Master internship subject

DeBIAN: Deep representation of the Brain Image for the Analysis of Neurodegenerative diseases

Hosting institute

ICube Laboratory (The Engineering science, computer science and imaging laboratory) at the University of Strasbourg is a leading research center in Computer Science, with more than 300 permanent researchers, with the recently opened AI graduate school supported by the French government.

Work place and salary

The thesis work will take place in the MLMS (Machine Learning, Modeling & Simulation) research team of the ICube laboratory (The Engineering science, computer science and imaging laboratory) of the University of Strasbourg, a leading research center with more than 300 permanent researchers. The workplace is located on the hospital site of the laboratory, a 10-minute walk from the heart of downtown Strasbourg, listed as a UNESCO World Heritage Site.

650 euros net monthly

Supervisors

– director: Hyewon Seo (ICube, Univ. Strasbourg)

– co-supervisors: Stephane Kremer (University hospital), Diwei Wang (ICube, Univ. Strasbourg)

Staring date

February – April 2025.

Context

Dementia with Lewy Bodies (DLB) and Alzheimer's Disease (AD) are two common neurodegenerative diseases among elderly people. Both associated with abnormal deposits of proteins in the brain, the diagnosis of these diseases can be challenging, particularly in distinguishing between them, as they exhibit similar symptoms in their early stages. Brain MRI provides detailed images of brain structures, allowing for the identification of structural changes associated with neurodegenerative diseases. Deep learning has shown great promise in analysing these images, enabling accurate predictions and interpretations. At the center of it are the recent emerging large-scale pre-trained vision-language models (VLMs), which have demonstrated remarkable performance thanks to their generalizable visual and textual representations.

Work description

We will deploy a VLM to improve the accuracy and efficiency of brain image analysis, with a specific focus on classification and associated reasoning presented in text form. Our specific focus will be on the analysis and understanding of neurodegenerative diseases, Dementia with Lewy Bodies (DLB), Alzheimer's Disease

(AD), and/or Parkinson disease. We will base our study on our recent work[1] [2], where the model we developed learns and refines visual, textual, and numerical representations of patient gait videos using a large-scale pre-trained Vision-Language Model (VLM) for several classification tasks.

We will proceed with the following tasks:

1. **Collection and organization of public dataset:** A first step is to collect the publicly available dataset and organize it to ensure seamless use as training data. Datasets from ADNI (Alzheimer's Disease Neuroimaging Initiative) are considered.
2. **Knowledge distillation:** Per-class textual description will be collected and refined in a semi-automatic manner, which we will use to initialize learnable prompts.
3. **Knowledge augmented strategy to classification of image-only data**: We will adapt our knowledge augmented prompt-tuning strategy combined with a VLM-based classifier model, to address the new task.
4. **Knowledge augmented strategy to classification of multimodal data**: We will develop methods to exploit paired demographic data, alongside images. Interestingly, this is analogous to the way neuro-radiologists interpret images.
5. **Experiments**: The developed models will be tested and compared both with each other and with state-of-the-art models.

Candidate profile

− Solid programming skills: Python/C++

− Experience in Deep Learning (Transformer, CLIP, etc.)

− Good communication skills

Application

Send your CV and academic records (Bachelor and Master) to seo@unistra.fr

[1] Wang D., Yuan K., Muller C., Blanc F., Padoy N., Seo H., "Enhancing Gait Video Analysis in Neurogenerative Diseases by Knowledge Augmentation in Vision Language Model", Lecture Notes in Computer Science (Proc. Medical Image Computing and Computer-Assisted Intervention), vol. 15005, pp 251–261, Springer, 2024.

[2] Wang D., Yuan K., Seo H., "GaVA-CLIP: Refining Multimodal Representations with Clinical Knowledge and Numerical Parameters for Gait Video Analysis in Neurodegenerative Diseases", under revision, 2024.