Abstract. A rapidly developing world brings up a progressively increasing need for professions which require: high qualifications, strong intellectual capabilities and abilities of coping with intensive cognitive workload. Roles such as those of pilots, professional drivers or air traffic controllers are related to significant cognitive workload and a mistake caused by mental fatigue can cause irreversible damage. Due to this the importance of estimating cognitive workload becomes especially significant. The most valuable data for analysis can be gathered directly in the process of carrying out professional activities. Hence, a practical tool convenient for collecting data for analysis is needed. The most frequently applied method of data collection for cognitive workload estimation is electroencephalography, which is complicated, prone to noise and time consuming. In my research I suggest the application of an eye-tracking technique for data collection combined with explainable machine learning methods for cognitive workload estimation as the solution to these issues.

The aim of my research was to investigate whether features based on eye-tracking and user performance can be used to classify cognitive workload and aid the development of an interpretable machine learning model allowing to classify cognitive workload levels. The improvement of the quality of cognitive workload level classification was also the goal of my study. In order to achieve the goals I have collected the experimental data, developed the processing procedure, and tested it on the collected data. A cognitive workload assessment was performed using machine learning methods using binary and multiclass approaches. All of the machine learning models were developed on the basis of a subject-independent approach. This approach is more general and enables the creation of a more flexible classification model allowing to predict the cognitive workload of any participant. The model is trained on the data of several participants and can be used on another participant.

I have performed a series of cognitive workload studies and I have conducted the following analyses: appliance of interpretable machine learning, appliance of fuzzy aggregation functions and calculation of new features. Interpretable machine learning was used in a multiclass classification task which allowed to analyze the importance of features and to understand the mechanism accompanying the processes related to cognitive load. In the next studies, fuzzy aggregation functions were used, which improved the results of classifying levels of cognitive load. This approach is based on a set of classifiers and the use of aggregation functions made it possible to improve the results in the case of initially weaker results of separate classifiers. An ex-Gaussian distribution was used to calculate new features for a model predicting cognitive load levels. The use of ex-Gaussian modeling was valuable in detecting dissimilarities. In all of the tested approaches, highly accurate classification results of over 96% were achieved. In conclusion, this dissertation may be useful to researchers looking for ideas and techniques for studying cognitive load.