Deep learning with added landmarks for improved object segmentation

1. Background

Convolutional neural network (CNN) methods are the state-of-the art approaches for many image analysis tasks, including segmentation of organs in a human body. However sometimes the training data is so large that batch training on common GPUs are hindered, and thus the training is done on smaller image patches instead.

In such cases, the networks ability to learn and recognize objects can suffer, and wider contextual information needs to be added to the network to improve it (e.g. [1]). State of the art network architectures like U-Net [2], DeepMedic [3] and P-Net [4] for example add context via skip connections, subsampled pathways or dilated convolutions. Sometimes, particularly in medical applications, there is other data (such as predefined landmarks) available in addition to the images. Such data can be used as a yet another way of feeding contextual information to the network.

In this project, the aim is to investigate whether using anatomical landmarks can lead to improved organ segmentation in whole-body MRI with patch-trained CNNs. In particular, whether the improvement can be achieved with architectures that already include some amount of wider image context by default, and when the network is trained on patches. Available dataset(s) contain MRI volumes, landmarks and ground truth segmentations.

2. Plan and expected outcomes

- do a literature review on the topic
- implement networks and different ways of landmark utilization (in Python + PyTorch)
- evaluate the effect of adding landmark information on the training of various architectures
- evaluate feasibility and effectiveness of adding context in different training settings
- summarize the findings and write a report

3. Supervision

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References

[1] M. Ghafoorian et.al. (2017). *Location Sensitive Deep Convolutional Neural Networks for Segmentation of White Matter Hyperintensities.* Scientific Reports, Volume 7.
[2] O. Ronneberger, P. Fischer, T. Brox (2015). *U-Net: Convolutional Networks for Biomedical Image Segmentation.* arXiv:1505.04597
[3] K. Kamnitsas et.al. (2017). *Efficient multi-scale 3D CNN with fully connected CRF for accurate brain lesion segmentation.* Medical Image Analysis, Volume 36, pp 61-78.
[4] G. Wang et.al. (2017). *DeepIGeoS: A deep interactive geodesic framework formedical image segmentation.* arXiv:1707.00652