Chair for Computer Aided Medical Procedures (CAMP)
Master Praktikum on
Machine Learning in Medical Imaging

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Chair for Computer Aided Medical Procedures & Augmented Reality

Team

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Course Regulations

Technische Universität München + Johns Hopkins Whiting School of Engineering

Basic Info about the course

- **Type**: Master Practical Course Module (IN2016)
- **Language**: English
- **SWS**: 6
- **ECTS**: 10 Credits
- **Webpage**:
  - https://wiki.tum.de/display/mlmi/MLMI+Winter+2023-2024
- **Time**:
  - Tuesdays, 16-18
- **Location**:
  - CAMP Seminar Room (03.13.010)
  - Virtual Meeting Room (Zoom)
- **Requirements**:
  - Background in machine/deep learning
  - Knowledge of software engineering principles (eg. version control, …)
  - Python programming

Objective

- Learn through practice:
  - Adapting Machine Learning techniques in General or Medical Application
- The course is divided into:
  - A series of talks (Usually one from NVidia and other institutes and a few from our chair)
  - A project involving a machine learning solution to a medical imaging problem

Content

Lectures on

- DL for Medical Image Reconstruction
- Semi-Supervised Methods
- Explainable DL
- Uncertainty Analysis
- Generative Models
- Graph Neural Networks
- Transformers
- A few Lectures by Invited Speakers

Projects

Structure:

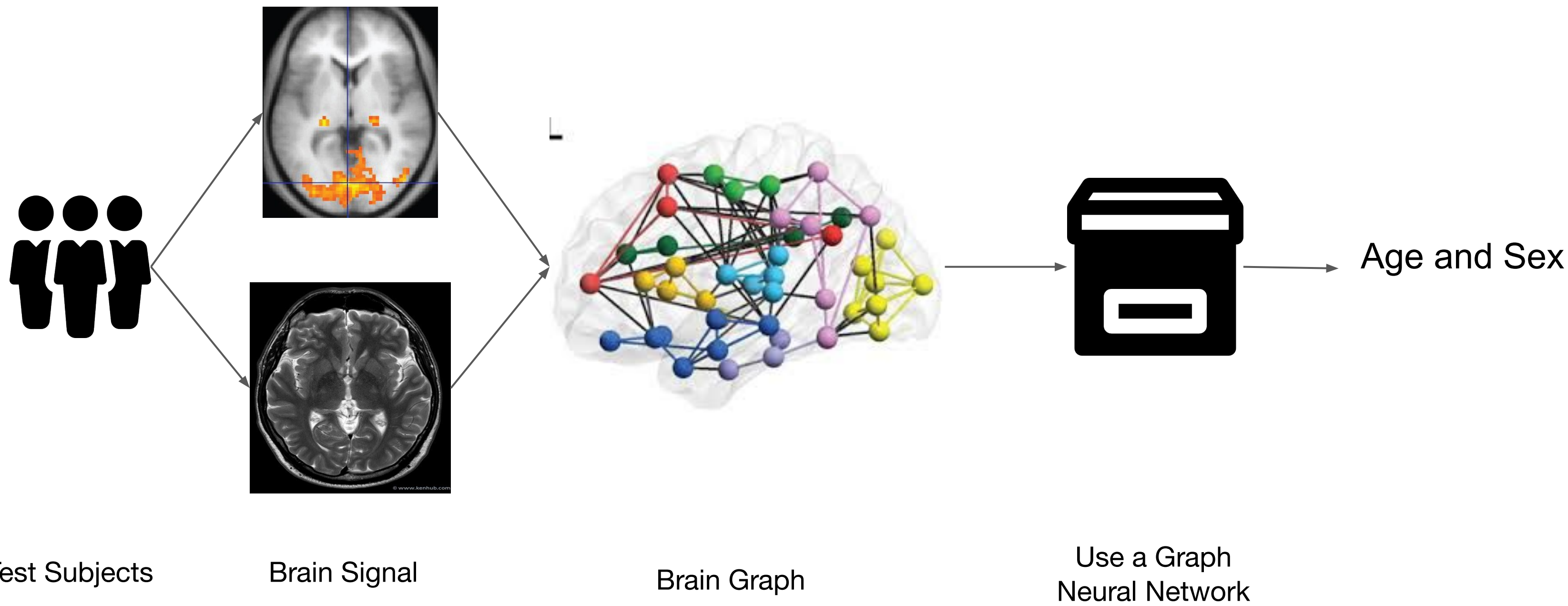
- 5 or 6 Groups of 4 students (max. 20 to 24 students)
- Weekly meeting with your supervisor

Example: (Previous semester)

Projects

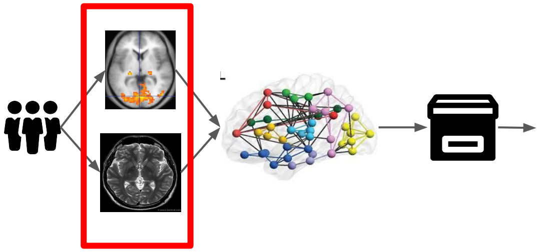
Project	Tutors	Description	FStudents
Explaining Medical Image Classifiers with Visual Question Answering Models	@Keicher, Matthias	MLMI_SoSe22_VQA Models.pdf	Fabian Scherer, Andrei Mancu, Alaeddine Mellouli, Çağhan Köksal
Structured report generation	@Zaripova, Kamilia	MLMI_SoSe22_Structured Report Generation.pdf	Yiheng Xiong, Jingsong Liu. Priyank Upadhya, Melis Gülenay
A comprehensive study of Semi-Supervised Learning in Medical Imaging	@Bdair, Tariq	MLMI_SoSe22_SemiSupervisedLearning.pdf	Mert Sayar, Anna Banaszak, Cenk Eralp, Umaid BIn Zubair
SceneGenie: Scene Graph to Image via CLIP Embeddings and Diffusion Model-based Generation	@Farshad, Azade @Yeganeh, Y. M.	MLMI_SoSe22_SceneGenie.pdf	Chengzhi Shen, Yu Chi, Jacopo Sitran, Tobias Vitt
Exploring generative models for OCT Image generation	@Mach, Kristina	MLMI_SoSe22_OCT Image Generation.pdf	Daria Matiunina, Furkan Çelik, Sebastian Richstein, Murilo Bellatini
GeNoMe: Generating Anomalies in Medical Imaging	@Farshad, Azade @Yeganeh, Y. M.	MLMI_SoSe22_GeNoMe.pdf	Andrea Matécsa, Jakob Ropers, Yixuan Hu, Ata Jadid Ahari

Examples of Projects in Previous Semesters



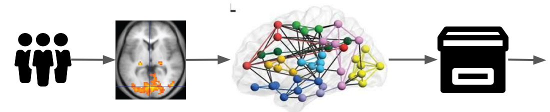
Box & people icons made by Smashicons & Pixel perfect from www.flaticon.com
fMRI: wikipedia.com; Version 8.25 from Textbook OpenStax Anatomy and Physiology
Brain Graph: Cohen, J. R., and M. D'Esposito. "The Segregation and Integration of Distinct Brain Networks and Their Relationship to Cognition." *Journal of Neuroscience* 36, no. 48 (November 30, 2016):

Two dataset



Dataset	Num. subjects	Features	Age labels	Task	Task structure
HCP	1003	fMRI time series	4 classes	age & sex prediction	**graph classification**
UK Biobank	14503	MRI + fMRI features	44-80y $\mu = 52.7 \pm 7.5$	age & sex prediction	**node classification**

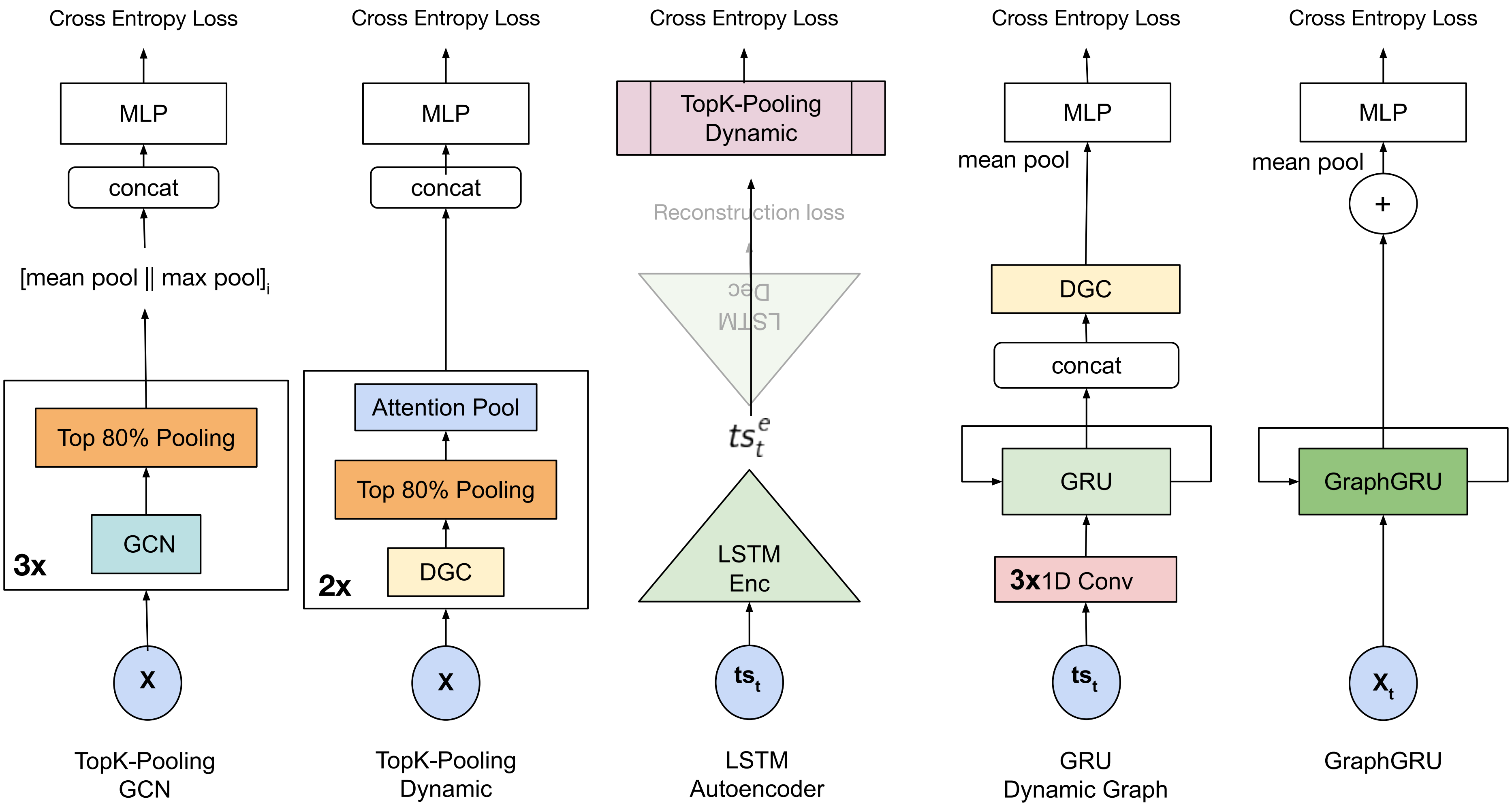
Previous work fMRI: age & sex



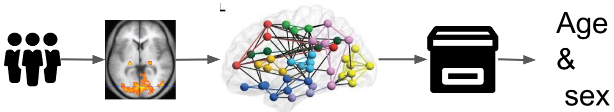
Paper	**Modality**	**Model**	**Dataset**	**Gender**	**Age**	**Why interesting?**
Arslan et al [AR18]	**fMRI**	GCN	UK Biobank 44-88y (N=14503)	88%	Missing	Best result only of fMRI
Pervaiz et al [PS20]	fMRI	Elastic Net	**HCP**	85.5%	58% prediction correlation	Best result on HCP fMRI
Xing et al [XS19]	T1 MRI + fMRI	GC-LSTM	ADNI2 (55-90)	89%	3 MAE	Similar network structure

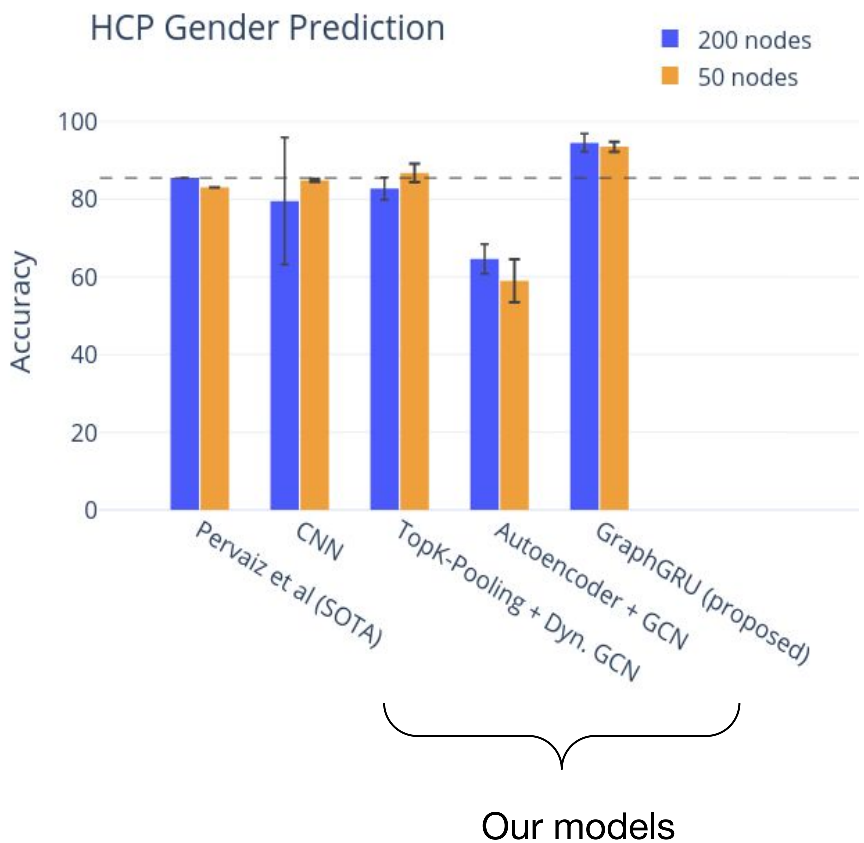
[AR18]Arslan, Salim, Sofia Ira Ktena, Ben Glocker, and Daniel Rueckert. “Graph Saliency Maps through Spectral Convolutional Networks: Application to Sex Classification with Brain Connectivity.” *ArXiv:1806.01764 [Cs]*, June 5, 2018.
[XS19] Xing, Xiaodan, Qingfeng Li, Hao Wei, Minqing Zhang, Yiqiang Zhan, Xiang Sean Zhou, Zhong Xue, and Feng Shi. “Dynamic Spectral Graph Convolution Networks with Assistant Task Training for Early MCI Diagnosis.” *MICCAI 2019*,
[PS20]Pervaiz, Usama, Diego Vidaurre, Mark W. Woolrich, and Stephen M. Smith. “Optimising Network Modelling Methods for FMRI.” NeuroImage 211, May 1, 2020

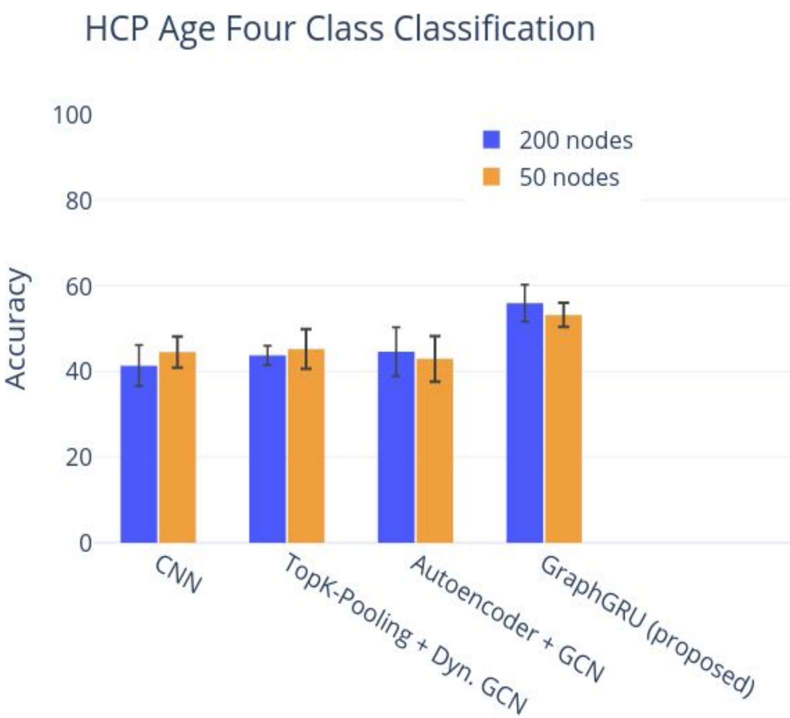
Proposed Models



Results HCP (fMRI)

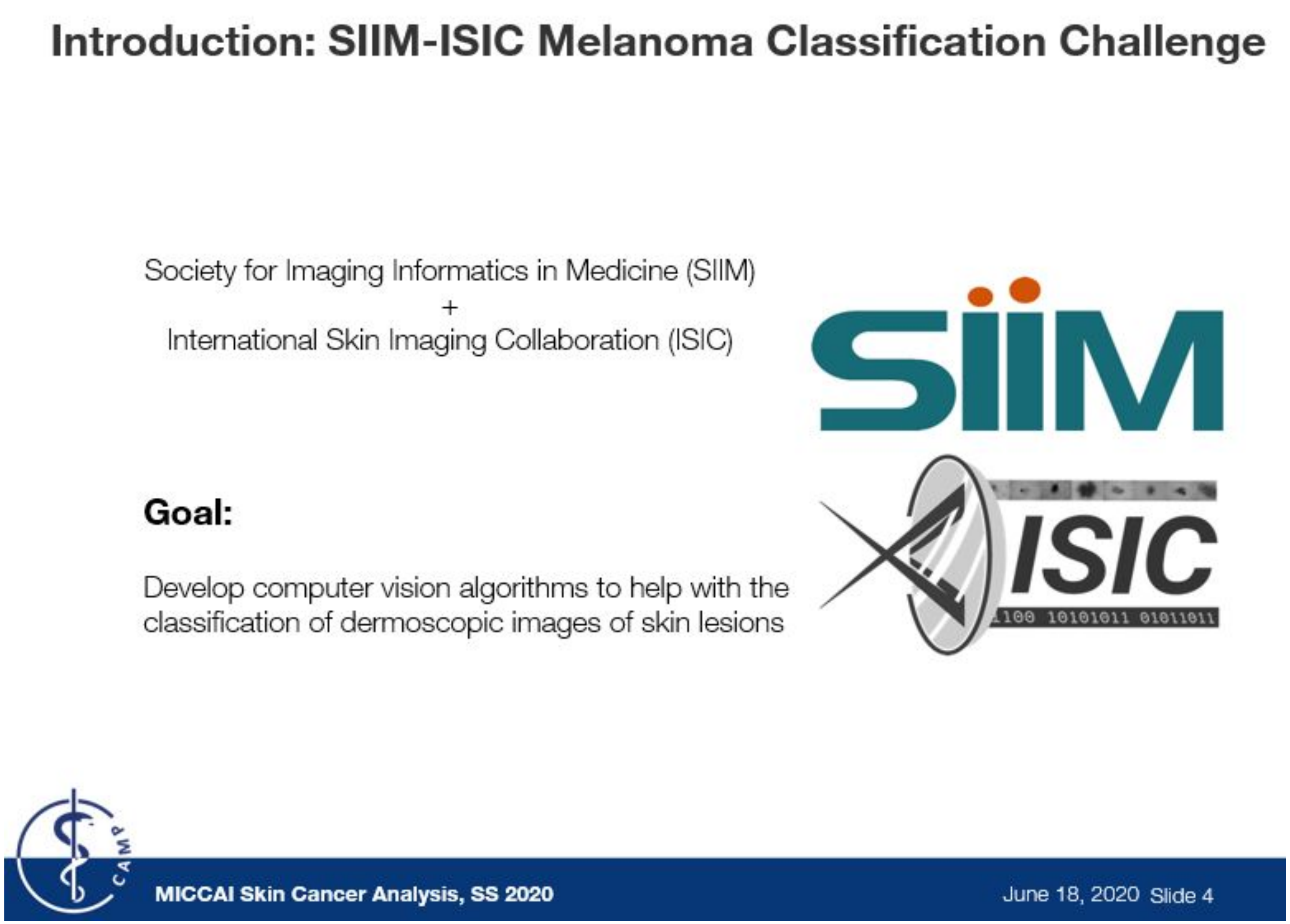






Examples of Projects in Previous Semester

EfficientNet with Robust Training: MICCAI ISIC challenge



Examples of Projects in Previous Semester

Problem Statement

Melanoma is the least common skin cancer, but also the most serious type. It is responsible for **75%** of skin cancer deaths

benign

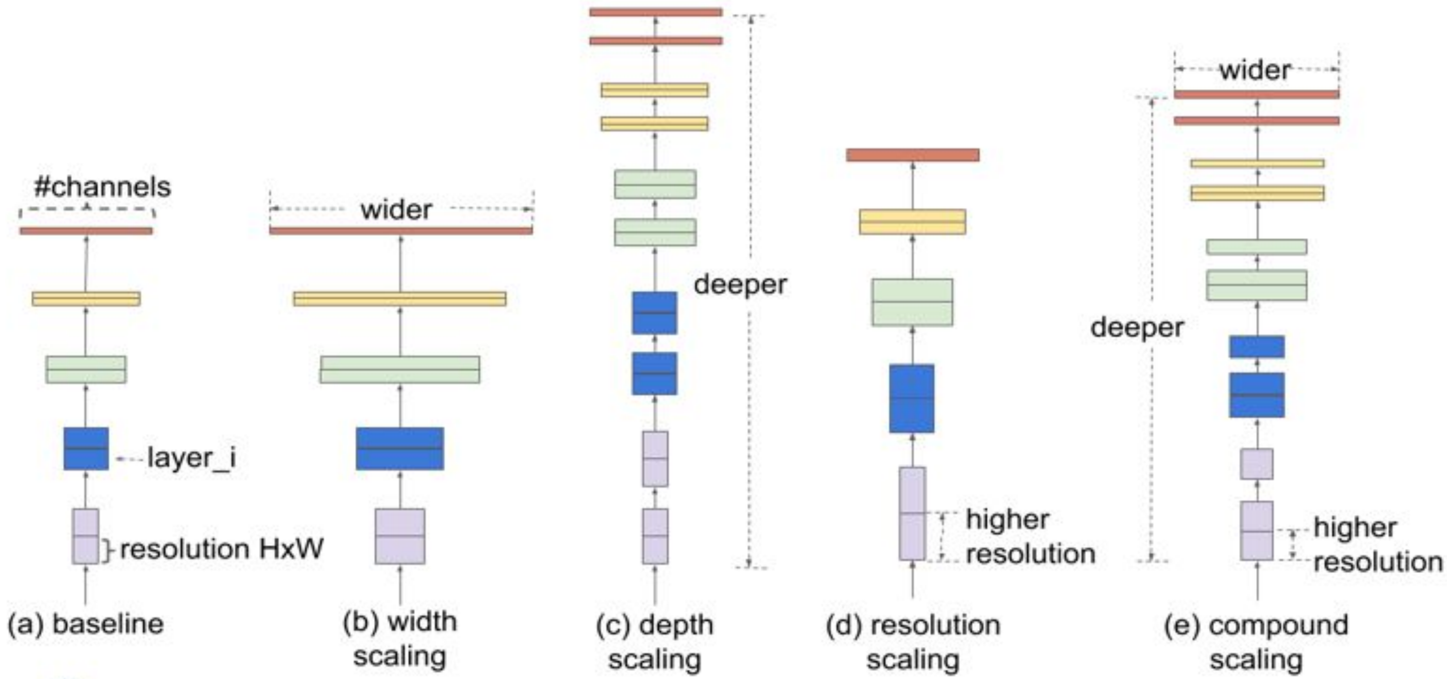
malignant

Goal: Using images within the same patient, determine which are likely to represent a melanoma

Examples of Projects in Previous Semester

EfficientNet [2] : Compound Scaling and AutoML

- Neural architecture search to develop the baseline network
- **Compound scaling** to scale the model structurally in all dimensions



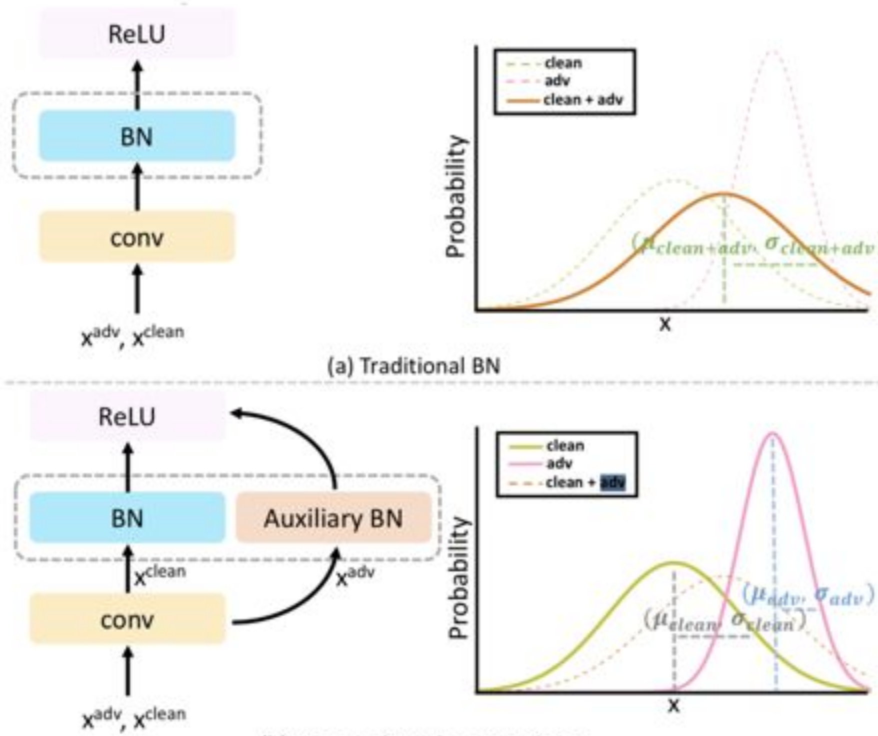
[2] Tan, M. and Le, Q.V., 2019. Efficientnet: Rethinking model scaling for convolutional neural networks. ICML

MICCAI Skin Cancer Analysis, SS 2020 June 18, 2020 Slide 20

Examples of Projects in Previous Semester

AdvProp [3] : Approach

- Using **auxiliary batch norm** to disentangle mixed distribution



(b) Proposed Auxiliary BN Design

[3] Xie, C., Tan, M., Gong, B., Wang, J., Yuille, A. L., & Le, Q. V. (2020). Adversarial examples improve image recognition. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 819-828)

Examples of Projects in Previous Semester

RandAugment[4] for learning better augmentations

- Using Data Augmentations increase performance but finding proper set of augmentations requires expertise and domain knowledge

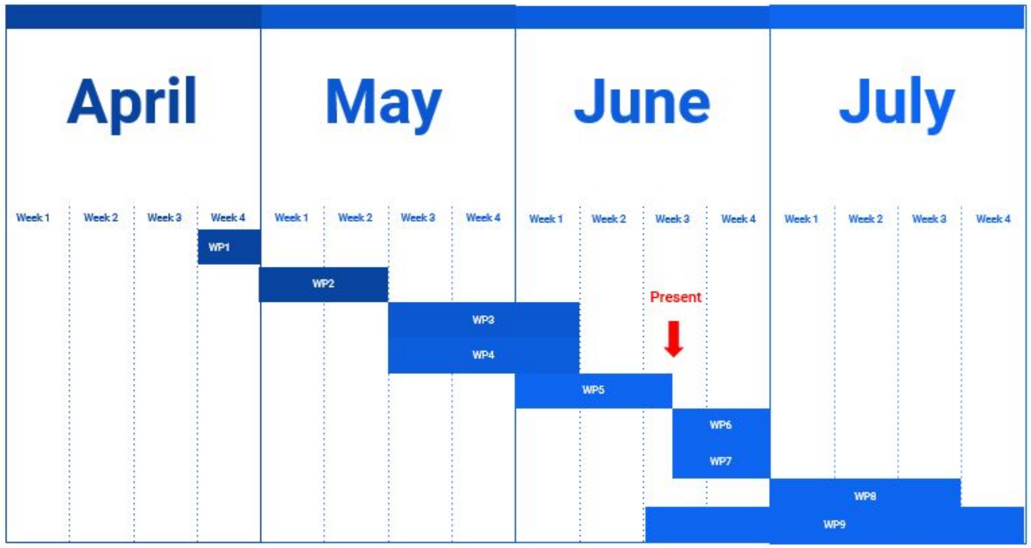
- Learning policies for choosing data augmentations on a proxy (smaller) task (AutoAugment)[7] is not always scalable to the task at hand.

- **RandAugment** proposes to simply find a set of transformations and the corresponding magnitude through Grid Search on the main task.

[4] CVPRW2020: Cubuk, E. D., Zoph, B., Shlens, J., & Le, Q. V. (2020). Randaugment: Practical automated data augmentation with a reduced search space. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshops (pp. 702-703)

[7] Cubuk, Ekin D., et al. "Autoaugment: Learning augmentation strategies from data." Proceedings of the IEEE conference on computer vision and pattern recognition. 2019.

Examples of Projects in Previous Semester



WP 1 Read and Familiar with Literature

- Getting familiar with Tensorflow

WP 2 Understanding the EfficientNet

- Getting familiar with pretrained models
- Tried and failed with Tensorflow version, started to use PyTorch

WP 3 Understanding and Implementation of Adversarial Propagation

WP 4 Understanding and Implementation of RandAugment

WP 5 Familiar with clinical data (challenge dataset)

- Implementing data reading
- Data pre-processing

WP 6 Implement and evaluate WP3 on challenge dataset

- Adversarial Propagation

WP 7 Implement and Evaluate WP4 on challenge dataset

- Rand Augment

WP 8 Evaluation on validation set

- Optimization of models

WP 9 Challenge Submission

- Test set results
- Documentation

Evaluation

Project: 100%

- **Progress: 50%**
  - Weekly supervision sessions with the tutors
  - Define a list of ToDo's
  - Share a code repository
  - Student's contribution will be monitored on LRZ Git
  - Evaluated by the tutor
- **Presentation: 50%**
  - Intermediate Presentation (15 mins + 5 mins. Q&A)
  - Final Presentations (15 mins + 5 mins. Q&A)
  - Evaluated by the all tutors
- **Participation in talks is mandatory**
  - Only one session is allowed to be absent
  - 0.3 points

How can you apply?

- Submit the registration form (on course webpage)

MLMI Registration

Student Name *

Email *

Master's Program *

Current Semester *

Related Courses *

If passed, mention the grades

Resume (max 150 words) *

max 150 words (if exceeded, your application will be discarded) You may talk about your related projects - publications/competitions/github repositories - work experience, ...

Deadline for the registration form: Same as the Matching System

Important Dates

Deadline for submitting the registration form:

Same as matching system

You can find these slides and other info on the course website:

https://wiki.tum.de/display/mlmi/MLMI+Winter+2023-2024

Don’t forget to register at TUM matching system

Register via matching.in.tum.de

Check the deadline of the Matching System