Structuring cortical wave analysis with Cobrawap: a modular and adaptable pipeline for heterogeneous datasets

Human Brain Project

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Summary

- Our analysis pipeline design enables the flexible alignment of cortical wave descriptions across data modalities.
- This approach improves the comparability of datasets, models, and analysis results.
- Its adaptable implementation promotes reuse, and collaborative research.

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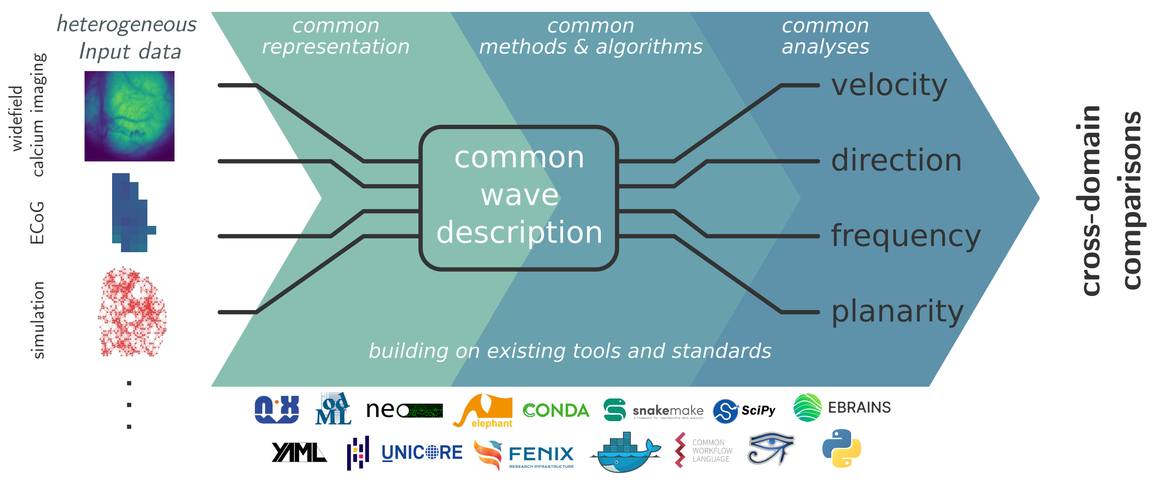
- *Gutzen et al. (2022) 10.48550/arXiv.2211.08527*
- Collaborative brain-wave analysis pipeline: *https://github.com/INM-6/cobrawap*

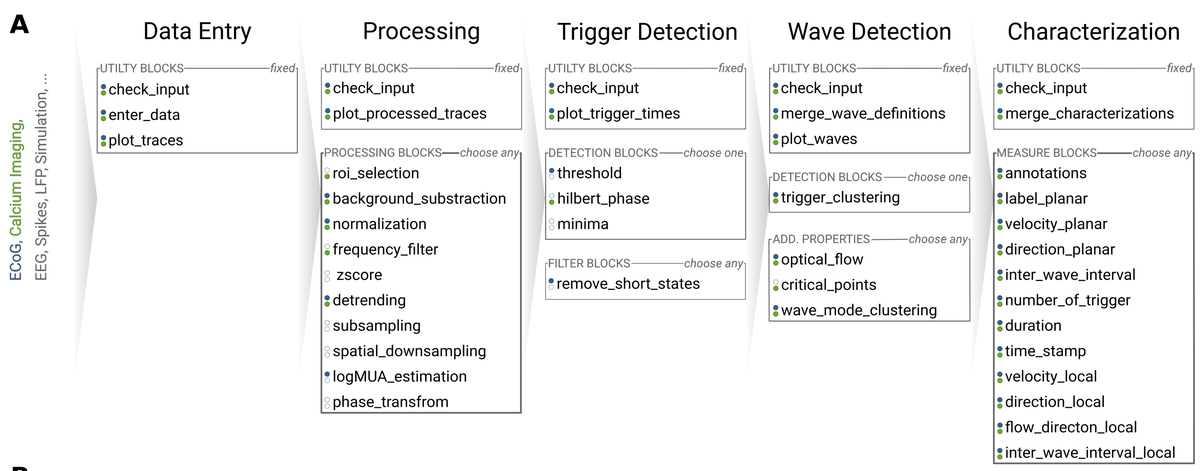
How to compare heterogeneous data

- Slow waves (<1 Hz)[1], which are typically present during sleep and anesthesia, are observable across species, scales, methods [e.g.,2,3,4].
- Comparability of heterogeneous data is needed for integration of data sources, model calibration & validation, quantifying experimental variability.
- To support comparability, analysis workflows require reproducibility and reusability.



Implementation of a modular analysis pipeline

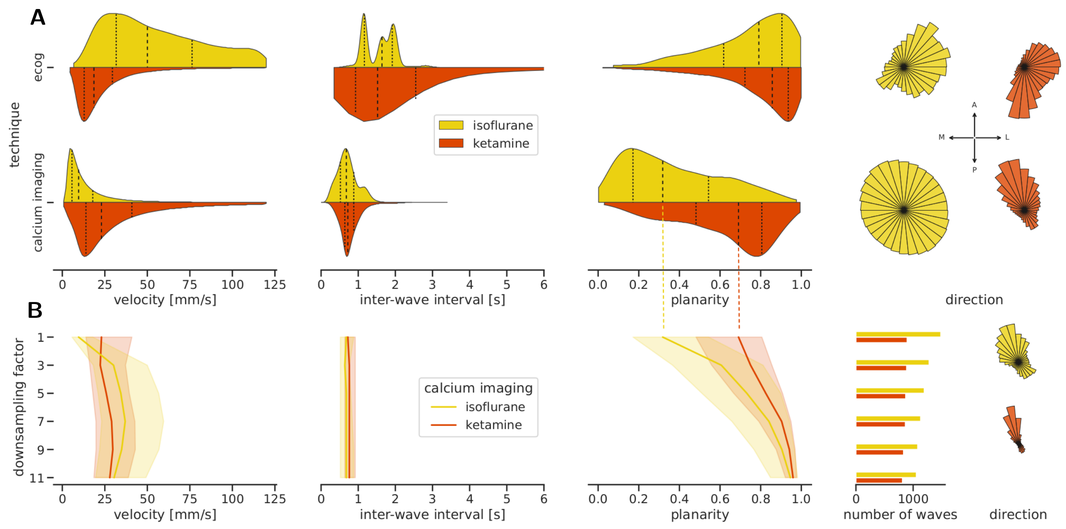
- We built a pipeline consisting of modular, adaptable, and reusable elements: sequential stages containing selectable method blocks (*A*).
- Each block is represented by a Python script and an input→output rule in a workflow manager, that handles the execution order and the parameter settings.
- By configuring the block and parameter selections, the pipeline can be adapted to the data and analysis needs towards a common description level (*B*).



Applications

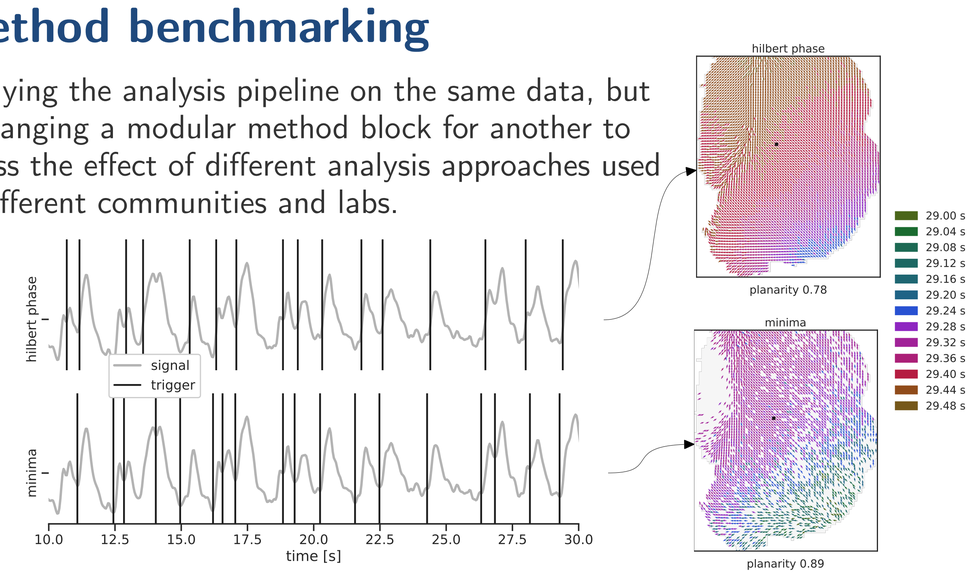
Meta-analysis across multiple datasets

Evaluating properties in 60 open-access ECoG and calcium imaging recordings of anesthetized mice[5-9], and comparing wave properties across measurement techniques and anesthetic types (*A*). Spatial downsampling shows that resolution accounts for some differences between the wave characteristics from different measurement techniques (*B*).



Method benchmarking

Applying the analysis pipeline on the same data, but exchanging a modular method block for another to assess the effect of different analysis approaches used in different communities and labs.



Model calibration and validation

Iteratively comparing wave properties between experimental data and model simulation to optimize model parameters reproducing the wave statistics, demonstrated in a companion study by Capone et al. (2023)[10].

Outlook

Ongoing efforts making Cobrawap more accessible and reusable:

- providing different install options, extending documentation & tutorials,
- executing the pipeline with EBRAINS HPC systems using UNICORE,
- enabling compatibility with the emerging EBRAINS workflow execution engine, and the CWL workflow language.

References

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EBRAINS

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