

Multi-Modal Brain Visualizations



Red Lemur

Mission

To automate and simplify the presentation of high dimensional multimodal neuroimaging datasets, facilitating a shift toward data-driven hypothesis creation in the Brain Science community.

Motivation

Early research into data driven phenotypic analysis shows that there may be biomarkers for psychopathologies detectable by neuroimaging techniques.

There is a wealth of heavily phenotyped multimodal neuroimaging data available which can be used by Brain Scientists can search for these biomarkers.

A well researched biomarker could be used to detect and intervene in the development of mental illness in children, which could significantly improve quality of life of those affected and reduce the costs of mental healthcare.

Problem

High dimensional multimodal neuroimaging datasets represent a unique class of data, for which proper visualization solutions are not found in traditional software packages.

There is some work in the statistical community toward developing meaningful visualizations for high dimensional and multimodal datasets, but there has been little work applying these methods to neuroimaging datasets.

Causes

Neuroimaging datasets are high dimensional time-series, representing a very complex data structure.

- There has been little influence taken by the brain science community from the statistics and finance communities addressing this problem.

Current neuroimaging visualization software has a steep learning curve, and useful functions are spread across different packages.

- This makes the visualization of neuroimaging data costly and resource intensive.

Current Best Practices

EEG Lab: <https://sccn.ucsd.edu/eeglab/index.php>

- An interactive gui visualization and preprocessing tool in MATLAB.
 - Specialized to certain EEG input formats

PySurfer: <https://pysurfer.github.io/>

- Python package for the visualization of cortical surface signals with extensions for MRI and MEG data.
 - 3D renderings with no statistical information or dimensionality reduction

Mindboggle visualization: <http://roygbiv.mindboggle.info/roygbiv/web/index.html>

- 3D visualization of cortical structure from DTI data

What's missing

What works:

- Basic visualizations such as sparklines and spectrograms
- 3D visualizations of electrical signal on cortical surface, and structural MRI

What's missing:

- One-click functionality without use of a clunky MATLAB GUI
- Advanced visualizations of high dimensional signals (dimensionality reduction)
- Analytics such as clustering and descriptive statistics
- Fusion of multiple data modalities

Solution

A one-click visualization tool for multimodal neuroimaging data

- Easy to use by neuroscientists, and scalable to large datasets ($n > 10000$)
- Lowers the barrier of entry to search for biomarkers

Development of new neuroimaging visualization techniques by adapting methods from data science

- Advanced dimensionality reduction and clustering
- Aesthetically pleasing and simple plots

Impact

Neuroscientists

- Provides much needed neuroimaging visualizations without the overhead of learning a software kit, hiring a data scientist, renting/purchasing a high performance computer

Statisticians, Computer Scientists, Data Scientists

- Gives a proof of concept for the application of high dimensional statistical analytic techniques to neuroimaging data, and may spur further applied research
- Provides a simple to use API for developers to extend and adapt the pipeline