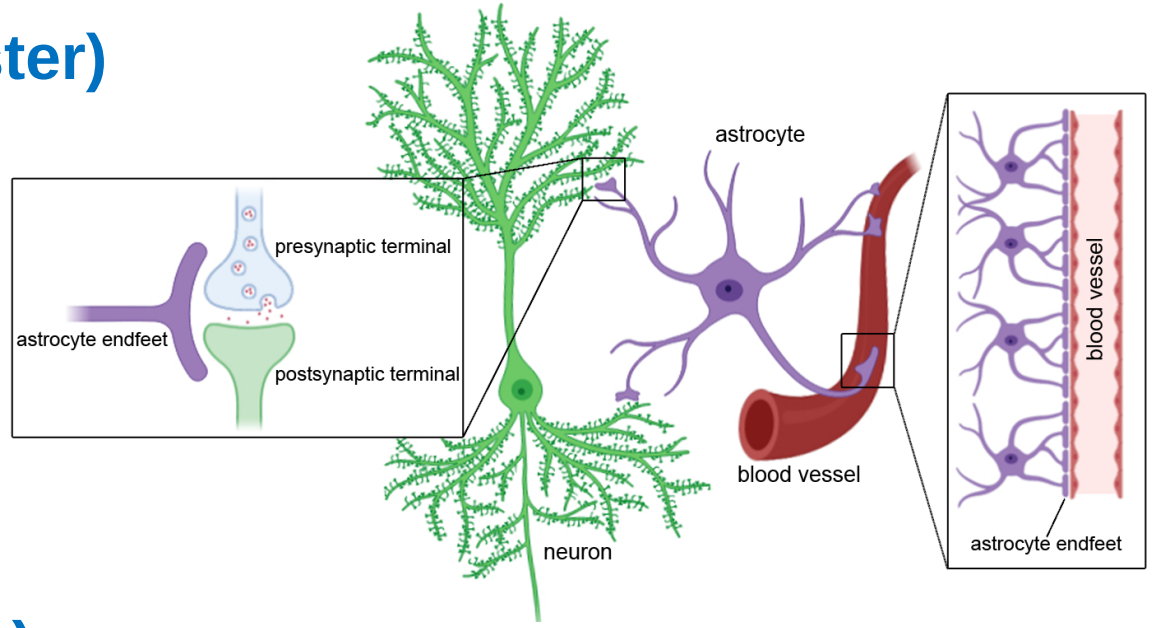
- Modeling of astrocytes (morphology, calcium signals)
- Astrocytes in neurodegenerative and psychiatric diseases
- Astrocytes and sex differences
- Neuron-astrocyte network models in synchronization and desynchronization
- Simulation of neuronal networks and parameter optimization
- Bioinformatics approaches to study neurons and astrocytes
- *In vitro* experiments to study neurons and astrocytes



kerstin.lenk@tugraz.at

Topic 1: Analysis of ChIP-Seq data (Master)

- Changes in the blood-brain barrier in major depressive disorder
- Methods: bioinformatics tools
- In collaboration with University of Regensburg and Prof. Leila Taher



Topic 2: Analysis of scRNA data (Master)

- Sex-specific differences in astrocytes
- Methods: bioinformatics tools
- In collaboration with University of Regensburg and Prof. Leila Taher

kerstin.lenk@tugraz.at

Topic 3: Differences between female and male astrocytes *in vitro* (Master; start in summer/autumn)

- Sex-specific differences in astrocytes
- Methods: Patch clamp and/or calcium imaging
- In collaboration with the Medical University of Graz

Topic 4: Modeling of chloride dynamics in astrocytes (Master)

- Computational model of chloride pathways in astrocytes
- Methods: Python

kerstin.lenk@tugraz.at

Institute of Neural Engineering (BCI Lab)

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, except Machine Learning)
  - ✓ Modul F: Biomedical Engineering (F1, F2)
  - ✓ Modul G2: Verfassen wissenschaftlicher Arbeiten
  - ✓ Signalverarbeitung

Institute of Neural Engineering (BCI Lab)

Prerequisites Master's Thesis

- ✓ 2 dates/per year to register: SS March/ WS October
- ✓ Bachelor's thesis done
- ✓ 2/3 of the courses done; in agreement with the potential supervisor
- ✓ Duration max. 12 months