Task1: 13/07/25

Dear Students,

From the available dataset, multiple objectives can be formulated for the following research questions.

- Which brain regions differ in AVH+ vs AVH−?

- which task (words, sentence, reversed) best separates groups?

- Can FC during *sentences* vs *white noise* predict hallucinations?

- Is reversed speech more confusing for AVH+?

I. Distinguish **AVH+, AVH−, Healthy (Ternary Classification)**.

Common Task: Preprocessing of fMRI data and calculation of Functional connectivity matrix is a common task.

1. Apply Different preprocessing steps on fMRI data before designing a deep learning/ML architecture
Refer "**GCN Analysis of Task-Based fMRI Data for Diagnosis of Schizophrenia** " or "Brain correlates of speech perception in schizophrenia patients with and without auditory hallucinations" papers for preprocessing parts.

  - Preprocessing of fMRI data
    - Discard initial volumes
    - Motion correction (MCFLIRT)
    - Brain extraction
    - Co-registration to structural and MNI space
    - Smoothing (FWHM = 5mm)
    - Movement thresholding (>3mm or >0.3mm)
    - Denoising (regression of motion, WM, CSF signals, etc.)
  - Define ROI or Parcellation
    Define **brain regions** (ROIs) using **AAL atlas** (90–116 regions) or **Harvard-Oxford atlas**
  - Compute **Task based Functional connectivity(During sentences, words, reverse sentences) (FCs for "sentences", "words", etc. can be concatenated)**

2. Feature extraction for ML or GCN for deep learning architecture (
3. Classification architecture (Implement different algorithms) (You can initially try the existing code available in the paper" Graph neural network and machine learning analysis of functional neuroimaging for understanding schizophrenia")
4. **Check whether model confuses AVH− with HC**
5. **Use SHAP to explain which connections are important (Explainable AI)**

II. Task Decoding (Multiclass: Sentences / Words / Reversed)
Goal:
Predict which task the subject was doing from their brain activity. Useful for brain decoding and understanding **task modulation** in schizophrenia.

Steps
1. Segment BOLD time series based on onsets (for each task)
2. For each task block:
   o Extract FC matrix or BOLD features
   o Label: "sentences", "words", "reversed" (ignore white noise)
3. Train a classifier:
   o Input: FC/BOLD per block
   o Output: Task label

Can show **which tasks are harder for AVH+ patients** (e.g., reversed speech might confuse more)

Work to be done : on or before 18/07/25 and present your results.

- **Do preprocessing steps and calculate FC matrix for sample subjects from each category healthy, AVH+, AVH-)**
- **Prepare a document to show the step by step results of each process.**