Development of Novel Deep Learning Architectures for Fine Motor Test Analysis

Summary

This research initiative focuses on digitizing and analyzing fine motor tests, crucial in diagnosing neurodegenerative disorders and assessing cognitive function. Despite recent efforts to employ AI, challenges persist due to the unique characteristics of these tests. The project aims to develop specialized deep learning architectures for analyzing drawing tests and human finger motions, with applications in diagnostics, cognitive assessment, and fatigue detection. The Ph.D. candidate will assess existing models, design tailored architectures, explore transferability between test types, and ensure compatibility with explainable AI methods. Additionally, responsibilities include teaching and supervision. Requirements include a Master's degree, proficiency in programming, and demonstrated interest in the research topic.

Research field:	Information and communication technology
Supervisor:	Dr. Sven Nõmm
Availability:	This position is available.
Offered by:	School of Information Technologies Department of Software Science
Application deadline:	Applications are accepted between October 01, 2024 00:00 and October 25, 2024 23:59 (Europe/Zurich)

Description

Fine motor tests, particularly drawing (e.g., spiral drawing test, Peupelreuter's test) and writing tests, have been integral to neurology and psychology for over a century. They aid in diagnosing neurodegenerative disorders like Parkinson's and Alzheimer's disease and assessing cognitive function. Recently, there's been a shift towards digitizing these tests and employing AI for analysis [1]. However, the unique characteristics of these tests, such as black and white drawings consisting of strokes, pose challenges for existing deep learning models. Also methodology developed for to support diagnostics attracts the interest from the areas of cognitive development and fatigue detection [2].

Research Objectives:

We aim to develop novel deep learning architectures tailored for analyzing drawing tests and human finger motions. These architectures will find applications in:

- Differential diagnostics of neurologic diseases.
- Assessment of cognitive function during education.
- Fatigue detection.

Ph.D. Candidate Responsibilities:

- Assess the limitations of existing models and identify their main drawbacks.
- Design specialized deep neural network architectures for drawing tests.
- Explore the transferability of learning between different test types and use cases.
- Ensure compatibility with explainable AI methods crucial for medical applications.
- Teaching and Supervision:
  - Delivering practical sessions on Data Mining and Machine Learning topics.
  - Co-supervising bachelor and master level students in the department of Software science.

Achieved results are expected to be published in top-tier (Q1) journals and conference proceedings.

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.

Supervisor: Prof Sven Nõmm

References:

[1] 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

[2] Transforming fatigue assessment: Smartphone-based system with digitized motor skill tests. E Valla, A.J. Toose, S Nõmm, A Toomela - International journal of medical informatics, 2023

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