Predicting fMRI-based task-related activation with Machine Learning

Cognitive Science and AI: Assignment 1

January 12, 2024

1 Instructions for submission

Deadline: 25/01/2024

Maximum marks - 100

- You may do the assignment in Jupyter or Colab notebook or a script that executes the code.
- A report should be submitted that includes all the deliverables. Report and code should be included in a folder specified by Roll Number and Name of the student and submitted in Moodle, adhering to the deadline.
- Include the assignment number, your name and roll number in the notebook/script as well for better identity.
- Late submissions are NOT accepted.
- IMPORTANT: Make sure that the assignment that you submit is your own work. Do not copy any part from any source including your friends, seniors. Any breach of this rule could result in serious actions including an F grade in the course.
- Your marks will depend on the correctness / convincing discussion points. In addition, due consideration will be given to the clarity and details of your answers and the legibility and structure of your code.
- Do not copy or plagiarise, if you're caught for plagiarism or copying, penalties are much higher (including an F grade in the course) than simply omitting that question.

2 Objective

This assignment is based on the experiments conducted in (Haxby et al. 2001) (paper uploaded on Moodle). The idea is to understand the brain regions that play a role in visual objection recognition. For this, we build Machine Learning models taking brain responses at voxels in various regions of the brain (time series signals) as features and accomplish binary classification *e.g., face vs house or face vs cat.* The idea is to understand how patterns of fMRI activity

time series signals extracted from the brain regions of distinct spatial locations contribute in discriminating various visual stimulus conditions.

3 Dataset that we use to conduct this assignment

The Haxby dataset is used for the assignment downloaded with Nilearn `https://nilearn.github.io/stable/modules/generated/nilearn.datasets.fetch_haxby.html#nilearn.datasets.fetch_haxby`

What is already provided? Time series signals pre-extracted from brain voxels of different brain regions are provided to you as 2D data feature matrix. These features are obtained from the following specifications:

- Pre-extracted from different brain locations such as Pre & Post-central, Superior Frontal & temporal, Inferior frontal and Cerebellar.
- Pre-extracted from ventral temporal region.

All these data matrices are provided to you for 5 subjects and the same can be downloaded from this link.

4 Tasks

Your task is divided into three parts for predicting two different contrasting conditions (binary classification). A schematic overview of the task is depicted in Figure 1. A Machine Learning model can be anything of your choice and use *LeaveOneGroupOut* cross validation strategy to report the mean accuracies. "Group" here denotes session (there are 12 sessions).

5 Deliverables

A visualization of the results (using a boxplot, a barplot with mean and standard deviation, or any other appropriate technique) should be shown in the report and followed by a discussion of the results.

Within each figure, two boxplots showing classification accuracy for the two contrasts *i.e.,* face vs house and face vs "X". A total of 3 such figures, for VT, VT (random 50% voxels), and the designated ROI for your group are to be shown in your results. [*Note: 6 groups are formed based on roll numbers. Please check which group you belong to, in order to know which of the 5 subjects, which contrast condition (X), and which ROI are designated for your group to do experiments on and for reporting results. Please clearly indicate these choices in your report for clarity*].

In another figure, show 2 different horizontally stacked barplots of classification accuracy of models built using brain responses from VT, VT (random 50% voxels), and designated-ROI, in classifying face vs house and face vs "X" conditions.

References

Haxby, James V. et al. (2001). "Distributed and Overlapping Representations of Faces and Objects in Ventral Temporal Cortex." In: *Science* 293.5539, pp. 2425–2430.

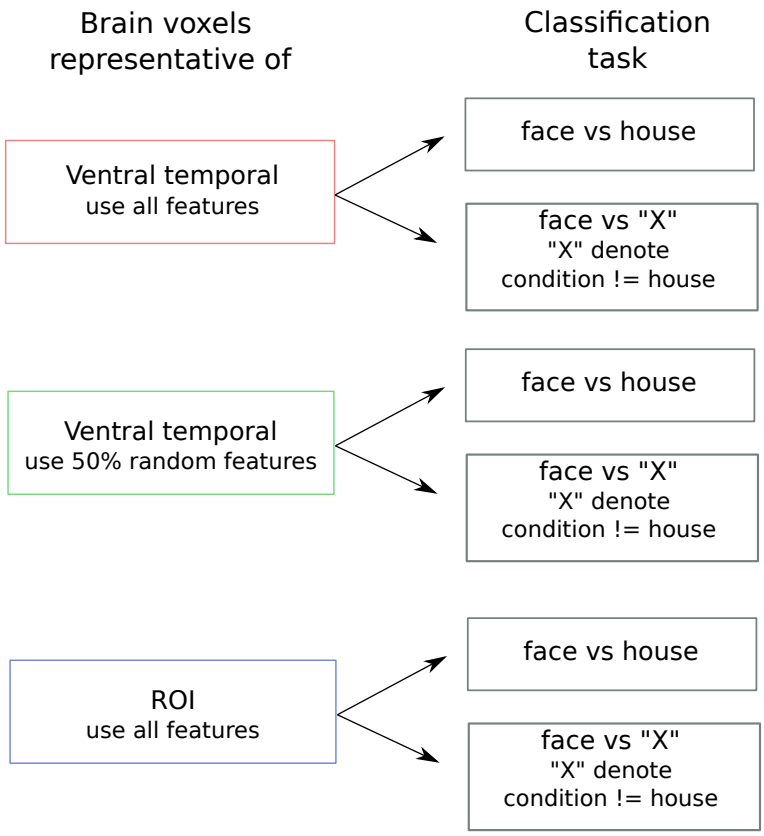

Figure 1: Description of the tasks that need to be executed in this assignment