Physiopy: a Python suite for handling physiological data recorded in MRI settings

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https://github.com/physiopy
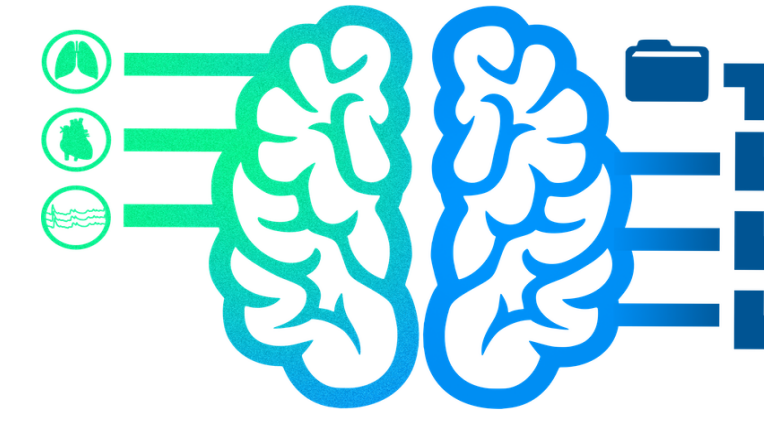
Physiology and fMRI
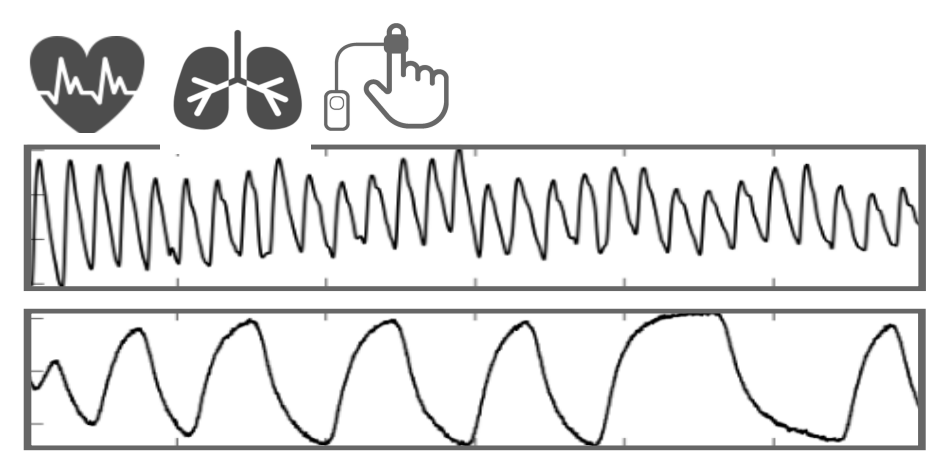
· The BOLD signal is not a perfect correlate of neural activity as it is also affected by regular physiological processes[1].
· It is crucial to disentangle neural and physiological signal components and understand the isolated effect of each.
· An effective strategy is to monitor physiological activity during fMRI acquisition, e.g., recording cardiac activity, chest compression, O_2/CO_2 gas levels or skin conductance.
· These measurements can be used to remove the variance associated to physiology from the BOLD signal[2].
· The collection and use of physiological data in fMRI settings is not a regular practice due to:
   1. The lack of established processing pipelines.
   2. The scarcity of tools and best practices for physiological data processing and management, as well as public data.

Physiopy core mission

To extend and facilitate the adoption of physiological data in MRI settings.

To simplify the construction of reproducible pipelines for physiological data management.

Create modular workflows and API to serve both minimal settings facing lack of resources and users looking for cutting edge approaches.

What is Physiopy

Python suite

Use case: prepare physiological data for MRI data processing and sharing.

Key features:
· Leverages the Brain Imaging Data Structure (BIDS) protocol[4].
· Open-source (Apache-2 license).

3 packages: phys2bids, peakdet and phys2denoise.

Each package is independent and fulfills a specific task in the physiological signal preparation pipeline, and can be used either as a python module or in shell through a CLI.

Community

· Community-driven governance.
· Open and inclusive.
· All contributions are recognized.
· New contributors are always welcome!
· Regular meetings about best practices in physiological data recording and analysis.

phys2bids
BIDSification
Inspection

· Transforms proprietary physiological recording files into BIDS format. It supports AcqKnowledge, LabChart, MATLAB, and Spike2.
· Minimal data query and visualization utilities.
· Automatic identification of a trigger channel, detection of timestamps corresponding to fMRI volumes, splits multi-run recordings, and adjustment of timings accordingly.
· Visualization of each signal and generation of a detailed report.
· Comprehensive documentation that includes installation guidelines, usage examples, and advice on how to collect, prepare, and analyze physiological data in MRI settings.
· Plugin to work within BIDScoin[5].

peakdet
Peak detection

· Functions to construct a reproducible physiological signal preprocessing pipeline that generates analysis-ready data.
· Supported operations: signal filtering, normalization, and feature extraction.
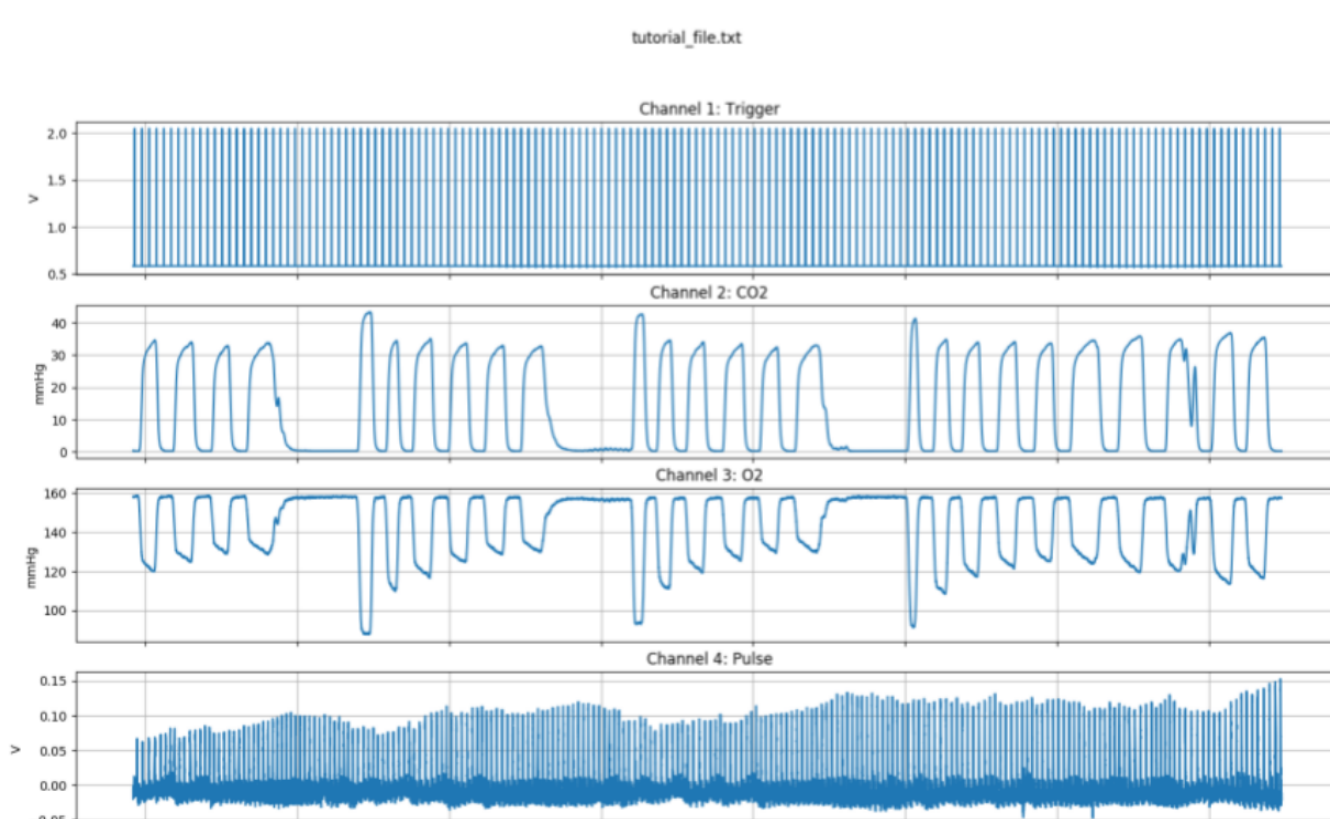· Automatic peak detection method that allows a GUI-based manual correction.
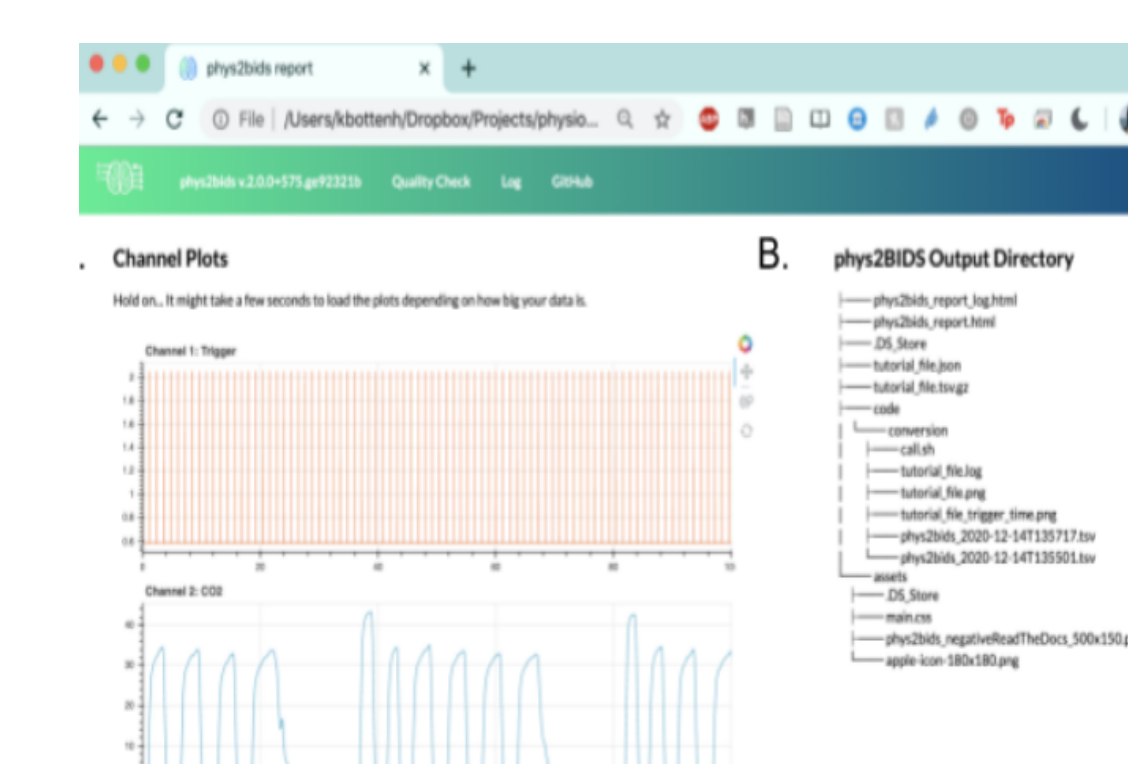
phys2denoise
Physiological modelling

· Scripts to extract time-series features to be used for physiological fMRI denoising (i.e. removing variance associated with physiological signals).
· Available features: common metrics related to cardiac and respiratory artifacts.
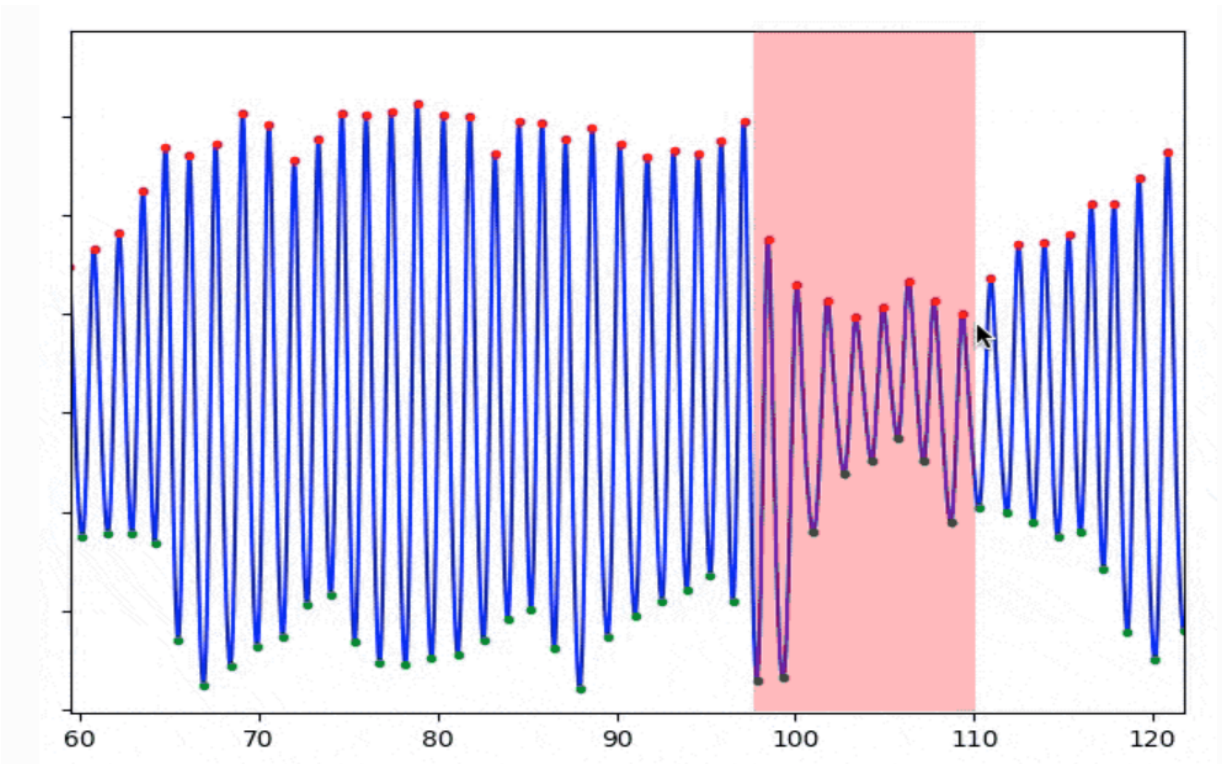
Data inspection

Visual report

Peak annotation

Future development

1. Extending support to MRI vendor physiological data.
2. Automatic signal labeling.
3. Integration with other toolboxes.
4. Fully interactive reports.
5. Improved peak detection and physiological data denoising.
6. Extending support to denoising metrics.
7. New complete automation of the pipelines.
8. Extending the documentation on physiological data collection and usage.

Altogether, Physiopy aims to become a complete toolkit for all tasks related to physiological data preparation.

References

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