ML-Neuro Seminar Summer 2023: Kickoff

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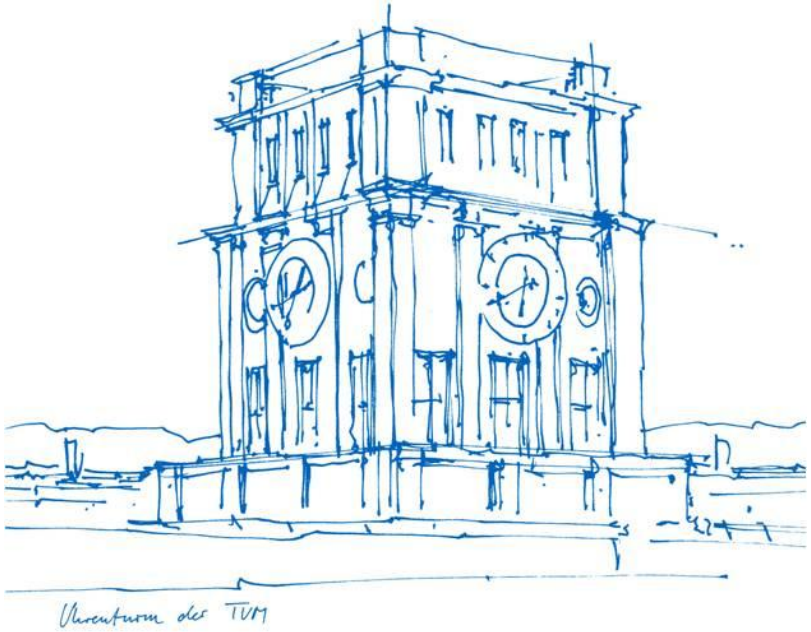
Lab for Artificial Intelligence in Medical Imaging

Department of Radiology / Faculty of Informatics

Technical University of Munich

23 October 2023



Agenda

- Introduction
- Usage of ChatGPT
- Timeline
- Organization and expectations
- Brief introduction to Transformers
- Distribution of papers
- Q & A

Lab for AI in Medical Imaging

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www.ai-med.de

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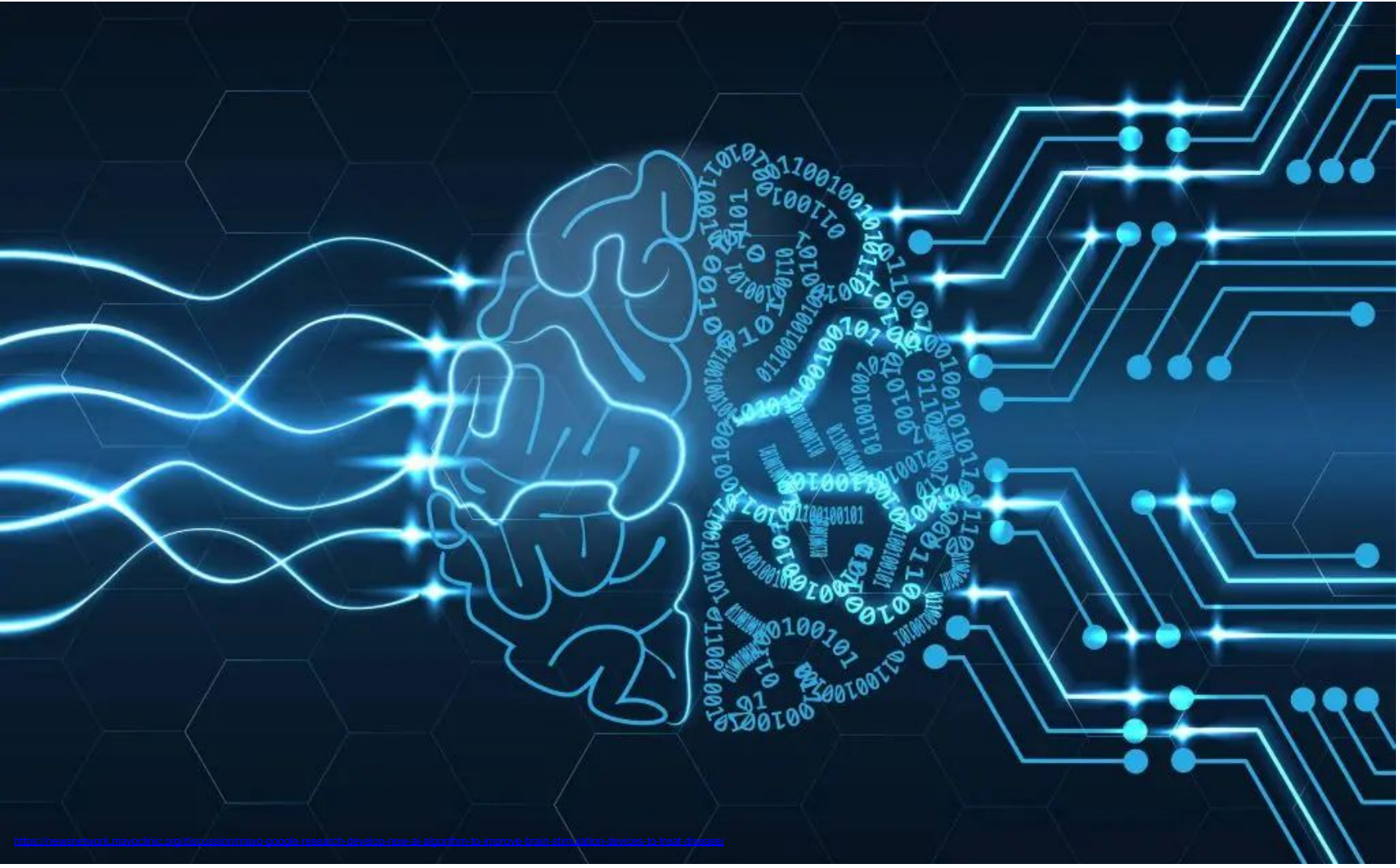
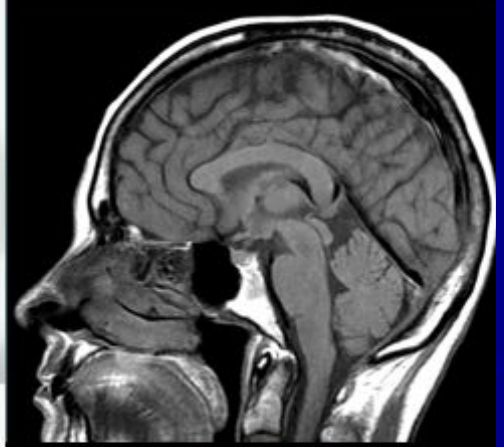


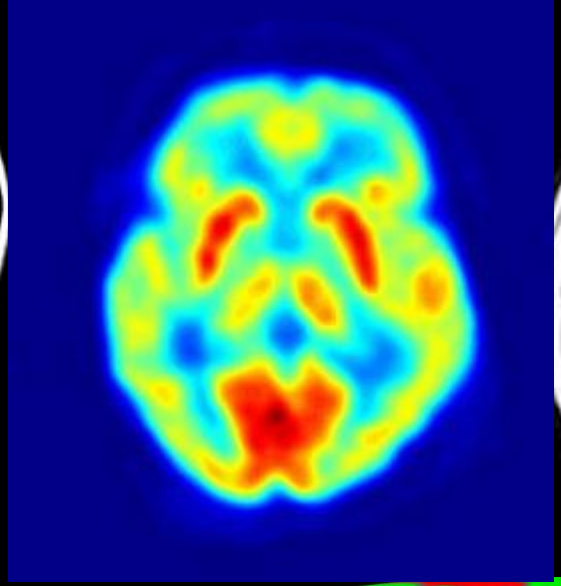
https://newsnetwork.mayoclinic.org/discussion/mayo-google-research-develop-new-ai-algorithm-to-improve-brain-stimulation-devices-to-treat-disease/

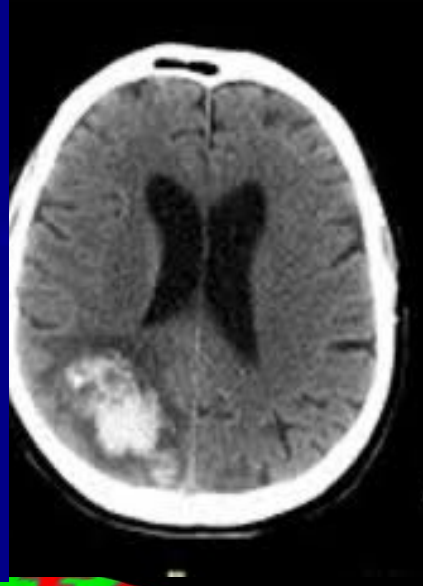

MRI

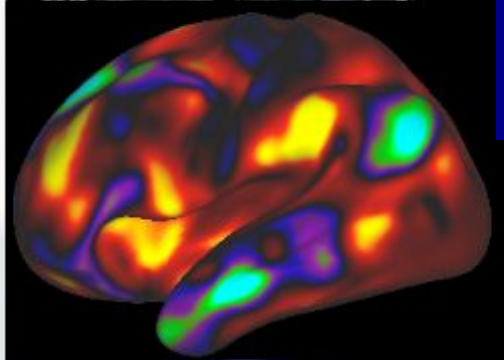

CT

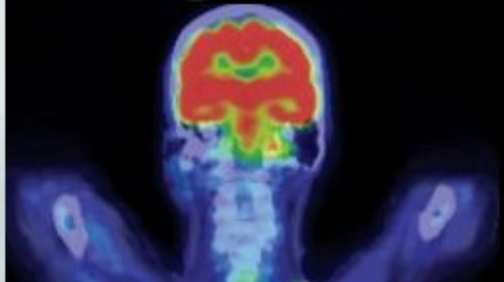

PET

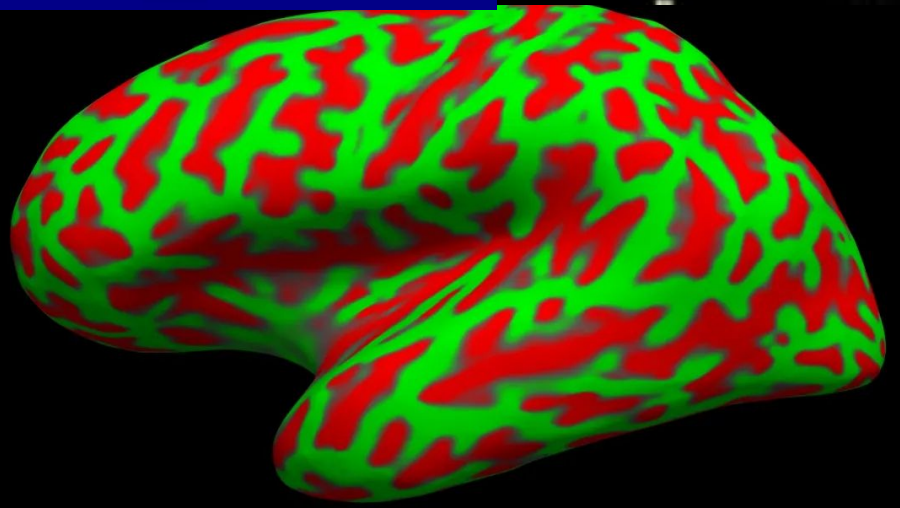


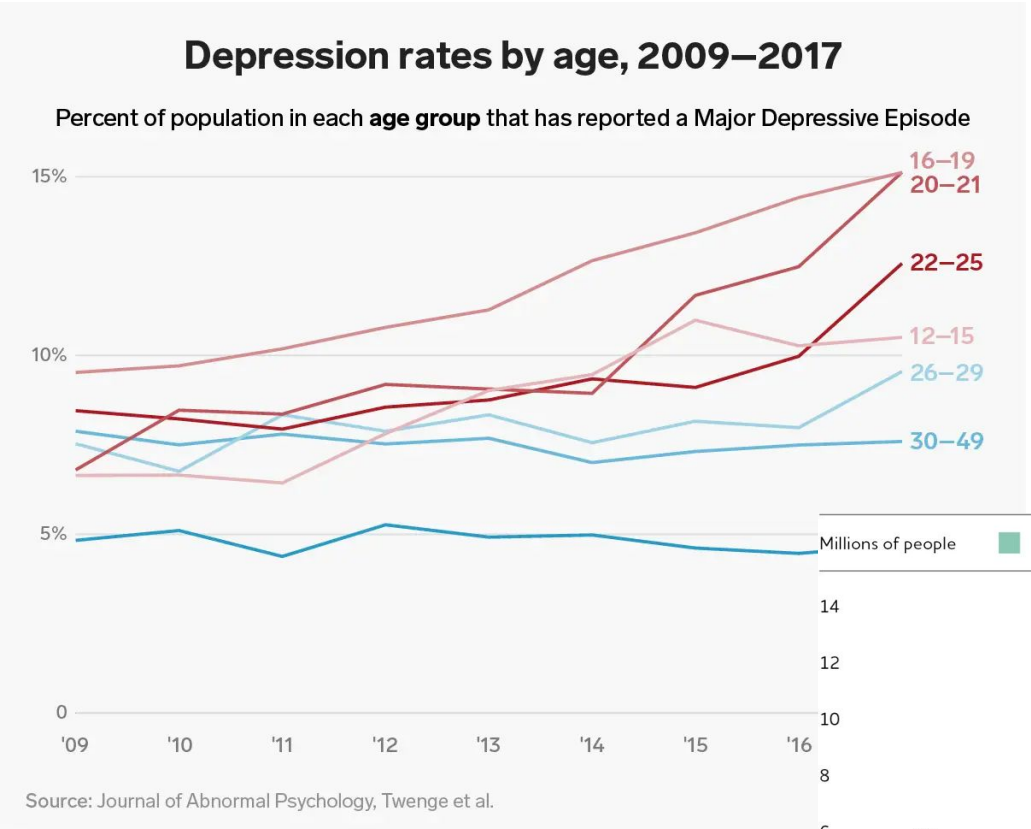




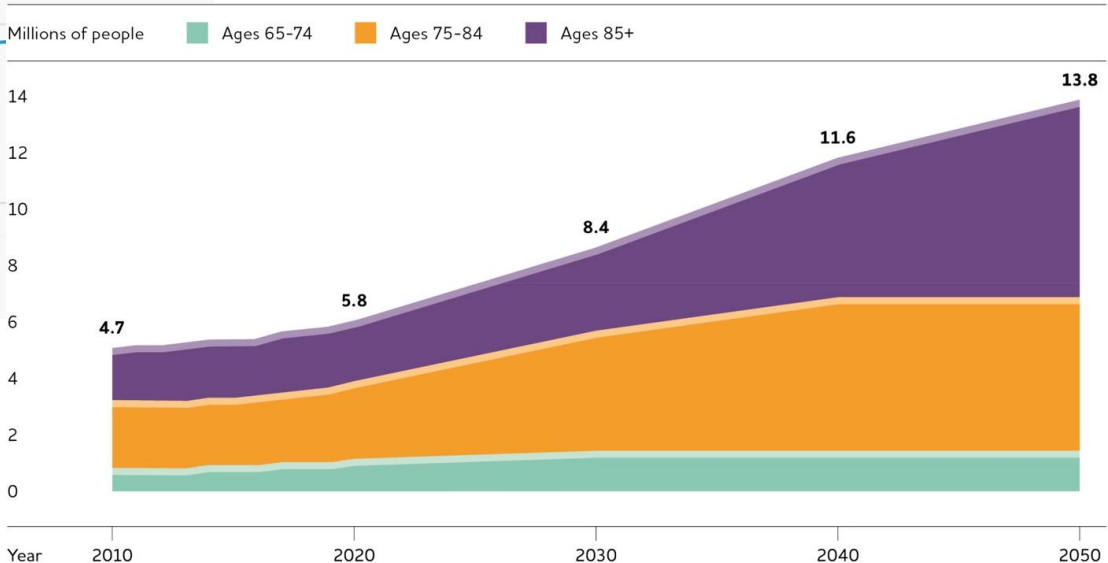




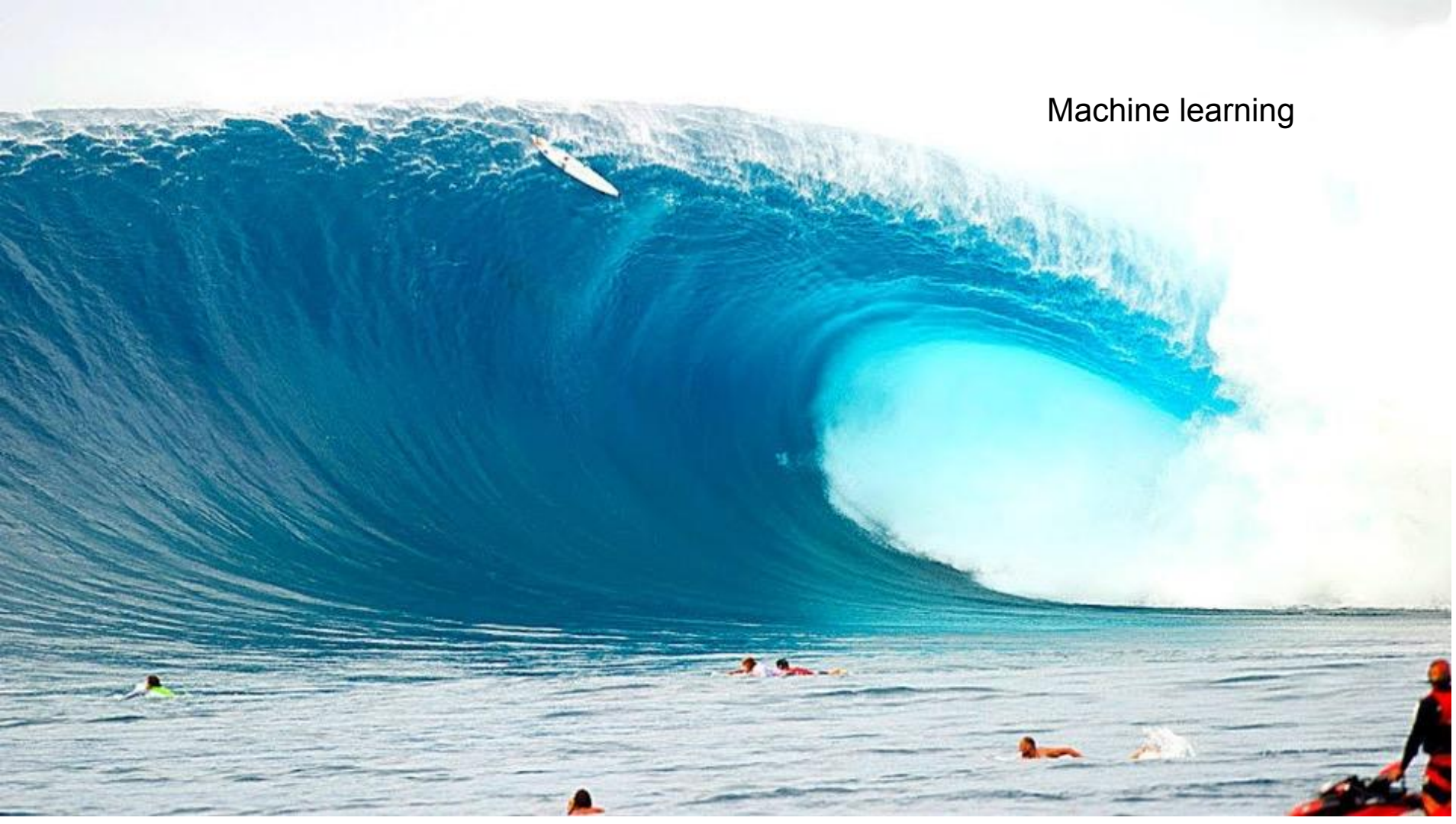




Alzheimer's disease



Neuroimaging data


Machine learning

ML-Neuro

Computer Science

Neuroscience

Machine learning

Neuroimaging data

ChatGPT

- Brainstorming: outlines, arguments
- Research assistance: additional supervisor (with a lot of time and patience :))
- Writing support

- Mention use of ChatGPT. Key ChatGPT prompts are to be listed at the end of the blog post.
- chatpdf.com
- Grading based on the quality (independent of using ChatGPT)

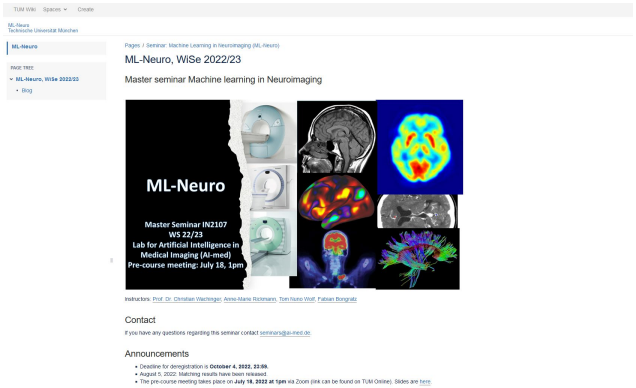
Warnings:

- Beware of hallucinations
- 10min discussion: ChatGPT cannot help you there. You need to understand the topic.

Platforms

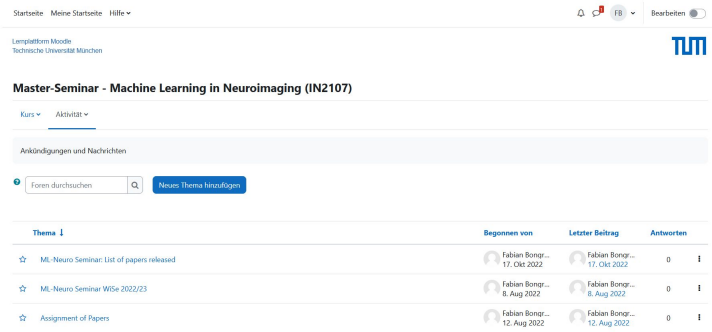
Wiki

- https://wiki.tum.de/display/mlneuro
- General information about the seminar
- Links to papers
- Additional material (e.g., exemplary blogs)



Moodle

- Platform for communication
- Questions & Discussion



Timeline


Kickoff
Work phase
Block seminar
23 October 2023
11/12 January 2024

Timeline

- General introduction
- Distribution of topics

Timeline

- Individual work on the assigned topic / paper
- Meeting with supervisor
  - Optional but recommended
  - Discussion of current state, e.g., preliminary headlines, subsections, core messages

Timeline

- Mandatory event
- Time: January 11, 13-17 & January 12, 9-14
- Location: Holbeinstrasse 11, third floor
- Presentations (live, in-person)
- Hand-in of blog post (two weeks after the seminar)

Expectations

- Being able to read a paper in a structured way
- Explanation of complex ideas in an understandable blog post
- Usage of modern AI tools (ChatGPT) in a deliberate way
- Presentation of research findings to a technical audience

What to deliver?

- Paper presentation

  70% of final grade

- Blog post (~4 pages DIN A4) about the selected paper, see these guidelines

  30% of final grade

Paper presentation

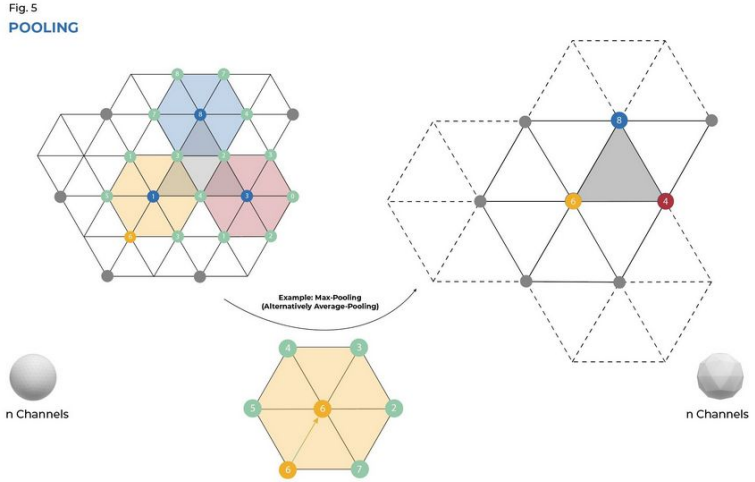
- 20 min. presentation, 10 min. discussion (will influence grade)
- Rule of thumb: 1–2 minutes per slide → 10–20 slides
- In-person
- Talks are held in English
- Technical audience: use appropriate language
- Hand-in of slides via wiki (restricted access page) until **9 January 23:59**
- Recommended structure:
  - Introduction
  - Overview / Outline
  - Method description
  - Experiments and results
  - Personal comments
  - Summary

Blog post

- Written and posted in the wiki
- Approx. 4 pages
- Mostly non-technical language
- Primarily self-made figures!
- Published on wiki
- Deadline: **24 January 2023** (two weeks after presentations)

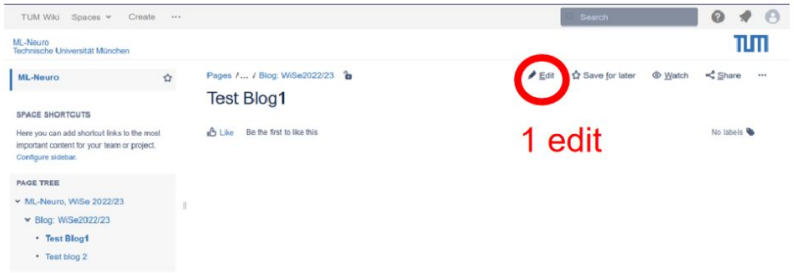
Blog post: be creative!

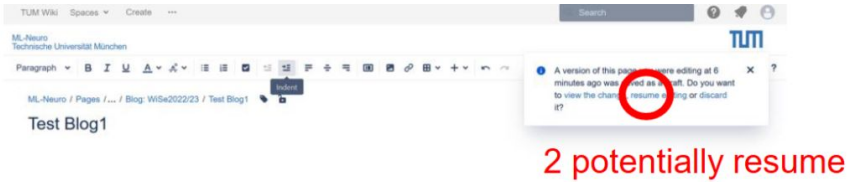
Figure 2: Two half steps vs. one full step in gradient descent and in Gingoog city

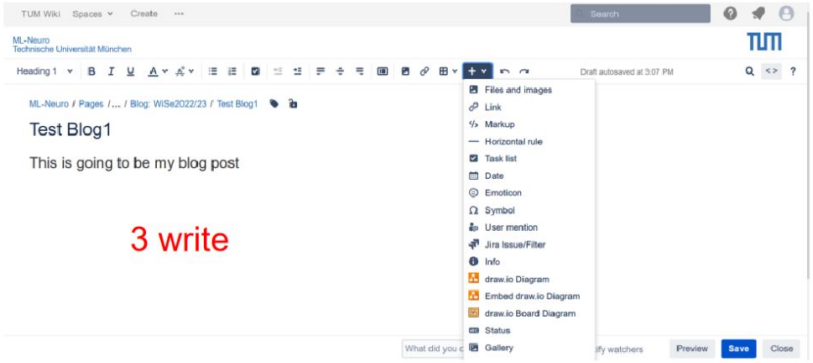


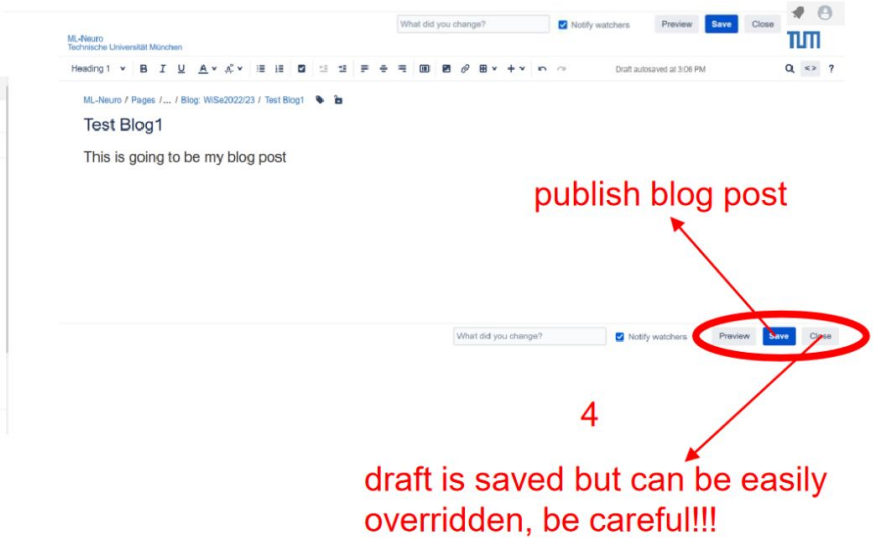
[Fig 5] The same DiNe-Filter can be used by applying it only on vertices that are still present in a lower resolution icosahedron (here orange, blue and red respectively) to achieve pooling.

Writing the blog post









Blog post heading

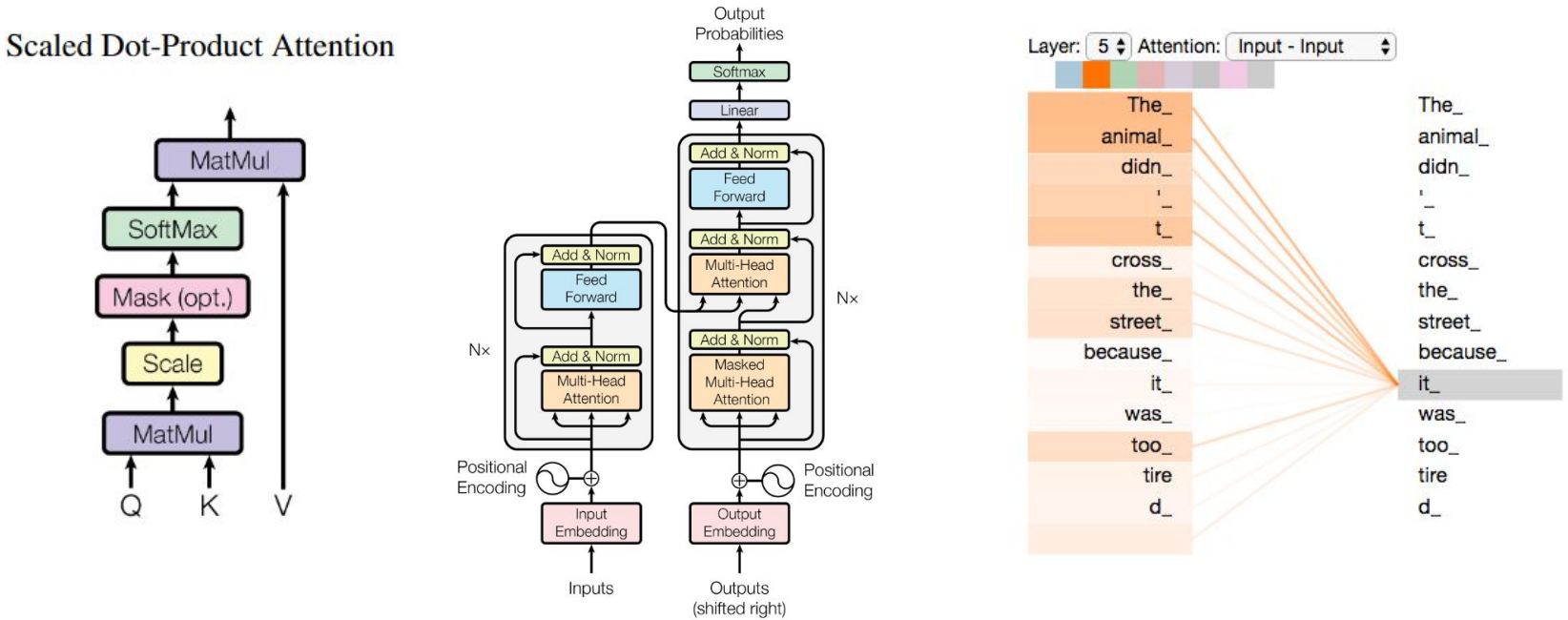
The heading of the blog post should be in the following format to distinguish you (the authors of the blog post) from the authors of the paper:

<Blog post Title>
Blog post written by: <Your name>
Based on: <Paper citation (APA)>

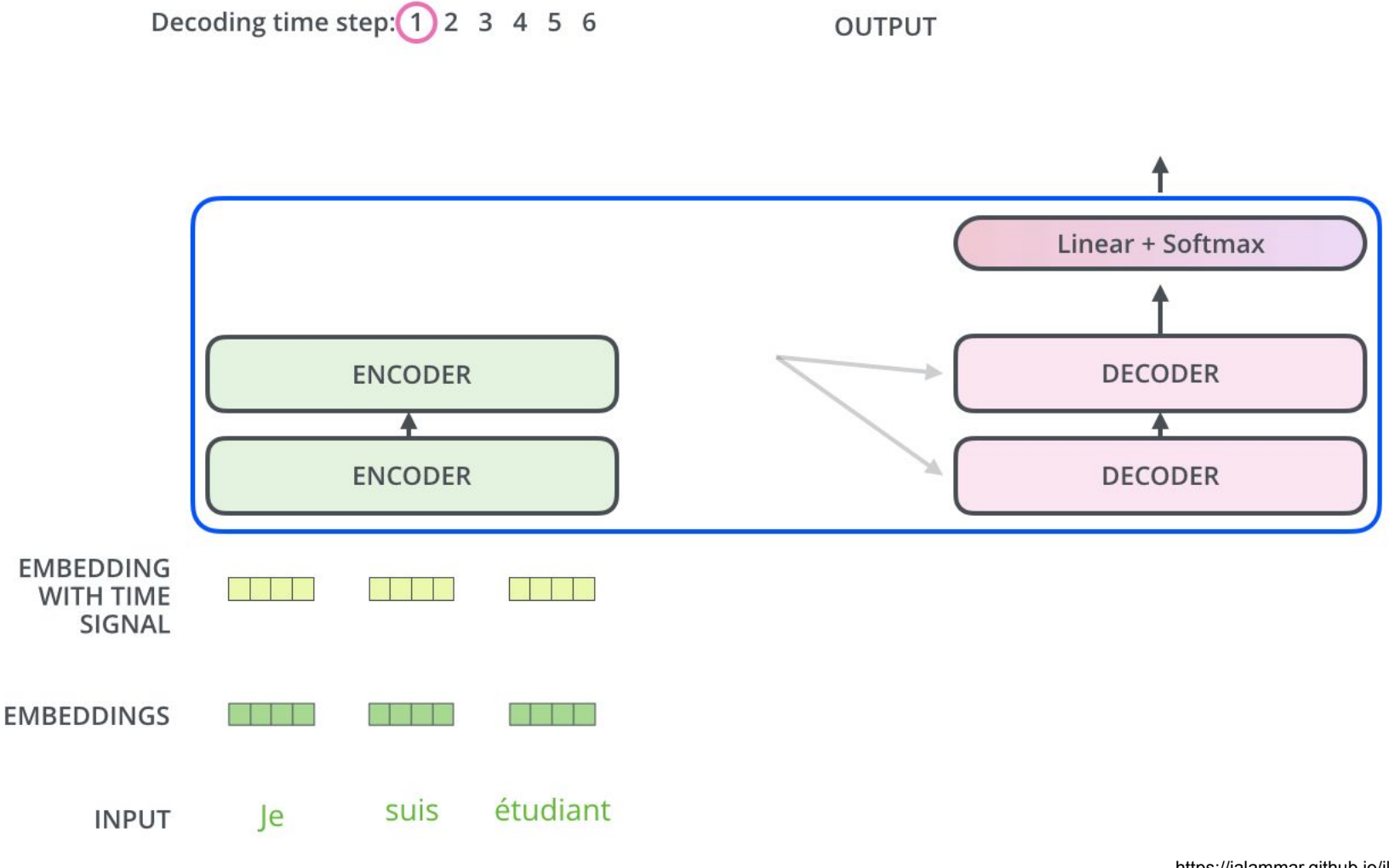
Transformers

Neuroimaging

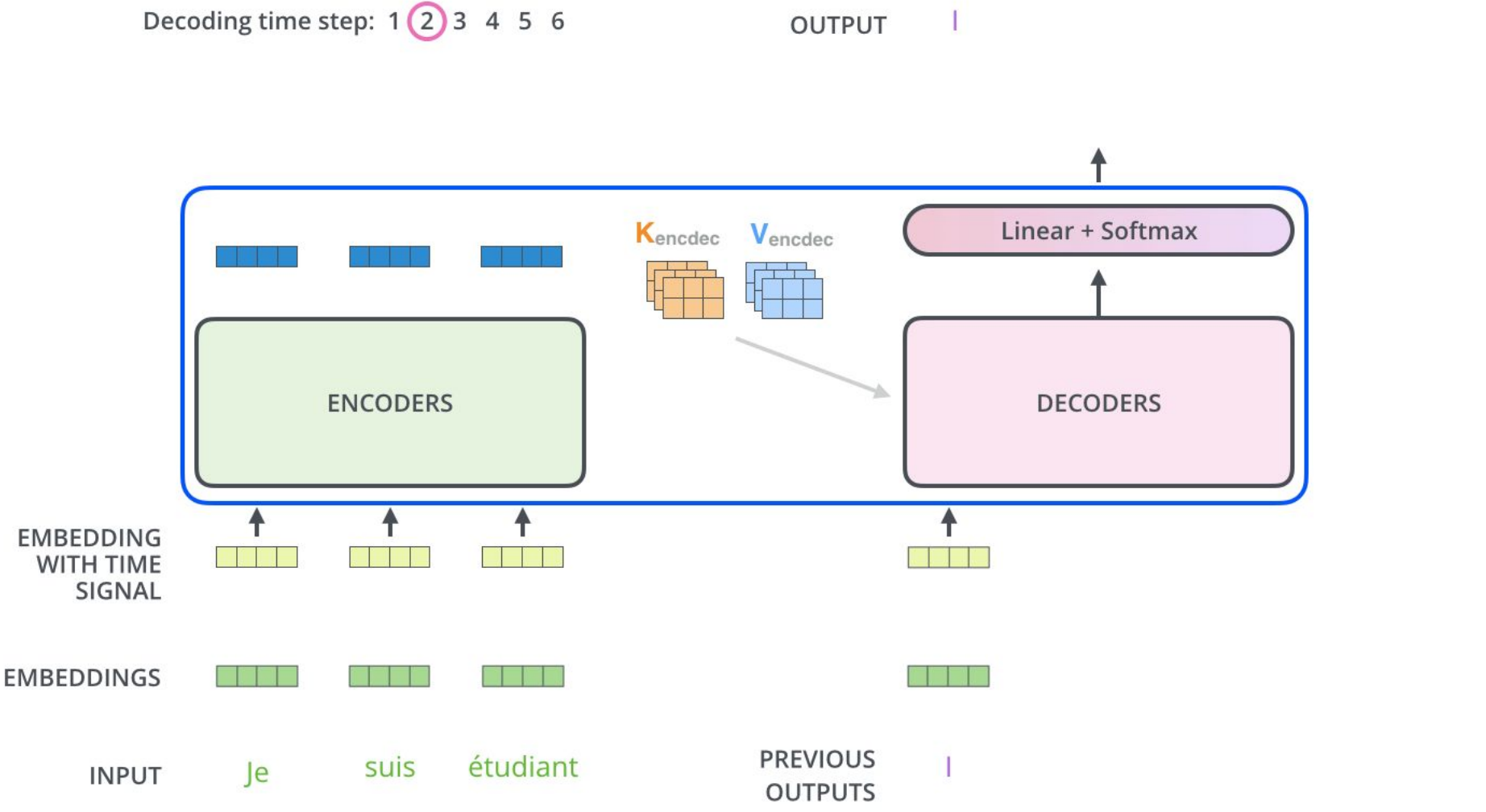
Background: (Self-)Attention in NLP



Images from: *Vaswani, A., Shazeer, N.M., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A.N., Kaiser, L., & Polosukhin, I. (2017). Attention is All you Need. NeurIPS.*
and https://jalammar.github.io/images/t/transformer_self-attention_visualization.png

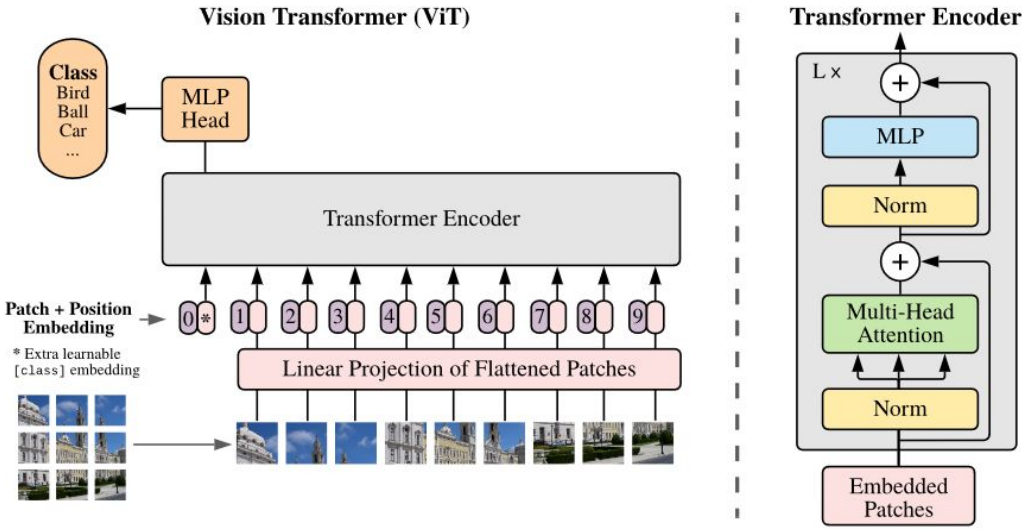


https://jalammar.github.io/illustrated-transformer/



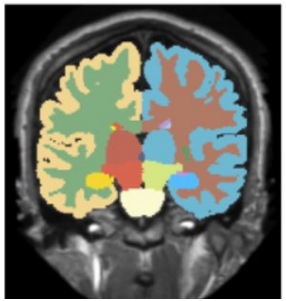
https://jalammar.github.io/illustrated-transformer/

Attention for Image Processing



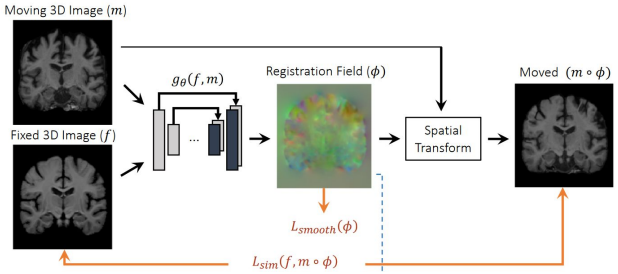
Dosovitskiy, A., Beyer, L., Kolesnikov, A., Weissenborn, D., Zhai, X., Unterthiner, T., Dehghani, M., Minderer, M., Heigold, G., Gelly, S., Uszkoreit, J., & Houlsby, N. (2020). An Image is Worth 16x16 Words: Transformers for Image Recognition at Scale. ArXiv, abs/2010.11929.

Segmentation



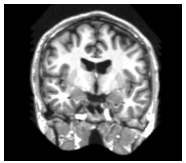
Guha Roy, A. et al. QuickNAT: A Fully Convolutional Network for Quick and Accurate Segmentation of Neuroanatomy. NeuroImage 2018

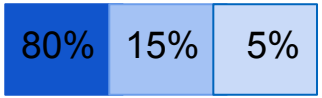
Registration



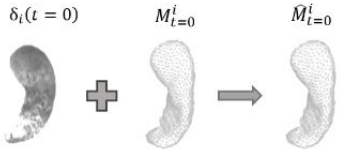
G. Balakrishnan, et al. "VoxelMorph: A Learning Framework for Deformable Medical Image Registration," in *IEEE Transactions on Medical Imaging*, 2019

Classification





Generation



Sarasua, I et al. CASHformer: Cognition Aware SHape Transformer for Longitudinal Analysis. MICCAI 2022

Paper assignment: see wiki

Topics

Paper ID	Title	Published in	Link	Group/Supervisor	Student	Ad
1	UNesT: Local Spatial Representation Learning with Hierarchical Transformer for Efficient Medical Segmentation	Medical Image Analysis	https://arxiv.org/abs/2209.14378	Fabian Bongratz	Mehmet Celimli	
2	Unsupervised brain imaging 3D anomaly detection and segmentation with transformers	Medical Image Analysis	https://www.sciencedirect.com/science/article/pii/S1361841522001220	Fabian Bongratz	Melisa Ankut	
3	Self-Supervised Pre-Training of Swin Transformers for 3D Medical Image Analysis	CVPR	https://arxiv.org/abs/2111.14791	Fabian Bongratz	Petru-Georgian Sicoe	
4	One Model to Synthesize Them All: Multi-contrast Multi-scale Transformer for Missing Data Imputation	IEEE TMI	https://arxiv.org/abs/2204.13738	Christian Wachinger	Thomas Sedlmeyr	
5	PTNet3D: A 3D High-Resolution Longitudinal Infant Brain MRI Synthesizer Based on Transformers	IEEE TMI	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9529647/	Christian Wachinger	Azza Jenane	
6	Towards Generalist Biomedical AI		https://arxiv.org/abs/2307.14334	Christian Wachinger	Hui Cheng	Re /st
7	TransMorph: Transformer for unsupervised medical image registration	Medical Image Analysis	https://arxiv.org/abs/2111.10480	Bailiang Jian	Hakan Buğra Erentuğ	
8	Affine Medical Image Registration with Coarse-to-Fine Vision Transformer	CVPR	https://arxiv.org/abs/2203.15216	Bailiang Jian	Luis David Reyes Vargas	
9	Preserving Tumor Volumes for Unsupervised Medical Image Registration	ICCV	https://openaccess.thecvf.com/content/ICCV2023/papers/Dong_Preserving_Tumor_Volumes_for_Unsupervised_Medical_Image_Registration_ICCV_2023_paper.pdf	Bailiang Jian	Furkan Yakal	
10	Clinically-Inspired Multi-Agent Transformers for Disease Trajectory Forecasting from Multimodal Data	IEEE TMI	https://ieeexplore.ieee.org/abstract/document/10242080	Yitong Li / Nuno Wolf	Yuliia Zinkeieva	
11	MetaVIT: Metabolism-Aware Vision Transformer for Differential Diagnosis of Parkinsonism with 18F-FDG PET	IPMI	https://link.springer.com/chapter/10.1007/978-3-031-34048-2_11	Yitong Li / Nuno Wolf	Ivan Stoyanov	
12	A Hybrid Multi-Scale Attention Convolution and Aging Transformer Network for Alzheimer's Disease Diagnosis	IEEE Journal of Biomedical and Health Informatics	https://ieeexplore.ieee.org/abstract/document/10109788	Yitong Li / Nuno Wolf	Arda Huseyinoglu	

Resources & Material

Giving talks

Doing a TED Talk. The Full Story

TEDx Speaker Guide

The secret structure of great talks

How to Deliver a Great TED Talk

Talk Like TED

AI-med

Questions?