Published: 11 October 2022

Online eye-movement classification with temporal convolutional networks

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Behavior Research Methods (2022)

Abstract

The simultaneous classification of the three most basic eye-movement patterns is known as the ternary eye-movement classification problem (3EMCP). Dynamic, interactive real-time applications that must instantly adjust or respond to certain eye behaviors would highly benefit from accurate, robust, fast, and low-latency classification methods. Recent developments based on 1D-CNN-BiLSTM and TCN architectures have demonstrated to be more accurate and robust than previous solutions, but solely considering offline applications. In this paper, we propose a TCN classifier for the 3EMCP, adapted to online applications, that does not require look-ahead buffers. We introduce a new lightweight preprocessing technique that allows the TCN to make real-time predictions at about 500 Hz with low latency using commodity hardware. We evaluate the TCN performance against other two deep neural models: a CNN-LSTM and a CNN-BiLSTM, also adapted to online classification. Furthermore, we compare the performance of the deep neural models against a lightweight real-time Bayesian classifier (I-BDT). Our results, considering two publicly available datasets, show that the proposed TCN model consistently outperforms other methods for all classes. The results also show that, though it is possible to achieve reasonable accuracy levels with zero-length look ahead, the performance of all methods improve with the use of look-ahead information. The codebase, pre-trained models, and datasets are available at `https://github.com/elmadjian/OEMC`.