A multi-dataset foundation model for pathology segmentation

Project Management and Software Development
for Medical Applications

General Info

Contact Person: Mehdi Astaraki

Contact Email: mehdi.astaraki@ki.se ; mehdi.astaraki@fysik.su.se ; mehast@kth.se ;

The project can be done in Stockholm (as an exchange or visiting student) or remotely.

Project Abstract

The current practice in the medical imaging community is to develop a model based on the specific dataset collected for that certain task. Interestingly, there exist different tasks for the same anatomical regions. Essentially, it means that there are several different datasets acquired from the same anatomies but were annotated for different applications. Such a cross-dataset synergy can be leveraged to build a foundation model.

Background and Motivation

Background: The success of medical image segmentation models heavily depends on the availability of large-scale heterogenous annotated datasets. However, labeling the 3D image volumes with pixel-level accuracy is a tedious task and is usually done for a limited number of subjects.

Motivation: While several different labeled datasets exist for the same anatomical regions, each of them is labeled for a certain task, i.e., they are partially labeled with respect to each other. On the other hand, integrating all these datasets potentially yields higher diversity in the acquisition parameters and a larger variety of anatomical/pathological structures.

Problem statement: In this project, a novel strategy will be employed to build a foundation model trained by large-scale diverse datasets. The well-trained model, then, will be optimized and fine-tuned for certain specific tasks of pathology segmentation in which only a limited number of labeled data is available.

Previous works: Previous approach to deal with different labels across multiple datasets focused on: 1) predicting one structure of interest for each forward pass, 2) training a network with one shared encoder and separate decoders for each dataset, and 3) not supporting overlapping labeled structures.

Student's Tasks Description

In this project, the student is expected to:

1 – Review the literature to understand the methodology and theoretical background.

2 – Implementation and gaining experience of 3D segmentation models

3 – Implementation and gaining experience of self-configuring segmentation models

4 – Practically learn how the pipeline of multi-dataset foundation model works

5 – Implementing, optimizing, and fine-tuning the foundation model for specific tasks such as head&neck, lung, and liver tumor segmentations.

6 – The ultimate goal of the project is to deliver a dockerized package of the model for both the training and testing phases.

- All the implementations will be done in PyTorch platform.

Please send the completed proposal to tianyu.song@tum.de, shervin.dehghani@tum.de and felix.tristram@tum.de. Please note that this proposal will be evaluated by the BMC coordinators and will be assigned to a student only in case of acceptance.

From this project, the student will gain theoretical knowledge and practical experience in developing and packaging state-of-the-art supervised methods for volumetric medical image segmentation tasks.

Technical Prerequisites

The student is expected to already have proficiency in Python programming language. Theoretical knowledge and practical experience in the implementation of deep learning models for computer vision tasks and/or medical images with PyTorch will be very helpful.

References

1 -- Learning multi-class segmentations from single-class datasets; DOI: 10.1109/CVPR.2019.00973
2 -- Label-Set Loss Functions for Partial Supervision: Application to Fetal Brain 3D MRI Parcellation ; DOI: 10.1007/978-3-030-87196-3_60
3 -- Context-Aware Voxel-Wise Contrastive Learning for Label Efficient Multi-organ Segmentation ; DOI: 10.1007/978-3-031-16440-8_62