Degree project 30 credits in Biomedical Engineering

Automatic Validation of XAI on MR scans for HLGD Classification

Biomedical Engineering R&D (MT-FoU) is a research and development department at the Center for Information Technology and Biomedical Engineering at Norrland University Hospital, Region Västerbotten. The department conducts international research, development and education in the field of biomedical engineering, with expertise in, for example, sensors and measurement systems, image and signal analysis and biomechanical models. MT-FoU is also a part of the competence center AI for Medicine in Northern Sweden, AIM North, which supports clinical research projects with technical method expertise in machine learning and AI.

Background

A Higher-Level Gait Disorder (HLGD) is one of the typical symptoms seen in Idiopathic Normal Pressure Hydrocephalus. The pathophysiology of this disease is still not entirely understood, including how morphological changes, such as enlargement of the cerebral ventricles, relate to the development of symptoms. Artificial Intelligence (AI) methods now offer the possibility to perform objective whole-brain analysis. To clarify the relationship between brain morphology and HLGD, we evaluated a cohort of older people with and without gait disorder. The application of AI methods on Magnetic Resonance (MR) images can help distinguish between subjects with HLGD and healthy subjects and identify the features that determine this distinction. The complexity of AI-powered systems has increased so that it is almost impossible to understand the processes of the underlying system clearly so that several learning algorithms, deep neural networks included, are considered black-box models. To open the black box and to understand how such models make such decisions, we have assisted the rise of eXplainable Artificial Intelligence (XAI) approaches, whose investigation is particularly relevant when findings derived from such systems are increasingly being employed to make predictions in critical contexts or to affect humans' lives.

Aim of the project

Using XAI techniques to quantitatively identify radiological markers unique to HLGD subjects could allow us to overcome important knowledge gaps in INPH physiopathology. To achieve this goal, we developed a deep architecture that performs an XAI method that provides, for each instance, visual insights into the areas of the brain involved in the decision process. Validating XAI methods is a complex but necessary task since it makes us understand if a developed network focuses on the correct regions. Therefore, this project aims to develop an automatic quantitative (and not qualitative) validation method. This way, further insights into the presented brain volume feature maps from the proposed XAI method can be extracted. The validation methodology will consist in using a software that segments the different anatomical regions of a given brain and combining this information with the returned maps of the developed XAI method. An analysis of the link between brain morphology deviations and gait symptoms will be carried out.

Work description

The Student will join an ongoing project on this topic, where we have developed network classifiers and an XAI method. The Student work will consist of the following main steps:

- Understanding the available dataset and its features
- Understanding the developed networks and XAI method
- Investigation of different software useful to segment the different anatomical regions
- Apply the chosen software on the HLGD cohort
- Validate the XAI maps to understand the areas of the brains highlighted by the given XAI method
- Deepen the validation results
- Thesis writing

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