

Computational Imaging Project

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Computational Imaging Lab (CIL), Friedrich-Alexander-Universität Erlangen-Nürnberg

Winter Semester 2023/2024



Outline

Introduction

Projects

Homework before our next meeting

1 Introduction



Who we are?

- ▶ Dr. Zhengguo Tan
 - ▷ Postdoc in CIL
- ▶ Prof. Dr. Florian Knoll
 - ▷ W3 professor of CIL

What is CIL/CIP about?

- ▶ Semester period: till 13. April 2024
- ▶ **10 ECTS = 300 working hours**
- ▶ Prerequisite - You should have taken one of these courses:
 - ▷ pattern analysis or pattern recognition
 - ▷ magnetic resonance imaging (MRI) 1/2
 - ▷ **computational MRI** (given by Prof. Knoll every winter semester)
- ▶ **Hands-on:** learning by doing

Effort & Attendance

- ▶ 1 project per student
- ▶ effort:
 - ▷ reading and understanding papers 50 %
 - ▷ implementing ideas (coding) 20 %
 - ▷ analyzing results 20 %
 - ▷ final presentation (about 20 minutes)
 - ▷ written report (about 10 pages) due in three weeks after your presentation
- ▶ attendance:
 - ▷ final presentations: 10 %

Office Hours

- ▶ Zhengguo: Tue and Wed 10:00 – 11:30
- ▶ Book 30 min slots via StudOn: <https://www.studon.fau.de/book5499411.html>
- ▶ In person: Meet at our office (Room 2.02, Werner-von-Siemens-Str. 61)
- ▶ Zoom: <https://fau.zoom-x.de/j/6394311813>

Mid-Term Presentations

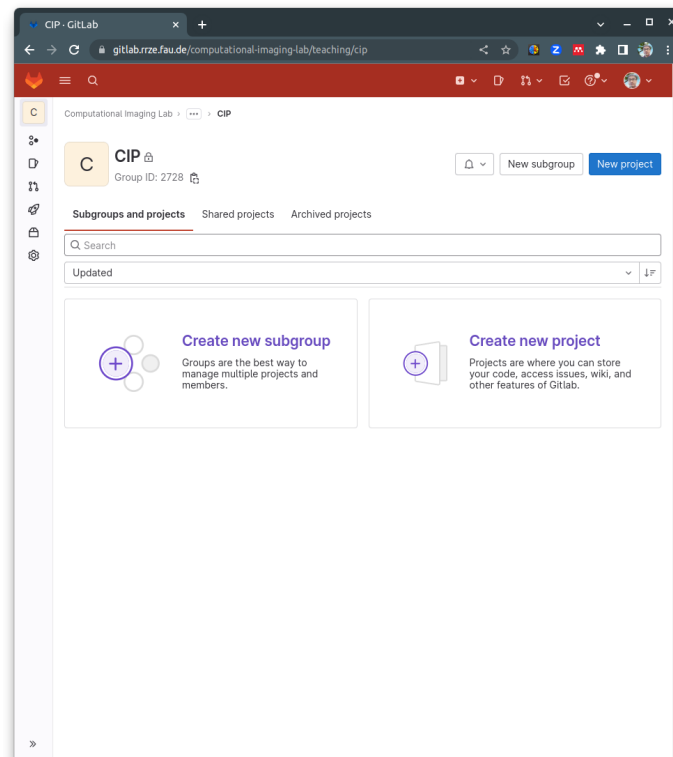
- ▶ tentative date: 09.01.2024 starting at 10 AM.
- ▶ place: Seminar room 03.17, Werner-von-Siemens-Str. 61
- ▶ every one needs to give a 5 to 10 minutes presentation about his/her project.

Final Presentations

- ▶ **Registration for the final exam via CAMPO (date: tba)**
- ▶ tentative date: 03.2024
- ▶ every one needs to give a 20 minutes presentation
- ▶ every one needs to attend the others' presentations

Management on Codes, Presentations, and Reports

1. unified environment: `https://gitlab.rrze.fau.de/computational-imaging-lab/teaching/cip/ws2023`
2. please request the FAU GitLab service via IdM-Portal.
3. I will then invite you to the your project repository.



Oral Presentation and Written Report

Presentation

- ▶ Format:
 - ▷ Motivation and Introduction
 - ▷ Theory
 - ▷ Methods
 - ▷ Results and Discussion
 - ▷ Conclusion

Report

- ▶ Format:
 - ▷ Introduction
 - ▷ Theory
 - ▷ Methods
 - ▷ Results and Discussion
 - ▷ Conclusion

- ▶ No template for presentation;
- ▶ there will be a \LaTeX template for the report.

Computing Options

► HPC @ FAU:

- ▷ <https://hpc.fau.de/>
- ▷ requires knowledge on bash script in Linux terminal, anaconda, and python.
- ▷ requires account application, so please let me know soon.

► JupyterHub @ FAU:

- ▷ <https://hpc.fau.de/systems-services/documentation-instructions/clusters/jupyterhub/>
- ▷ this is a new offer from NHR@FAU!
- ▷ GTX1080Ti GPU

► Google Colab:

- ▷ usually you can get a Tesla T4 GPU for free.
- ▷ requires knowledge on jupyter notebook (bash script and python).

► Your own computer.

Computing Environments

▶ **Anaconda** → conda

- ▷ flexible
- ▷ reproducible
- ▷ learning material:

<https://conda.io/projects/conda/en/latest/user-guide/index.html>

▶ **Jupyter Notebook**

- ▷ learning material:

<https://jupyter-notebook-beginner-guide.readthedocs.io/en/latest/>

▶ IDE: Spyder, Visual Studio Code, PyCharm

Questions?

Self Introduction

- ▶ who I am?
- ▶ study program / semester / courses
- ▶ what you want to learn/do in the CIL/CIP?

2 Projects



VarNet vs. MoDL

► Articles:

- Hammernik K, Klatzer T, Kobler E, Recht MP, Sodickson DK, Pock T, Knoll F. Learning a variational network for reconstruction of accelerated MRI data. *Magn Reson Med* (2018). doi: 10.1002/mrm.26977
- Aggarwal HK, Mani MP, Jacob M. MoDL: Model-based deep learning architecture for inverse problems. *IEEE Trans Med Imaging* (2019). doi: 10.1109/TMI.2018.2865356

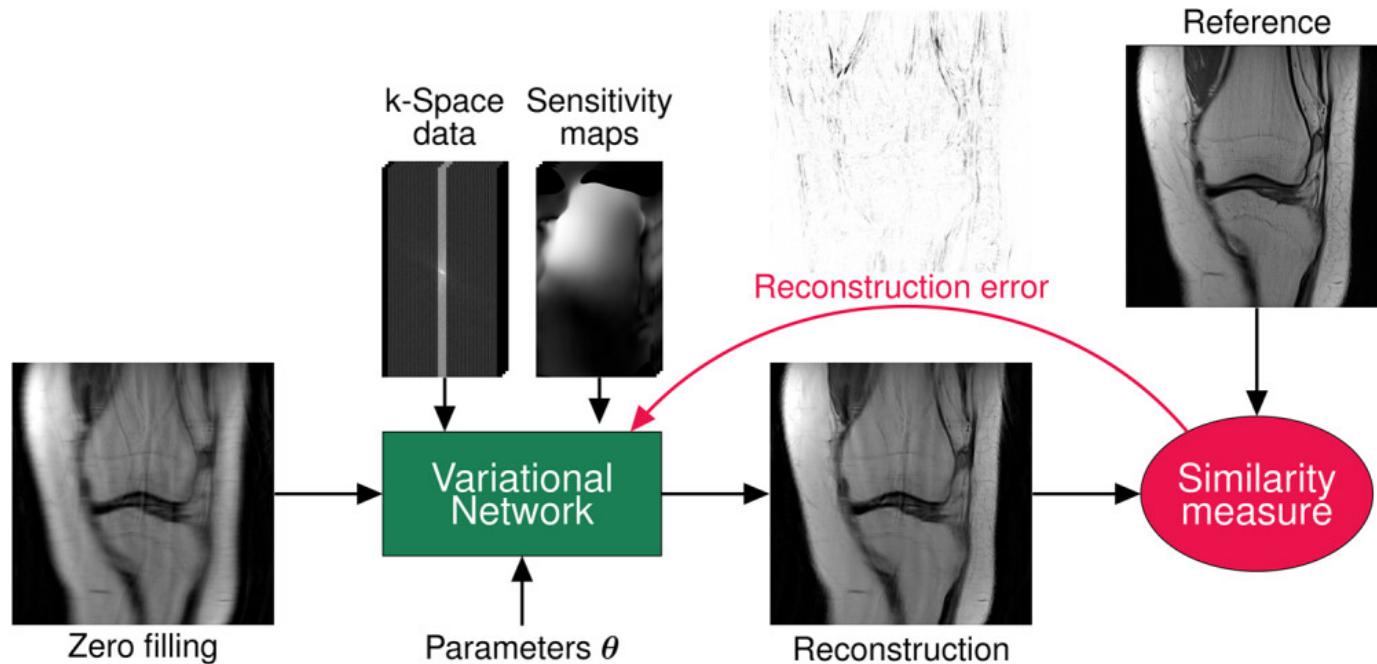
► Basic code & data: https://github.com/ZhengguoTan/MoDL_PyTorch

► Suggested computing option: HPC

► Tasks:

- Run both Varnet and MoDL based on the github repository;
- Use fastmri dataset instead;
- Change the UNet in VarNet and the ResNet in MoDL to a transformer.

VarNet: with fully-sampled images available; supervised learning



Self-supervised learning via data undersampling (SSDU)

► Article:

- ▷ Yaman B, Hosseini SAH, Moeller S, Ellermann J, Uğurbil K, Akçakaya M. Self-supervised learning of physics-guided reconstruction neural networks without fully sampled reference data. *Magn Reson Med* (2020). doi: [10.1002/mrm.28378](https://doi.org/10.1002/mrm.28378)

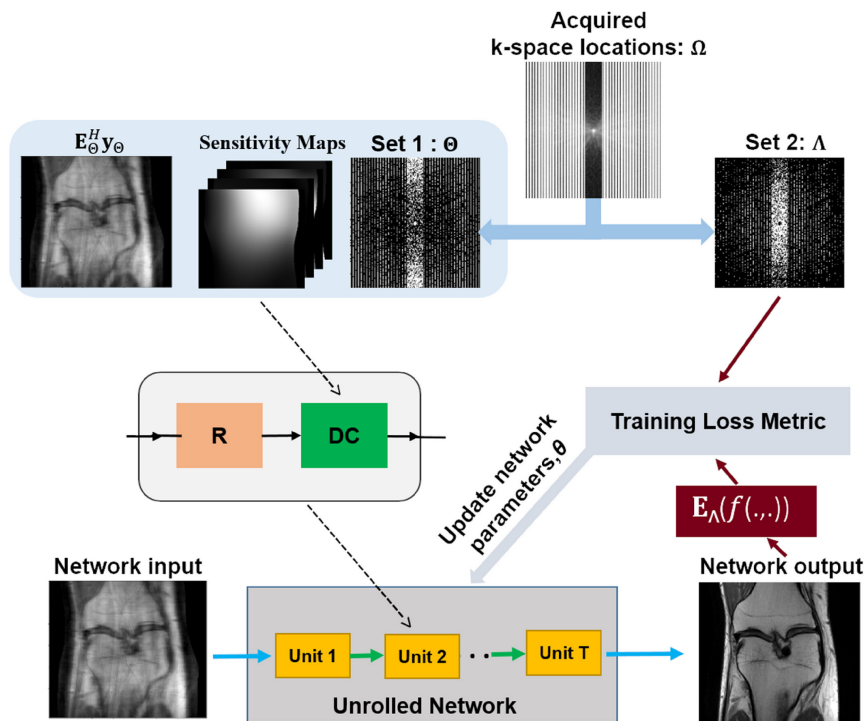
► Basic code: <https://github.com/byaman14/SSDU>

► Suggested computing option: HPC

► Tasks:

- ▷ Understand the main concept of the SSDU architecture: ResNet;
- ▷ Reproduce the existing implementation;
- ▷ Apply different types of SSDU masks;
- ▷ Analyze training and testing results;
- ▷ Change the ResNet to a transformer.

SSDU: without fully-sampled images; self-supervised learning



Notes

- ▶ Every 2 or 3 students has the same project;
- ▶ Students with the same project are allowed to discuss with each other, but not to copy & paste;
- ▶ Presentations and Reports must be done individually and will be graded individually.

3 Homework before our next meeting



Homework

- ▶ read the slides and papers again;
- ▶ think about which project you want to work on;
- ▶ read the articles (and codes) related to your project;
- ▶ start to work on the project.

- ▶ **please sign up for the office hours:**
<https://www.studon.fau.de/book5115803.html>

- ▶ Meet again next week (10 AM, 21.11.2023; Seminar Room 03.17)

Let's get started ...

- ▶ Thank you for your interest and attention!

Let's get started ...

- ▶ Thank you for your interest and attention!
- ▶ However, attention is not all you need - you also need to accomplish the project.