Leids Universitair Medisch Centrum

Master Thesis project
In Biomedical Machine Learning

Prediction of Lumbar Degeneration from Radiological Imaging and Clinical Data

In collaboration with the Division of Image Processing, Department of Radiology (dr. M. Staring) and the Department of Neurosurgery (dr. Vleggeert-Lankamp, MD) from the Leiden University Medical Center.

Who?
We are looking for a student:
- searching for a Master thesis project
- majoring in computer science, mathematics, biomedical engineering, artificial intelligence, physics, or a related area
- with affinity for (python) programming and machine learning

What?
Lumbar canal stenosis, which is a type of spinal degeneration, is a very common diagnosis in spine clinics. Spinal degeneration increases with aging of the patient and, although it is a natural process, can cause debilitating symptoms for which surgery may eventually be necessary. However, despite spine surgeons assessing the eligibility of patients for surgery beforehand, an operation may not always result in a successful outcome. In order to improve surgical success rates artificial intelligence (both Machine Learning and Deep Learning) may be used on radiological imaging and clinical data that could predict a patient's surgical result.

The research aim is two-fold: first, we want to automate a scale that reflects the degree of degeneration on X-ray images. For this step 160 pre-operative X-ray images are available from patients that underwent surgery for lumbar canal stenosis. For the second step, we want to develop a predictive model for surgical results. A dataset of 160 preoperative MRI images from the same patients is available. Patients filled in a questionnaire after the operation (Zurich Claudication Questionnaire) which can be dichotomized into 'success' and 'failure' to express the surgical result. Using a Deep Learning model we want to predict this binary outcome based on preoperative MRI imaging. Patients also reported their back and leg pain on a continuous scale after surgery. The Deep Learning model can also be created to predict a patient's post-operative outcome for these scales. In addition, these scales can be dichotomized using a cut-off value for improvement (≥ 50% improvement in leg or back pain). For implementation in the health care setting, it is generally important to understand the reasoning behind a predictive model. Using a so-called heat map hot spots can be detected on MRI images that the model uses to predict the surgical result. These hot spots may be translated to their clinical implication and significance. In addition to MRI images, X-ray data and clinical features from the same 160 patients are available and can be used to create a Deep Learning network for prediction of surgical results. Clinical features such as age and gender may affect post-operative outcome and therefore, it could be very valuable to incorporate these factors in a network together with radiological data. Your result will contribute to the process of clinical decision making in spinal surgery.

Where?
You will be embedded in the LUMC and experts from both departments will be available for consultation. At the department of Neurosurgery there is years of experience with spinal research and a high publication rate. Students

will be offered the opportunity to co-publish their results and present on a scientific conference. At the Division of Image Processing Machine Learning expertise and infrastructure is readily available.