

Bachelor/Master Thesis Topics

Cognitive Systems Lab

Conversational speech for dementia detection

→ Possible BA or MA topics:

- *Detective work in speech processing: Detect, analyse and quantify potential pitfalls (audio encoding, diarization, feature extraction)*
- *Can speech & language embeddings predict cognitive test results?*
- *Analyze semantic embeddings of ILSE interviews for detection of cognitive decline*
- *Conversation analysis for dementia detection (turn taking, coherence, etc.)*

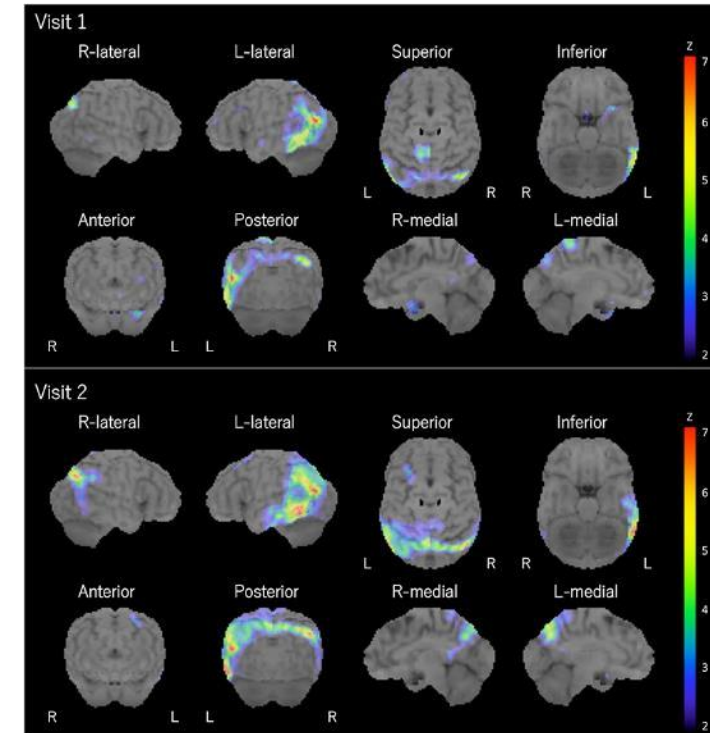
→ Requirements:

- Good Python programming skills
- At least basic ML/ASR knowledge

→ Contact: Elisa Brauße (elisa.brausse@uni-bremen.de)
with short introduction and CV

ML on MRI Imaging Data

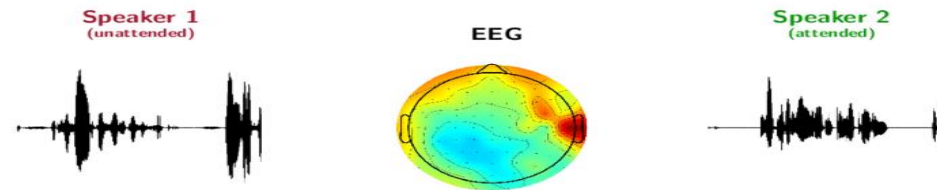
- ILSE does not only offer speech data!
- Pretty loose topic with lots of freedom for brainy students, Bachelor's or Master's thesis possible
- Your tasks:
 - Work with Magnetic Resonance Imaging (MRI) data
 - Implement ML models for MRI-based dementia (or: depression) classification
 - e.g. MA: Un- / semi-supervised learning for dementia detection
- Requirements:
 - Good Python programming skills
 - At least basic ML knowledge
- Contact: Elisa Brauße (elisa.brausse@uni-bremen.de) with short introduction and CV



Selective Auditory Attention – Bachelor's Thesis

Interesting thesis topics on Solving the Cocktail Party's Problem using EEG

- Topic: **Source Sound Decoding with Electroencephalogram** (Auditory Attention Decoding)
- Understanding of Auditory Attention Decoding and decoding source sound using eeg samples(with public datasets)
 - Preprocess available data and fed it to machine learning/Neural Networks(Train different models) to classify the attended speaker
 - Visualize results through various methods of applicable Neural Networks and compare results
 - Classify performance based upon different validation measures & specify optimal way out



General requirements: Good knowledge in Python, at least basic knowledge in machine learning(Deep learning), motivation, reliability, personal responsibility, willingness to learn new topics

We offer: Intensive support, regular/weekly meetings, feedback discussions, nice work environment

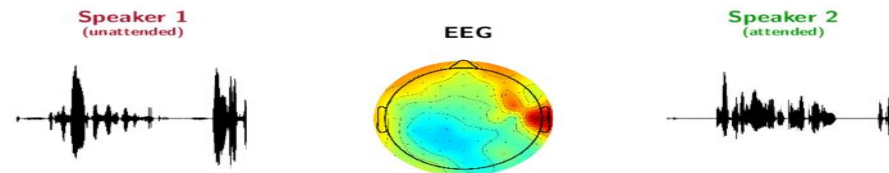
Contact: Saurav Pahuja ☎ 0421-218-64282 ✉ saurav@uni-bremen.de

Selective Auditory Attention – Master's Thesis

Interesting thesis topics on Solving the Cocktail Party's Problem using EEG

→ Topic: **Brain Tracking of Sound using Deep Learning** (Auditory Attention Decoding)

- Understanding of Auditory Attention Decoding and decoding source sound using eeg samples (public datasets) with Different Optimized Deep learning Models(CNN, GCN, Hybrid Models...)
- Generate Augmented Data using GAN... & check performance with other networks using original data and new generated data
- Try to interpret & Visualize results of different applicable Neural Networks and compare results based on EEG samples
- Do Ablation Analysis over different Networks and see through performance, various different visualizations the effects of Auditory Attention Decoding on Brain



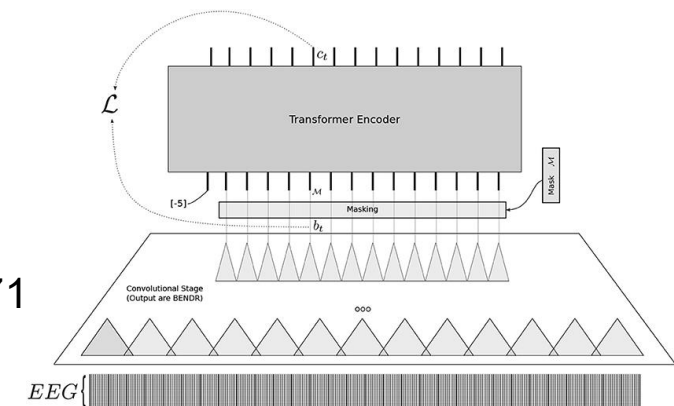
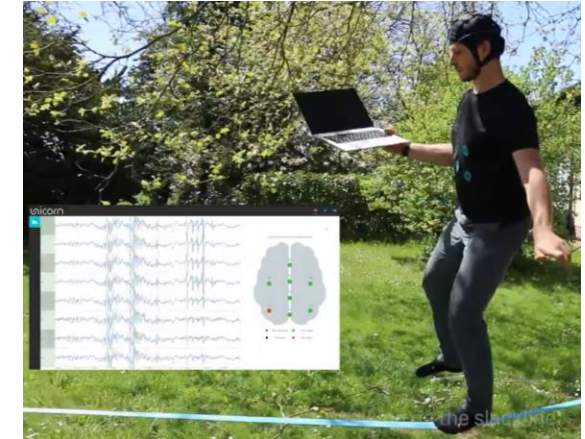
General requirements: Good knowledge in Python, at least basic knowledge in Deep learning, motivation, reliability, personal responsibility, willingness to learn new topics, some experience with EEG would be nice!

We offer: Intensive support, regular/weekly meetings, feedback discussions, nice work environment

Contact: Saurav Pahuja ☎ 0421-218-64282 ✉ saurav@uni-bremen.de

Casual Brain Activity Data Recording

- Most recordings of brain activity data take place in the laboratory
 - Highly controlled, but also unrealistic and not generalizable
 - Small amounts of well-labeled data → does not scale
- Alternative: Casual recording of brain activity data
 - Completely uncontrolled, during everyday activities
 - No or very weak labeling
 - Leveraging self-supervised learning methods, foundation models
- **Your thesis:** Collect and evaluate such data
 - Set up sensors, design data collection protocol „in the wild“
 - Apply state-of-the-art machine learning for classification
- Contact: Dr. Felix Putze, felix.putze@uni-bremen.de or Discord: felix.putze#871



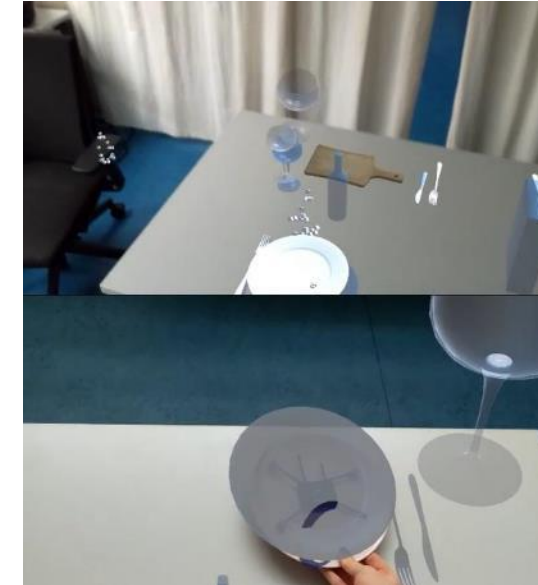
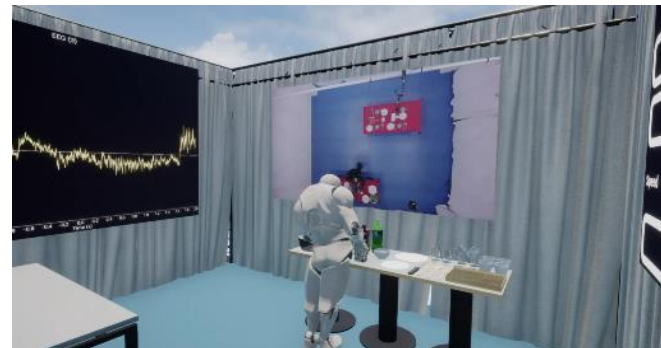
Representation Learning for Cognitive Modeling

- Representation learning: Automatically finding a compact, latent representation of high-dimensional input
 - Retaining important semantics and data characteristics
 - Input: video, text, biosignals, graphs, ...
- At the core of recent machine learning advances (Transformers, Large Language Models, Generative AI, ...)
- **Your thesis:** Apply representation learning for modeling context and cognition in Human-Computer Interaction:
 - Representing context from video recordings of Augmented Reality device
 - Representing neural data from EEG for Brain-Computer Interfaces
 - Representing semantic concepts for creative idea generation
- Contact: Dr. Felix Putze, felix.putze@uni-bremen.de or Discord: felix.putze#8717



Augmented/Virtual Reality for Cognitive Science

- Motivation 1: In Augmented and Virtual Reality, we can create realistic, but controllable experiments to **study human behavior and cognition!**
- Motivation 2: AR/VR can benefit from cognitive modeling to **adapt its user interfaces**



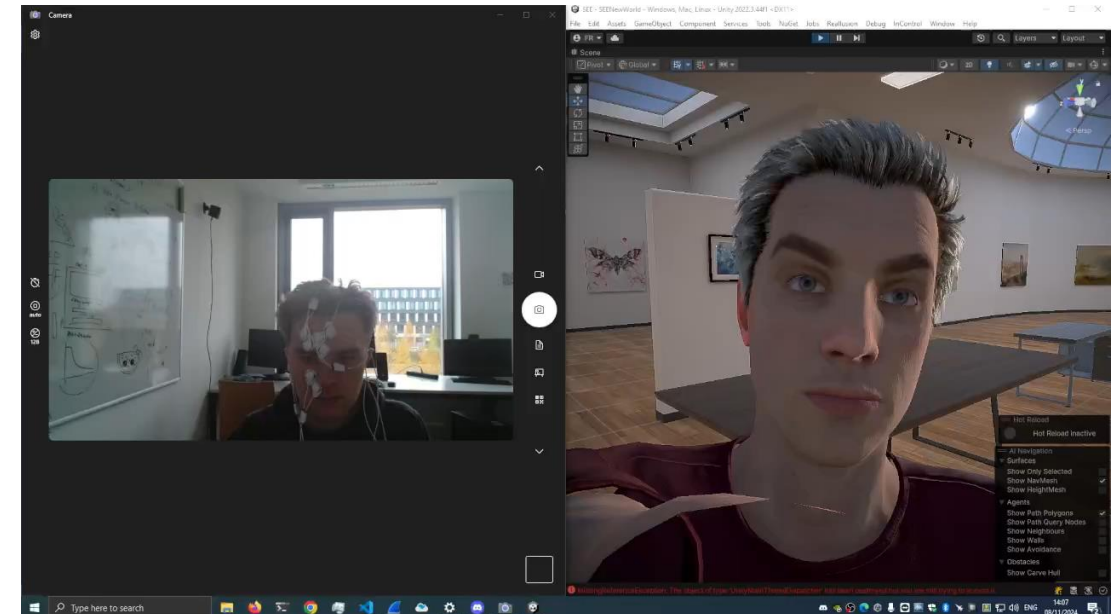
- **Your thesis:** Create AR/VR applications in the context of cognitive science, e.g.:
 - Study in VR how different impairments influence how people solve a task
 - Create an AR application that tracks the wearer's state of attention and adapts it

→ Contact: Dr. Felix Putze, felix.putze@uni-bremen.de or Discord: [felix.putze#8717](#)

Recognition of Facial Expressions from Electromyography (EMG, BA/MA)

Today, facial expressions are typically detected via a webcam, using image recognition software. However, cameras are privacy-intruding, and also not always available (e.g., when wearing Virtual Reality device). Our aim is to use EMG to classify facial muscle movements in real time, and then to stream them onto a high-quality 3D-Avatar (see video)

- **Main Task Thesis 1:** Focus on the Machine Learning classification of facial expressions
- **Main Task Thesis 2:** Focus on Biosignals-based 3D animation and interaction
- **Empirical parts** can be balanced between already available data and a new data collection
- **Technical Background:** Python, ML, and/or Blender/Unity
- **Contact:** Dennis Küster (kuester@uni-bremen.de)



<https://www.scitepress.org/PublishedPapers/2025/133893/>

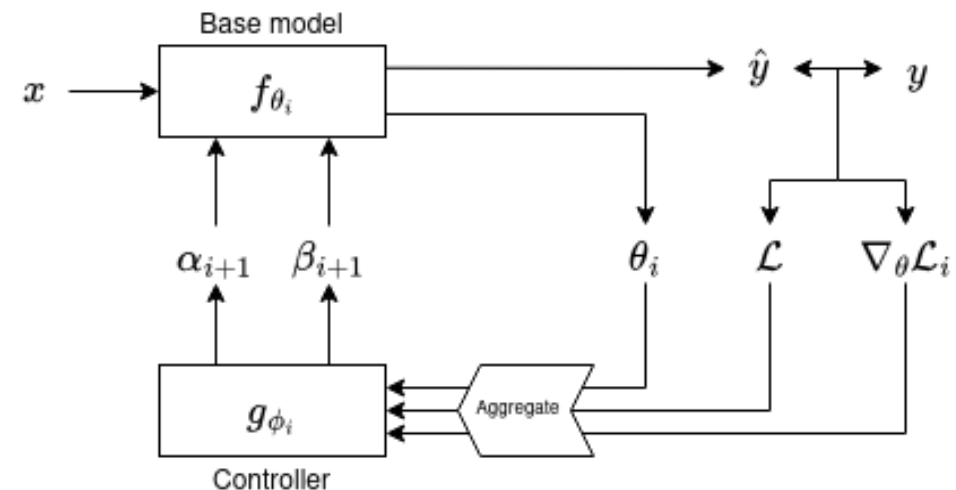
Note: This ongoing project recently won a best-paper award! There's a lot still to be done (and fun!).

Online Hyperparameter Adaptation via Learned Controllers (MA)

Contact: Anthony Richardson
(antmen@uni-bremen.de)

Motivation: Most hyperparameter search strategies rely on static hyperparameter schedules or manual tuning, which is often suboptimal and time-consuming.

Goal: Pair a machine learning model with a light-weight controller that dynamically adjusts the used training hyperparameters throughout the course of the training.



1. Train base model for K epochs.
2. Train controller for M epochs.
3. Repeat steps 1 and 2 until base model converges. Update hyperparameters every N steps.

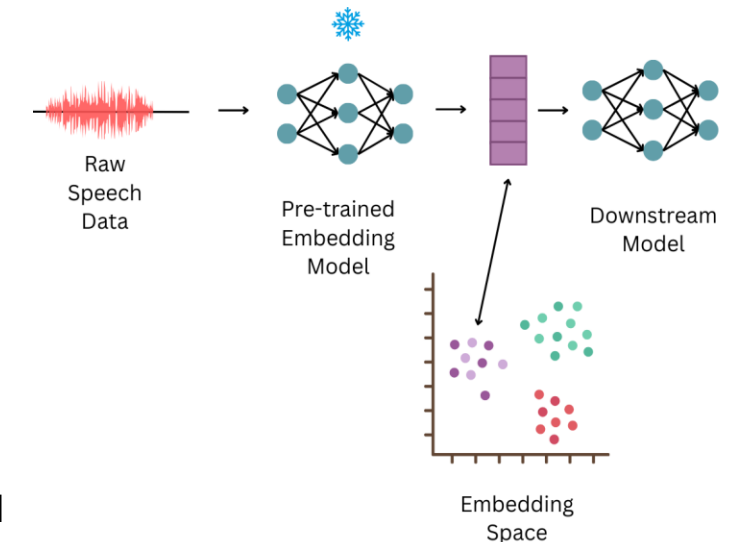
Systematic analysis of pre-trained audio embeddings

With focus on the influence of different recording microphones

Pre-trained audio embedding networks are becoming increasingly prominent, especially in domains with limited data availability such as medical diagnostics. These embeddings provide powerful representations that can serve as the basis for a wide range of downstream tasks in the speech domain. At the same time, they function as a kind of black box, with little understanding of what information they actually encode. This lack of transparency raises the risk of downstream models utilizing irrelevant factors, for instance differences in the recording condition like a change in the microphone type.

Your thesis (BA/MA):

- literature search on state-of-the-art audio embedding models (with focus on acoustic aspect)
- selection of models (e.g. wav2vec, Trill) and implementation of a pipeline to extract the different embedding types on a speech dataset
- general characterization of the different approaches: dimensionality of embeddings, architecture, ...
- embedding analysis with focus on microphone factor: e.g. measure the discriminative power of the embeddings with regard to different microphones, investigate how device-related information is spread across the dimensions, traversal of embedding space or utilization of distance metrics, ...



Requirements: Good python skills, Deep Learning knowledge advantageous but not essential

Contact: Iva Ewert (iewert@uni-bremen.de), Jordan Behrendt (jobe@uni-bremen.de)

Procedural Dance Challenges in VR (BA/MA)

- We have a dancing-exergame in virtual reality, Inspired by BeatSaber/OhShape. Currently this game only supports pre-programmed songs & their corresponding dances. Your task is to implement a system that generates fitting dance-prompts (and their timings) from an audiofile.
- For a masters thesis, it would also be interesting to parameterize this generation, i.e. allow different levels of difficulty, exclude or encourage certain motions, etc.
- Technical Background: Game Engines (Thesis will be in Unity), VR, Audioprocessing
- If youre interested, contact Asmus Eilks (aeilks@uni-bremen.de)



Machine Listening

We equip machines with the human ability of selective listening. This paves the way for the development of intelligent hearing aids and reliable speech-based human-computer interaction. Within this field, we offer several bachelor and master theses topics!



Source: <https://www.vocal.com/wp-content/uploads/2019/09/cocktail-party-problem.jpg>

Topics:

1. The 3D cocktail party: Build a 3D soundscape simulation tool
2. Go smaller! Construct an ensemble learning for auditory attention detection on brain-signals
3. Language-aware listening: Inducing language information into speech separation algorithms
4. Best of both worlds: Connecting speaker and language information for speech separation
5. Let's debate! Implement an LLM council for various tasks!

*We can also brainstorm about other topics!
Just text me!*

We offer: Intensive support, regular meetings, feedback discussions, great working environment

Requirements: Good knowledge in Python, at least basic knowledge in machine learning, motivation, reliability, personal responsibility, willingness to learn new topics

Contact: Dr.-Ing. Marvin Borsdorf ☎ 0421 218 64291 ✉ marvin.borsdorf@uni-bremen.de

Automatic Speech Recognition for Pathological Speech Analysis

- Speech samples for disease classification are transcribed using ASR systems to extract linguistic features
 - ASR systems are often trained with speech from healthy people
 - Diseases can influence the speech production process, and therefore altering characteristics of the speech signal
 - The extent to which ASR performance affects disease classification performance is unclear
- **Main Tasks:**
 - Analyze a given dataset with different ASR systems
 - Manipulate dataset to control word error rate
 - Apply machine learning techniques to classify diseases
- Contact: Mira Richts, mira.richts@uni-bremen.de

Speech Production and Cognitive Load

- Different cognitive processes are important for speech production
 - Complex tasks, distractions, or interruptions can influence characteristics of planned and spontaneous speech
- **Main Tasks:**
 - Plan and conduct a speech data collection
 - Prepare data for analysis (e.g. preprocessing, feature extraction, ...)
 - Analyze the influence of cognitive load on the speech signal
- Contact: Mira Richts, mira.richts@uni-bremen.de