

Proposals for experimental projects

Graz, Nov. and Dec. 2025



Intro experiments



- Course set-up
 - Intro+background
 - Experiments (1 or 2 persons), brief (7min) presentations
 - Short report (1 person)
 - Assessment based on active participation and report
- ASR is way too broad to be addressed in just a few weeks
 - You might choose topic from precooked list
 - Keep the research question doable
 - Keep it feasible

Python **scripts** available

- In github repo **ltenbosch2/Graz_github**

Proposal experiments

- Bridging phonetics and ASR/deep learning
 - Locating phonetic structure in latent representations
- Prompting Whisper
 - ASR is context dependent
- Reasoning
 - Can we explain/understand the outcome of reasoning models?
- Behavior of transformer based networks on small (user-build) data sets
 - E.g., boolean mappings
 - Regular expressions: <https://aclanthology.org/2020.emnlp-main.576.pdf>

List of experimental options

1. Bridging phonetics and ASR/deep learning

- Start by using pretrained wav2vec2.0 via Huggingface
 - Choose dataset
 - Process mono wave file (16 kHz)
 - Extract hidden layer k , *and* logit tensor
 - Select two vowels (for example) that minimally differ, e.g.
 - **Bahn** [ba:n] – "track, railway" – **Bonn** [bɔn] – (city name)
 - **Beet** [be:t] – "garden bed" – **Bett** [bɛt] – "bed"
 - **fühlen** ['fy:lən] – "to feel" – **füllen** ['fʏlən] – "to fill"
 - **Ofen** ['o:fən] – "oven" – **offen** ['ɔfn] – "open"
- Use logit matrix to locate the corresponding time stamps
- Try to measure these differences in vector space (as function of k) by LDA or different

List of experimental options (cont'd)

2. Whisper prompting

- Present a wave file, keep this file fixed and investigate what effect text prompting has on Whisper output
- Follow the recipe in following link
https://cookbook.openai.com/examples/whisper_prompting_guide
- Helpful to prompt whisper for certain transcription style
- Keep it simple and transparent

List of experimental options (cont'd)

3. Use of a Large Reasoning Model (LRM)

- Select an LRM (minimum DeepSeek-v1, install ollama)
- Select say 10 (simple to hard) questions directly related to this course (speech recognition, AI, transformers)
- Let the LRM provide a reasoning for all questions
- Assess these answers in detail
 - Define your assessment method – based on knowledge/literature
 - Provide a conclusion about the quality of the LRM chosen
- Defend your choices in model selection, method and data selection

Reasoning example (depends on # free GB)

- install ollama
- Run any of your preferred models, e.g. deepseek (many versions)
- `ollama run deepseek-coder-v2`

Q: Do you see how the towers of Hanoi problem can be solved for all $N > 1$ by using recursion?

A: “Thinking... Alright, so I'm trying to understand how to solve the Tower of Hanoi problem recursively for any number of disks greater than one. From what I remember, the classic Tower of Hanoi has three rods and three disks: two large disks and a small one. The goal is to move all the disks from the starting rod to another rod while following these rules:... [etc.]”

List of experimental options (final)

4. Behavior of transformer based networks on small (user-build) data sets

- Small data sets (training, validation, testsets)
- Minimal functional transformer models

Various proposals (in .txt files):

- Graz_various_transformer_studies.txt
 - 4 specific cases (from vector sequence to vector, to Boolean, character sequences)
- Graz_regular_expressions_training_transformers.txt
 - Data are created in Graz_regular_expressions_create_training_test_sets.txt
 - MA_002 (data also in github) $A*B$ versus $B*A$, in random real vector sequence
 - MA_003, ABC versus ACB in random integer vector sequence (dim = 5)
 - MA_003b, same as MA_003 but with dim = 3
 - MA_004, random integer sequence \rightarrow Boolean (whether the last vector is between first two, or not)

Short report

- Report of 3 pages proceedings format (2-column format)
 - Approx 2000 words
 - Intro + RQ
 - Method
 - Experimental data + set-up
 - Results
 - References



Computational platforms

Up to you:

Own laptop
• Windows, Linux

Cluster

Jupyter

SageMath

LaTeX

Cocalc:

<https://cocalc.com/>

For those interested in more involving experiments

- There are (too) many options!
- E.g. Compare wav2vec2.0 **without** lexicon versus **with** lexicon and LM
 - LM of small order (e.g., 3), via KenLM toolkit
<https://kheafield.com/code/kenlm/>
 - finetuning XLSR model (Facebook, 2022) by fairseq toolkit (Ott et al., 2019)
 - Fairseq is a toolkit. With Fairseq you can train models that achieve state-of-the-art performance on machine translation and summarization tasks. It includes pre-trained models