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LETTER TO THE EDITOR

An interactive platform for detecting cerebellar complex spikes

Akshay Markanday,* Junya Inoue,* Paul Vialkowitsch, and Peter Thier
Hertie Institute for Clinical Brain Research, University of Tübingen, Tübingen, Germany

TO THE EDITOR: In 2020, Markanday et al. published an innovative methodology for detecting cerebellar complex spikes (CSs), resorting to a convolutional neural network (CNN)-based deep learning algorithm. In brief, the process could be divided into four main steps: labeling CS data, training the algorithm, CS detection, and final verification. For labeling, the beginning and end of a small subset of putative CSs for every recorded Purkinje cell (PC) were manually marked. CSs, which are known for their typically complex wave morphology in action potential (AP) records, are also characterized by massive deflections in the local field potentials (LFP). Experts generally rely on these simultaneously appearing features in the AP and LFP records for accurate judgments on the credibility of detected CSs. Therefore, for best results, the data set training the CNN relied on both the marked AP and the associated LFP signals. This yielded a matrix of weights underpinning the automated CS detection by the network. Importantly, the CNN not only detected the occurrence of a CS but also marked their onset and offset, allowing the calculation of CS duration, the latter arguably complementing CS rates as carriers of information. Moreover, the network was remarkably sensitive to morphological changes in the CS waveforms, classifying them as distinct clusters in a dimensionality-reduced space. Finally, in a verification step, the experimenter could control the algorithm's performance in detecting CSs by checking if the detected CS induced the expected 10–20 ms long suppression of SS firing (1–3). Our algorithm outperformed alternative approaches available at that time with a performance matching that of human experts.

Although the code for running the CNN had been accompanied by a well-documented tutorial (https://github.com/jobellet/detect_CS), a complete and user-friendly software package involving data preparation and the later verification steps had been missing. Hence, additional programming efforts on the part of users were needed. Considering the user experience and the many suggestions and requests we received, we now introduce an Easy Platform for Identification of CSs (EPICS) that is a simple and fully interactive graphical user interface (GUI) that integrates all the earlier-mentioned steps in a single platform. All necessary steps appear as distinct sections within the GUI and can be executed independently at different points in time. Important parameters such as the sampling rate, signal interval, etc. can now be directly adjusted within the GUI framework. The core of the GUI remains the CNN-based CS detection algorithm presented in Markanday et al. (4). The python-based GUI application can be installed locally on both Windows or MAC-based operating systems.

A full description of individual steps is provided in a "READ.md" file (https://github.com/LeFalko/detect_CS). For a quick start, we also provide a video tutorial (https://youtu.be/It5F0qacMUQ) that shows how to navigate through the application and describes all its features. We believe that the ease and simplicity of the GUI will substantially alleviate running our CNN algorithm for the fast and reliable detection and quantitative characterization of CSs, allowing the cerebellum community to finally reap the advantages and opportunities of this tool.

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DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

A.M., P.V., and P.T. conceived and designed research; J.I. analyzed data; J.I. prepared figures; A.M. drafted manuscript; A.M., J.I., and P.T. edited and revised manuscript; A.M., J.I., and P.T. approved final version of manuscript.

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*A. Markanday and J. Inoue contributed equally to this work.
Correspondence: P. Thier (thier@uni-tuebingen.de).
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