Master Project
Medical Image Segmentation

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Digital Health - Machine Learning

Context
Three-dimensional image datasets from MRI, CT or microscopy unlock a new quality of insights in Life Science and Medical Domains. Unfortunately, these insights are hidden in very large images. Manually annotating this data is extremely laborious and expensive. Therefore, the images need to be processed automatically, in order to extract the information. Current software tools, for example, Freesurfer, are slow or require extensive manual corrections. Unfortunately, manual corrections made by users are ignored and ultimately don't help the software to improve.

Machine Learning (ML) technologies, such as deep artificial neural networks, are well-suited for image segmentation tasks. They are a powerful tool to produce high-quality results on large sets of images. However, these algorithms require lots of labeled training data which is, again, expensive to obtain.

A new approach called Active Learning (AL) makes the training data generation more efficient. The system directs the user's attention to a specific region in the images to generate labels only in regions of the data that are most likely to improve the quality of the ML system. For example, the system could ask for a label in the region of the image where it is most uncertain in its prediction.

Based on the multidimensional image annotation system VISIAN (http://visian.org) of the Digital Health - Machine Learning chair, we want to explore new ways to allow domain experts to train machine learning models for medical image segmentation using Active Learning.

Goal
The goal of the Master's project is to test and implement **active learning concepts** in medical image segmentation, focusing on brain MRIs.

Different query selection strategies and ideas for termination criteria should be explored and compared.

What you will do
- Research active learning concepts in the medical imaging domain.
- Implement deep neural networks.
- Perform a statistical analysis of different query selection strategies.
- Present your work to other researchers.

What you will learn

- Concepts of medical image processing.
- Advanced deep learning concepts (active learning, uncertainty quantification).
- Real-world applications of ML in medical imaging and how to overcome its challenges.
- Development processes in a team with outside collaborators.

What you should bring with you
Every participant should have experience in **at least one** of the following skills

- Software engineering
- Deep Learning (in Python)
- Medical imaging (MRI, CT)