EEG Inverse Assignment

Objective:

To reconstruct the true brain source activity (S) from the measured EEG scalp data (Y) using the leadfield matrix (G) and to compare different inverse problem-solving methods. Students will evaluate the accuracy and stability of these methods under two conditions:

1. Without noise
2. With added sensor noise

The goal is to understand how each inverse technique performs in estimating the original brain sources from noisy EEG recordings.

Group Work Plan:

- Students will work in groups of five (5).
- Each group will select two inverse methods from the list provided below.
- For each selected method:
    1. Apply the method once using noise-free data.
    2. Apply the method again with added noise.
    3. Compare the reconstructed sources ($\hat{S}$) to the true sources (S_true).
- Each group must:
    - Calculate and tabulate accuracy.
    - Visualize true vs estimated sources for selected channels.
    - Submit a short report (1–2 pages) summarizing findings and interpretation.

Data Files

File Name	Description	Dimensions
Source.xlsx	True source signals over time (ground truth).	16 sources × 1000 samples
Leadfield.xlsx	Leadfield (Gain) matrix G, mapping sources to sensors.	32 sensors × 16 sources
EEG Data.xlsx	Measured EEG scalp data from sensors.	32 × 1000
Noise.xlsx	Noise data to be added to EEG signals.	32 × 1000

Relationship:
$Y = G \times S + N$
where Y = EEG data, G = leadfield matrix, S = true sources, and N = noise.

Inverse Methods

No.	Method
1	Ordinary Least Squares (OLS)
2	Tikhonov Regularization (Ridge)
3	Weighted Minimum-Norm (WMN)
4	Sparse Solution (LASSO / L_1)
5	Beamformer (LCMV-like)
6	Equivalent Current Dipole (ECD)