Leveraging eXplainable AI to Enhance Fine Motor Test Analysis for Cognitive Disorder Diagnostics

Summary

For over a century, drawing and writing tests have been integral in the fields of psychology, neurology, and psychiatry. The advent of digital tablets, followed by tablet PCs, has paved the way for the digitisation of these tests, significantly expanding their potential. By integrating statistical machine learning, and more recently, deep learning techniques, the ability to analyse fine motor tests has greatly improved, offering sophisticated insights that support the diagnosis and monitoring of Parkinson's disease and other cognitive disorders. However, the application of AI in the medical field presents unique challenges, especially regarding the transparency of AI-driven decisions. In such a delicate area as healthcare, it is imperative that AI models can be understood and trusted by medical professionals. Transparency is often achieved through the addition of so-called 'explainers' or 'interpreters' as a post-hoc step in the workflow. These tools typically highlight the importance and location of features that influence the decision-making process, often pointing out the most relevant parts of images or data. Despite these advances, current AI workflows may still produce feature sets that are not entirely comprehensible to healthcare practitioners. The complexity of the models can make it difficult for clinicians to interpret results in a meaningful way. This research aims to bridge that gap by prioritising explainable AI capabilities in the development of workflows that are designed specifically for medical practitioners. The goal is to create AI-driven diagnostic tools that are not only accurate but also transparent, providing clear insights that enhance decision-making in cognitive disorder diagnostics.

Research field:	Information and communication technology
Supervisors:	Dr. Sven Nõmm Aaro Toomela
Availability:	This position is available.
Offered by:	School of Information Technologies Department of Software Science
Application deadline:	Applications are accepted between January 01, 2025 00:00 and January 24, 2025 23:59 (Europe/Zurich)

Description

Research Objectives

Develop the techniques for popular tests such as Archimedean Spiral Drawing Test and Luria's alternating series tests.

Adapt the technique to the tests with stronger semantic component, such as, Poppelreuter test or embedded figure test.

Ph.D. Candidate Responsibilities:

- Publish and present scientific articles top-tier (Q1) journals and international conferences.
- Co-supervising bachelor and master level students in the department of Software science.
- Assist in teaching of relevant courses.

Requirements:

- Master's degree in computer science or related field.
- Demonstrated interest in the research topic (expressed in motivation letter).
- Proficiency in Python, MATLAB, and R programming.
- Excellent English communication skills.
- Strong analytical and writing abilities.
- Ability to work independently and collaboratively.
- Preferred: Experience in programming and deep learning, showcased through GitHub projects.
- Applicants are encouraged to submit preliminary research plan.

Supervisors: Prof. Sven Nõmm (TalTech), Prof Aaro Toomela (Tallinn University)

[1] Deep CNN based classification of the archimedes spiral drawing tests to support diagnostics of the Parkinson’s disease. Sven Nõmm, Sergei Zarembo, Kadri Medijainen, Pille Taba, Aaro Toomela, IFAC-PapersOnLine

[2] CNN based analysis of the Luria’s alternating series test for Parkinson’s disease diagnostics. Sergei Zarembo, Sven Nõmm, Kadri Medijainen, Pille Taba, Aaro Toomela. - Recent Challenges in Intelligent Information and Database Systems: 13th Asian Conference, ACIIDS 2021, Phuket, Thailand, April 7–10, 2021, Proceedings 13

[3] Generative Adversarial Networks as a Data Augmentation Tool for CNN-Based Parkinson's Disease Diagnostics E Dzotsenidze, E Valla, S Nõmm, K Medijainen, P Taba… - IFAC-PapersOnLine, 2022

[4] Comparison of one-two-and three-dimensional CNN models for drawing-test-based diagnostics of the Parkinson’s disease X Wang, J Huang, M Chatzakou, S Nõmm, E Valla… - Biomedical Signal Processing and Control, 2024

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