BrainIAK Education: User-Friendly Tutorials for Advanced, Computationally-Intensive fMRI Analysis

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Learning Advanced fMRI Analysis

Pre-Processing: There exist multiple packages (AFNI, FSL, SPM, FreeSurfer, fmriprep) to perform fMRI pre-processing and basic statistical analysis. These packages come with detailed tutorials, examples, and bootcamps.

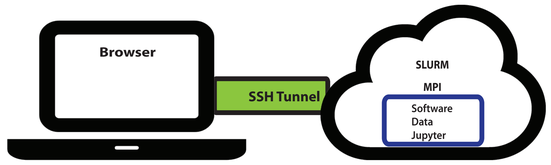
Advanced analysis: Users often face the following challenges when trying to learn advanced fMRI analysis:

- Complicated, high dimensional datasets.
- Documentation of analysis techniques is often inadequate.
- Few training materials are available for performing analysis on high performance clusters (HPC).

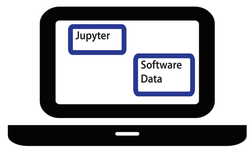
Our Goal: Create user-friendly learning materials for advanced fMRI analysis.

- Basics to advanced fMRI analysis on HPC.
- Detailed, step-by-step execution of analysis.
- Use open source tools for free sharing and collaboration.

A. Tutorial architecture at Yale/Princeton



B. Tutorial on individual machine



C. Tutorial topics - from basic to advanced

Basic	Classification/ Correlation	Advanced Techniques
Data Loading	Cross-Validation	Searchlights
Z-scoring	Dimensionality Reduction	Full Correlation Matrix Analysis[5,6] (FCMA)
Plotting Time-Series	RSA	Functional Alignment: Inter-Subject Correlation[3], Inter-Subject Functional Correlation[4] (ISFC), Shared Response Model[2]
Haemodynamic Shift	Pipelines	Event Segmentation: Hidden Markov Model[7]
	Simulated Data	Real-Time fMRI[8]

Highlights

These tutorials were successfully used as part of an advanced fMRI analysis course at Yale University and are currently being used in a course taught at Princeton University.

Novice users were performing advanced analysis by the end of the course, on HPC.

A scientific challenge question, relevant to cognitive neuroscience, is posed in each tutorial to highlight the applicability of a method.

These materials can be easily integrated with other teaching materials.

Future Work

Public release is planned in early 2019.

Use the QR code to view sample tutorials, and to sign up for updates on the tutorials.

Methods

Tools: Jupyter, Bash Scripts, SLURM, Python

Packages:

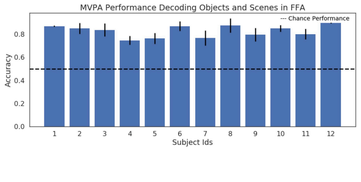
scikit learn, ni learn

BrainIAK[1]

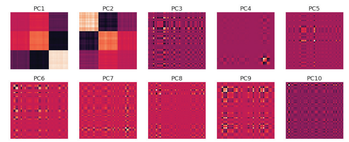
Publicly available datasets: Block Designs, Event Related Designs, Movie Datasets.

Simulated data using BrainIAK's simulator.

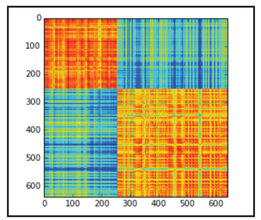
D. Samples of student generated plots

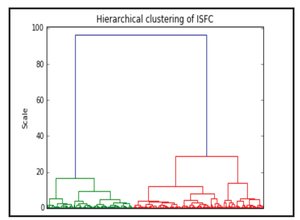


Classification Accuracy



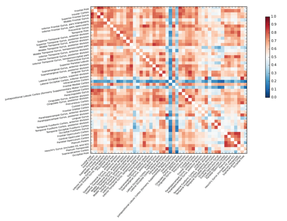
PCA: Covariance





ISFC Clustering

Also see: [Board LLL13] "Searchlight analysis over functional rather than anatomical space reveals higher representational similarity with deep learning models."



Parcel Correlation Matrix

FCMA: Circos Plot

Acknowledgements

Funding for this project was provided by Intel labs.

We would like to thank the many contributors to the BrainIAK code base, BrainIAK examples, and the tutorial alpha-testing team for their contributions.

Plot Credit: Clara Colombatto, Jacob Prince, Sreejan Kumar, and Paula J. Brooks.

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BrainIAK: http://brainiak.org