Active Learning for 3D Medical Image Semantic Segmentation

Contact: Aiham Taleb (aiham.taleb@hpi.de)

Generating expert annotations of 3D medical images at scale is non-trivial, expensive, and time-consuming. This characteristic is common across multiple domains of application of supervised machine learning methods. Hence, several techniques have been developed to address this challenge, in order to reduce the annotation effort required. A particular example technique is called Active Learning [1,2], which is a powerful technique for attaining data efficiency. Instead of a-priori collecting and labelling a large dataset, which often comes at a significant expense, in AL we iteratively acquire labels from an expert only for the most informative data points from a pool of available unlabelled data. After each acquisition step, the newly labelled points are added to the training set, and the model is retrained. This process is repeated until a suitable level of accuracy is achieved. The goal of AL is to minimise the amount of data that needs to be labelled [3].
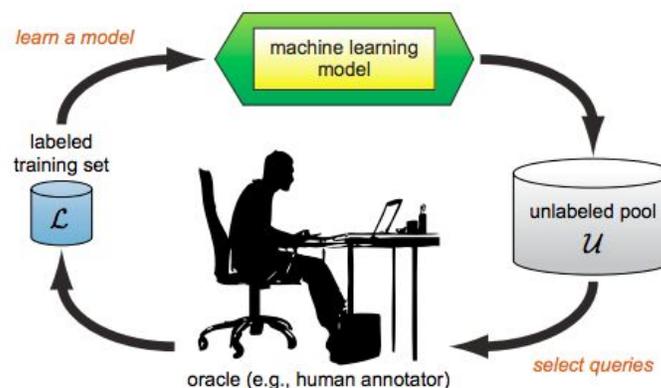

Figure from [7].

These techniques become more interesting when operating on image semantic segmentation applications, where the tasks are more involved and may require better quantification for the model's uncertainties. The research in this area is sporadic [4,5,6], and only few works have explored these techniques for 3D medical images. In this thesis, you have the opportunity to discover the existing works in this field, and develop new methods and algorithms to advance the status quo of active learning in the medical imaging domain.

Your profile

- Master's student in Computer Science (ITSE), Digital Health (DH), Data Engineering (DE), and all related programs.
- Knowledge in areas of Deep Learning (ideally attended deep learning courses offered by the chair)
- Good programming skills (e.g. Python)
- Experience in Deep Learning frameworks (e.g. Tensorflow or PyTorch) would be a great plus
- Quick learner and willing to share knowledge
- Good English language skills

If you find this topic interesting, please contact us.

References

[1] https://en.wikipedia.org/wiki/Active_learning_(machine_learning)

[2] David A Cohn, Zoubin Ghahramani, and Michael I Jordan. Active learning with statistical models. Journal of artificial intelligence research, 4:129–145, 1996.

[3] Andreas Kirsch, Joost van Amersfoort, and Yarin Gal. BatchBALD: Efficient and Diverse Batch Acquisition for Deep Bayesian Active Learning. Advances in Neural Information Processing Systems (NIPS 2019)

[4] Active Learning for Interactive 3D Image Segmentation Andrew Top, Ghassan Hamarneh, and Rafeef Abugharbieh.

[5] Active Learning Technique for Multimodal Brain Tumor Segmentation Using Limited Labeled. Dhruv Sharma, Zahil Shanis, Chandan K. Reddy, Samuel Gerber, and Andinet Enquobahrie.

[6] A Survey on Active Learning and Human-in-the-Loop Deep Learning for Medical Image Analysis. Samuel Budd, Emma C Robinson, and Bernhard Kainz.

[7] https://medium.com/@ODSC/active-learning-your-models-new-personal-trainer-a89722c0db5a