# Random Forest for Event Classification of Eye Movements: Towards Effective Cognitive Workload Estimation

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**Background:** Classifying eye tracking data into discrete oculomotor events (eye fixation, saccades, and post-saccadic oscillations) is crucial for eye movement research. In general, event detection algorithms can be summarised into four categories, namely velocity-based, dispersion-based, probabilistic-based, and machine learning (ML) based. The major drawbacks for the first three (non-ML) approaches is that they require users to manually select thresholds based on hand-crafted signal features for event classifications. These thresholds can be highly subjective to the perspective of the decision maker and the velocities of eye movements can also vary for different tasks, thus the threshold selection process is nontrivial. Such discrepancies can lead to biases and wrong interpretations in research activities based on them. Therefore, an autonomous and unbiased approach for classifying oculomotor events is needed.

**Aim:** ML have proven to be highly effective in classification tasks. Most research in eye movement classification, however, have been conducted based on time-consuming manual event detection or by non-ML algorithms based on a set of rules with parameters chosen manually according to some given performance measures. In this work, we aim to evaluate the performance of a random forest classifier by comparing it with other existing ML approaches and assess its applicability for oculomotor event classification applications.

**Method:** In this work, we implemented and evaluated a random forest classifier for robust event detection using features including raw gaze X and Y coordinates, and pupil size of time series. We classify eye movements into six events, namely, fixation, saccade, post-saccadic oscillation, smooth pursuit, blink, and noise. For benchmarking, we used the dataset published by Lund University that contains 350,631 samples (Larsson et al. 2013). It has been manually annotated into the six eye movement events, which aligns with our objective. We used 80% of the samples for training and the remaining 20% for testing. The model is implemented in Keras using 30 estimators and an entropy function for probability distribution. Our proposed method is fully automated, end-to-end generalized, has no dependency on any threshold, and requires no pre-processing on raw data or post-processing steps.

**Results:** We have performed a series of analyses on ML-based event classification. Our random forest classifier has outperformed other existing ML approaches under test with an overall accuracy of 97%. Others (Hoppe et al., 2016, Startsev et al., 2019, Zemblys et al., 2019, and Marie et al, 2019) have shown accuracies of 71%, 83%, 93% and 94% respectively, and they can only classify eye movement data into three events while the proposed method can work on six categories.

**Conclusions:** Eye movement event classification is essential for eye tracking applications in education, training, marketing, psychology, and medical image interpretation. It can also be used to identify fatigue, stress, and cognitive workload. To provide a universal approach irrespective of sampling rate or task dependency for cognitive workload classification using ML approaches, data augmentation will be used in our future work to improve the performance of the proposed solution by avoiding overfitting. Next, we will use unsupervised learning for cognitive workload detection.

**References:**

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