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Minimizing time-to-result: Cobrawap latest developments and applications

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Abstract

Cobrawap (Collaborative Brain Wave Analysis Pipeline) [1,2] is an open-source, modular and customizable data analysis tool developed in the context of HBP/EBRAINS [3], with the aim of enabling standardized quantitative descriptions of cortical wave dynamics observed in heterogenous data sources, both experimental and simulated. The tool intercepts the increasing demand expressed by the Neuroscience community for reusability and reproducibility, offering a software framework suitable for collecting generalized implementations of established methods and algorithms, and for embracing innovative procedures. Inspired by FAIR principles [4] and leveraging the latest findings in software engineering, Cobrawap is structured as a collection of modular Python3 building blocks that can be flexibly arranged along sequential stages, implementing data processing steps and analysis methods, directed by Snakemake or CWL workflow manager [5,6].

Cobrawap faces a general drawback of complex analysis tools, namely the need for technical efforts required for the initial installation and configuration, and the non-negligible demand for computational resources for execution on local machines. Offering Cobrawap within the EBRAINS infrastructure allows for addressing a larger community, multiform in background, expertise and objectives, thus at the same time pushing developers to pay attention to increased usability and user facilitation for the software release and execution. Following this line, actions have been completed to successfully deploy Cobrawap on FENIX-ICEI federated HPC sites, executable through direct ssh login or from the EBRAINS Collab. Other actions under the same guiding light (i.e. minimize the time-to-result, with users focusing on the scientific side without caring about the technology behind the scenes) have been to wrap the source code and all the dependencies as a standalone installable Python package and as a Docker image. Finally, recent efforts have been addressed in optimizing and improving algorithms to pursue the benefits of parallel computing (e.g. through vectorization approaches and parallelization libraries).

Among the latest scientific developments, dedicated efforts have been focused in dealing with both high-resolution recordings from brain imaging, and simulations of neuronal dynamics in the human brain obtained from models implemented through heterogenous simulation engines (e.g. TVB [7]). In the first case, annotated images are passed through a recursive algorithm ("HOS", Hierarchical Optimal Sampling) that dynamically tunes the resolution across the field of view, optimizing both the signal-to-noise ratio and the dataset size. The second case represents a crucial step along the challenging pathway to reliably analyze human brain data (e.g. from EEG), extending the quasi-planar approach assumed for murine cortical data [8] towards the more complex geometrical structure of the human cortex.

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