## **MainSimulation**

Generates the File ‘VisioMotor’ containing Samples (user defined number of Samples) of simulated EEG Data time series (user defined time extension) from sources activity (up to 5 sources) in different spatial configurations (up to 32) and subjects Lead Fields projections (up to 9 Subjects). This is an small example of (2 configurations X 2 Subjects X 201 time points X 3 samples).

Download the complementary file with the 9 subjects Lead Fields ‘LeadFields.rar’ at the link:

<https://lstneuro-my.sharepoint.com/:u:/g/personal/deirel_paz_neuroinformatics-collaboratory_org/EYDaspNhtUFCnBsLkL-lp0sB0i_-INJ4AryD9Dj6F6wA2Q?e=OHNwm0>

Extract it and copy it into same folder that the routine ‘MainSimulation’.

The simulation can be extended by changing the settings at following Lines of the routine ‘Initialize\_simulation’:

Line 2: Load cell array with 9 Lead Fields ‘LeadFields’ from the Cuban Connectome Project.

Line 3-4: Select specific Lead Fields for analysis by introducing a row with numbers from 1 to 9 , e.g. subject = [1, 2].

Line 10: Defines number of noisy sources to be placed at the vertices ‘Nnoise’.

Line 12: Defines the number of time points of the simulation ‘Nt’.

Line 23-27: Defines cortical points at the Occipital ‘O’, Temporal ‘T’, Parietal ‘P’, Motor ‘M’ and Frontal ‘F’ areas. ‘L’ and ‘R’ indicates the hemisphere of the positioning.

Line 29-39: Generates all possible interhemispheric combinations in which 5 points ‘O’, ‘T’, ‘P’, ‘M’ and ‘F’ appear. Totally 32 combinations of points storage within the cells of ‘point\_sim’.

Line 41: Row vector containing the geodesic radius ‘d’ of 5 patches to be simulated. The centroids of the patches are the points ‘O’, ‘T’, ‘P’, ‘M’ and ‘F’ that correspond in order to the elements within ‘d’, e.g. d = [30E0, 15E0, 25E0, 10E0, 5E0].

Line 43: Amplitude of the waveforms ‘m’ associated to each of the 5 patches, e.g. m = [1, 1.5, 1, 3, 5]. ‘O’ and ‘F’ were set to zero in this case.

Line 57: Define the configuration by a row of numbers from 1 to 32 after its visualization, e.g. config = [1, 4, 25, 32].

***Outputs (List of Variables within ‘VisioMotor’):***

LeadFields: Cell array con containing within cells the Lead Field matrices (120 electrodes X 6003 generators) from the Cuban Connectome Project selected for analysis.

Jsim: Cell array containing within cells simulated sources time series (6003 generators X 201 time points) of different spatial configurations.

G: waveforms (5 sources X 201 time points) of the simulated sources.

vertices: Coordinates of the Surface vertices in which the EEG generators were defined.

faces: Triangulation of the Surface vertices.

index\_sim: Cell array containing within cells the indices of the sources in the different spatial configurations.

V0\_sim: Cell array containing the EEG Data from the projection of the simulated sources activity for the different configurations. Every cell contains an imbedded cell array of different subjects (Lead Fields) projection. The embedded cells contain matrices of the EEG time series (120 electrodes X 201 time points).

Svv0\_sim: Cell array containing the outer product of the EEG Data from the projection of the simulated sources activity for the different configurations. Every cell contains an imbedded cell array of different subjects (Lead Fields) projection. The embedded cells contain 3D arrays of the EEG Sample Covariance at every time point (120 electrodes X 120 electrodes X 201 time points).

V\_sim: Cell array containing the EEG Data from the projection of the simulated sources activity for the different configurations. Every cell contains an imbedded cell array of different subjects (Lead Fields) projection. The embedded cells contain 3D arrays EEG time series (120 electrodes X 201 time points X 3 Samples) that were corrupted with 3 Samples of Noise (Biological and Sensors Noise).

Svv0\_sim: Cell array containing the averaged outer product (Sample Covariance) of the EEG Data from the corrupted projection of the simulated sources activity for the different configurations. Every cell contains an imbedded cell array of different subjects (Lead Fields) projection. The embedded cells contain 3D arrays of the EEG Sample Covariance at every time point (120 electrodes X 120 electrodes X 201 time points).

Nsamp: Number of Samples from Noise.

## MainInverseSolvers

Uses different Inverse Solution methods to compute the sources activity from the EEG Data generated by ‘MainSimulation’. All the methods incorporated into the routine are based on modalities of either the Hierarchical Elastic Net or the Hierarchical Elitist LASSO, presented in:

Paz-Linares, D., Vega-Hernandez, M., Rojas-Lopez, P.A., Valdes-Hernandez, P.A., Martinez-Montes, E. and Valdes-Sosa, P.A., 2017. Spatio temporal EEG source imaging with the hierarchical bayesian elastic net and elitist lasso models. Frontiers in neuroscience, 11, p.635.

InverseSolver\_enet\_ssbl: Complex/Real vector regression by Hierarchical Elastic Net model. The source activity is defined as a vector on the generators space. Models combination of L1 and squared L2 norms. Learning of the Hyperparameter of the L1 and squared L2 norms.

InverseSolver\_elasso\_ssbl: Complex/Real vector regression by Hierarchical Elitist LASSO model. The source activity is defined as a vector on the generators space. Models the squared L1 norm. Learning of the hyperparameter of the squared L1 norm.

The compute the Inverse Solution switch the settings in the following Lines in MainSimulation:

Line 7: Define the method IS = 1 (InverseSolver\_enet\_ssbl), IS = 2 (InverseSolver\_elasso\_ssbl).

Line 10: Define the time/frequency components for the regression by a row of numbers from 1 to 201 after its visualization, e.g. config = [1, 2, 35, 201].

***Visualization***

Switch the following lines to visualize different subject or time/frequency component (from those selected before to run the Inverse Solution), e.g. subj = 1, comp = 2.

Line 26 27 (InverseSolver\_enet\_ssbl)

Line 25 26 (InverseSolver\_elasso\_ssbl)

***Outputs:***

sol\_enetssbl: a cell array containing, cell 1 – 4D array of Inverse Solution (generators X time points X samples X subjects), cell 2 – 3D array of the squared L2 norm regularization parameter (time points X samples X subjects), cell 3 - 3D array of the L1 norm regularization parameter (time points X samples X subjects).

sol\_elassossbl: a cell array containing, cell 1 – 4D array of Inverse Solution (generators X time points X samples X subjects), cell 2 – 3D array of the squared L1 norm regularization parameter (time points X samples X subjects).