

# COL 786 - Advanced Functional Brain Imaging

## Assignment-2 and Assignment-3

Due Date: 7:00pm on Monday, 22<sup>nd</sup> March, 2021

### Assignment 2

Max Marks : 100

#### Notes:

- The objective of this assignment is to:
  1. Make you learn how to use the FSL tool to perform all the preprocessing and GLM analysis for a single subject.
  2. Make you learn how to perform linear registration of images to a standard atlas through the command line interface.
  3. Let you explore brain regions involved in different aspects of vision, audio processing, language processing, motor functions, through the following stimuli: *video\_sentence*, *video\_left\_hand*, *video\_right\_hand*, *audio\_sentence*, *audio\_left\_hand*, *audio\_right\_hand*, *vertical\_checkerboard* and *horizontal\_checkerboard* using the **Brainomics/Localizer** database (Orfanos, D. P., Michel, V., Schwartz, Y., Pinel, P., Moreno, A., Le Bihan, D., Frouin, V. (2017). *The brainomics/localizer database. Neuroimage, 144, 309-314.*).
- The assignment is to be done individually.
- You are required to submit a report containing
  1. Figures of selectively activated brain regions obtained using *fslview/fsleyes* for each of the tasks and contrasts. The figures should highlight the main areas of the brain found active, similar to the Figure 5 of the paper Pinel, P., Thirion, B., Meriaux, S., Jobert, A., Serres, J., Le Bihan, D., ... Dehaene, S. (2007). *Fast reproducible identification and large-scale databasing of individual functional cognitive networks. BMC neuroscience, 8(1), 1-18.*
  2. A table similar to Table 2 of the above paper.
  3. Your comments on whether the activations found by you are consistent with the existing literature. Try to write your results in the form of a short paper. The evaluation will be based on the quality of your writeup, not on the number of words used.
  4. Link to the google drive directory containing all your scripts and results. Include a README.txt file in the directory that describes the file names for the preprocessed data and registered (non-thresholded) zstat maps. Do not include any data/files in your submission.

The report is to be submitted by email in the form of a pdf attachment to rahulgarg@cse.iitd.ac.in

- There may be a demo of your assignment, but the assignment will primarily be evaluated based on the quality of your report. You may be notified about the demo later.
- Upload your final directory containing all your results and the design.fsf files and all your scripts (if any) in a google drive folder and submit a readable link in your report to your folder. **Make sure that you do not change any files in the drive after the assignment deadline. Failure to comply to this instruction, may lead to a disciplinary action.**

- This assignment is divided into two parts. The first part involves single subject preprocessing, GLM analysis of the fMRI BOLD data along with registration of the results obtained to a standard template. The second part requires you to identify the brain regions activated for the contrasts generated in part 1. Finally, you are supposed to present your findings in the form of a report. You need to comment on all the main brain regions that you found to be active in specific task conditions and whether your results are consistent with the prior knowledge on these areas. You are encouraged to take help of Wikipedia, Scholarpedia, google scholar and other online resources to put your results in perspective of the prior knowledge. Give suitable references about prior knowledge in your report justifying the regions found to be active in your analysis.
- The data of this assignment is based on the Brainomics/Localizer database. For more details about the protocol, refer to the following papers.
  - Orfanos, D. P., Michel, V., Schwartz, Y., Pinel, P., Moreno, A., Le Bihan, D., Frouin, V. (2017). *The brainomics/localizer database. Neuroimage, 144, 309-314.*
  - Pinel, P., Thirion, B., Meriaux, S., Jobert, A., Serres, J., Le Bihan, D., ... Dehaene, S. (2007). *Fast reproducible identification and large-scale databasing of individual functional cognitive networks. BMC neuroscience, 8(1), 1-18.*
- The data for this assignment can be downloaded from *here*. The structural and fMRI files are named as follows:

**fMRI BOLD** functional.nii

**Structural** anatomical.nii

The 3-column EV files for the various stimuli are named as follows:

**audio left hand** EV2\_audio\_left\_hand.txt

**audio right hand** EV3\_audio\_right\_hand.txt

**audio sentence** EV4\_audio\_sentence.txt

**horizontal checkerboard** EV5\_horizontal\_checkerboard.txt

**vertical checkerboard** EV6\_vertical\_checkerboard.txt

**video left hand** EV8\_video\_left\_hand.txt

**video right hand** EV9\_video\_right\_hand.txt

**video sentence** EV10\_video\_sentence.txt

- The assignment will take time. Start early. Do not postpone till the last few days.
- For doubts send an email to aman.bhardwaj@cse.iitd.ac.in

1. **Preprocessing and registration [40 marks]** Perform the pre-processing steps using the FSL tool. The pre-processing should include brain extraction, spatial smoothing (4mm FWHM) and temporal filtering (100 seconds high pass), motion correction and linear registration to the standard 2mm MNI brain template. Your submission should include the design.fsf file, the log of FSL runs and the output, intermediate files and/or any other scripts that you may have used. Check the quality of your registration using fslview/fsleyes and re-run with changed parameters if needed.
2. **Generating Contrasts [60 marks]:** The following Explanatory Variables (EVs) are used: audio left hand, audio right hand, audio sentence, horizontal checkerboard, vertical checkerboard, video left hand, video right hand, video sentence. The 3-column format files for the EVs are given with the data. You are required to generate the following contrasts and explain (in your report) if your findings are consistent with the existing literature. Include your zstat.nii files in your final submission.
  - (a) video sentences- checkerboard
  - (b) video left motor – checkerboard
  - (c) video right motor – checkerboard
  - (d) video motor – checkerboard
  - (e) (video+audio) right motor – (video+audio) left motor
  - (f) (video+audio) sentences - checkerboard

### Assignment 3

Max Marks : 100

The objective of this assignment is to make you learn how to use the FSL tool to perform higher-level analysis across subjects and study the mean group effect, i.e., whether the group activates on average. The same contrasts (as defined in A2) are to be used for the group analysis. A similar report (as specified in A2) and output files need to be submitted. The data for this assignment will soon be made available.