Review of the dissertation thesis

Author: **Mgr. Filip Děchtěrenko**

Title: **Comparison of scan patterns in dynamic tasks**

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In his thesis, Filip Děchtěrenko addressed the problem how to work with segments of spatiotemporal data obtained in eye tracking measurements. Measuring eye movements is an important method in many fields, ranging from the research in psychology or neuroscience to industry applications, and including computer science. The thesis stems from this interdisciplinary research and addresses current research problems from the perspective of theoretical computer science. Developing proper mathematical or statistical methods as well as algorithms constitutes an important part of the research field. To clarify, the thesis included several experiments, which may seem to be more related to psychology – but importantly, the experiments were used to show deeper methodological questions and to demonstrate statistical procedures proposed in the thesis.

In particular, Filip addressed three problems: **measuring the similarity of eye tracking data**, **methods for statistical comparison** and **predicting eye movements** in a particular task. The thesis consists of an introductory chapter and three subsequent chapters, each dedicated to one of these problems. Filip published his methods online (R package called scanpatterns at GitHub) and the thesis is accompanied with a large attachment, which can be used to replicate his simulations and analyses.

The first chapter serves as an introduction into the problem of eye movement measurements. Filip described how the visual information is acquired and processed by humans and the current methods for eye movement measurements. I appreciate he described also technical details (how the raw data look like etc.) as it helps to better imagine the processing necessary in the follow-up stages. Later, he describes a particular psychological task used to measure human attention (Multiple Object Tracking, MOT), which is used throughout the thesis as a model dynamic task, in which the eye movements are investigated. Filip described why this task is convenient relative to other dynamic tasks (e.g., viewing video).

The raw eye tracking data are usually not used directly, but often processed to obtain a high-level representation as a sequence of events. In Chapter 2, Filip described the typical methods how to compare the processed or unprocessed data. Filip's contribution is in designing four simulation experiments where he tested the effect of systematic noise on different similarity measures. The described patterns and values may be used when reviewing results obtained with different similarity measures.

In complex tasks, eye movements are never equivalent or repeated due to many low-level and high-level factors. Subsequently, we need methods to compare such noisy measurements and make judgements about statistical significance of the observed differences. Filip proposed three possible approaches to this problem in Chapter 3, which is the main chapter of the thesis. He compared the proposed methods on simulated data and ran two experiments testing the symmetry in real world eye movements.

The amount of eye movement data obtained in a number of experiments using a same task creates an opportunity to use machine learning techniques to find regularities in the data and possibly predict the eye movements. In the last chapter, Filip built on his master thesis. He pooled and preprocessed the data from multiple experiments and trained a feed-forward neuron network to predict where people looked. He discussed the relative importance of different sources of information, which is also an interesting contribution for the MOT theory.

As a supervisor, I would like to highlight Filip's work during his doctoral studies. He was eager to learn and worked on his research steadily. He started new international collaborations, which provided him with new opportunities to study, broader feedback from others, and led to successful journal publications.

I **recommend** the work for defense and I believe the author **should be awarded** the Ph.D. degree.

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