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Event detection is a challenging stage in eye movement data analysis. The major drawback of current event detection methods is that parameters have to be adjusted based on eye movement data quality. However, a fully automated classification of raw gaze samples as fixations, saccades or other oculomotor events can be achieved using a machine learning approach. Any already manually or algorithmically detected events can be used to train a model to produce similar classification of other data without the need to set parameters. In this study we explore the application of random forest machine learning technique for the detection of fixations, saccades and post-saccadic oscillations (PSOs). Specifically, we train separate classification models using manually (MAN) and automatically (NH, Nystrom and Holmqvist, 2010) annotated data utilizing features used in classical deterministic algorithms: velocity, acceleration, dispersion, directional data, etc. The NH model achieved 94% (Cohen's Kappa, K=81.2) classification accuracy on test set of automatically annotated data and 90.6% (K=62.2) on manually annotated data. The MAN model achieved 93.2% (K=71.8) and 95.3% (K=87.2) accuracy, respectively. As a baseline, the agreement between the NH and MAN training data was 92.1% (K=66.5). Our findings furthermore reveal that PSOs are the most challenging events to classify, because even expert annotators have a hard time tagging onsets and offsets of PSOs. For example, the NH model misclassifies 1/3 of the PSO samples as fixation and almost 1/5th as saccade samples, compared to the NH algorithm output itself. Variable importance analysis further indicates that for the NH model, velocity, acceleration and directional information are the most important features to achieve classification, while the MAN model utilizes standard deviation and RMS instead of directional information.

We conclude that machine learning techniques are a very good substitute for current state of the art event detection algorithms and manual coding, resulting in very similar classification. We will further extend the classifier to achieve good classification in noisy data and data with a low sampling rate, and to detect other eye-movement events (such as smooth pursuit and nystagmus) by including other training sets.