**LIMO EEG: LINEAR MODELING OF EEG DATA**

**List of functions**

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1. **GUI**

*eegplugin\_limo*: show the plug in EEGLAB

*limo\_central\_tendency\_questdlg*: allows choosing estimators 1st and 2nd level e.g. mean per subjects and trimmed mean across subjects

*limo\_contrast\_manager*: GUI for visualization of the design matrix, takes contrasts, and check them, also compute tfce if bootstrap performed

*limo\_import*: import GUI

*limo\_gui*: starting GUI

*limo\_random\_effect*: GUI for 2nd level analysis

*limo\_results*: GUI for looking at results

*limo\_tools*: GUI showing various tools to select

1. **Wrappers and handling functions**

*limo\_batch*: batch for 1st level analyses

*limo\_best\_electrodes*: find best electrodes across subjects (in terms of max value)

*limo\_central\_tendency\_and\_ci*: get the trimmed mean, or Harell-Davis 0.5 decile, or median and 95% CI

*limo\_eeg*: does 1st level analysis

*limo\_get\_files*: utility to get files

*limo\_match\_electrodes*: create a data set of dim [expected chanloc, start-stop, values] giving as imput data (dim electrodes, time frames, values), expected chanlocs and start / stop time frames

*limo\_random\_robust*: call stats routines to perform 2nd level analysis

*limo\_random\_select*: selection of files and creation of LIMO.mat for 2nd level analysis

*limo\_stat\_values*: compute statistical thresholds for mass univariate analyses

1. **Visualization**

*limo\_display\_results*: read files, get the stats and do the plots

*limo\_plot\_difference* compute and plot the difference between 2 data sets

*limo\_plots* allows to plot data in various format – this function will be updated with robust estimators

1. **Statistical functions**

**GLM related**

*GenCalcHFEps*: Grennhouse-Geisser correction

*GenOrthogComps*: generate orthogonal contrasts for univariate repeated measure ANOVA

*limo\_contrast*: post-hoc tests from limo\_glm1.m, allows testing combinations of regressors

*limo\_decomp*: Cholesky factorization or SVD (for non positive semidefinite matrix)

*limo\_glm1*: allows performing two-samples t-test, ANOVA, ANCOVA and regression. Note analyses are performed for a given electrode. For full brain it is necessary to loop. As input it takes 3 methods ‘OLS’ ‘WLS’ and ‘IRLS’. For now ‘OLS’ has been fully tested and showed to work. ‘IRLS’ has been tested and seems to work (be cautious more test is needed). ‘WLS’ is a new method where we have 1 single weight per trial for all time frames. It has not yet been validated (i.e. do not use yet).

*limo\_glm1\_boot*: bootstrap for limo\_glm1.m – note that once the bootstrap is performed and data saved, limo\_contrast will look for H0\_betas and also perform the bootstrap of the contrast. Note, like limo\_glm1, analyses are performed for a given electrode. For full brain it is necessary to loop.

*limo\_IRLS* computes weights to plug into limo\_glm1 to perform an Iterative ReWeighted Least Square (uses a bisquare function)

*limo\_model\_selection* for a design with only one categorical factor (counfound) and many continuous covariates, find the best subset of continuous covariates

*limo\_non\_linear* for design with ordinal variable, the analysis can be performed using a regression (i.e. truly linear) or break into several conditions (ANOVA model). The difference between the two model allows testing if there is non linearities

*limo\_OrthogContrasts* create orthogonal contrasts

*limo\_pcout* Limo Principal Components Projection find multivariate outliers

*limo\_rep\_anova* Hotelling test for repeated measures ANOVA and gp x repeated measures

*limo\_rep\_anova\_old* standard univariate repeated measure anova

*limo\_semi\_partial\_coef*: compute semi partial coefficients

*limo\_WLS* computes trial weights for a Weighted Least Squares GLM

**Other tests**

*limo\_bootttest1*: bootstrap 1 sample t-test

*limo\_boot\_yuen\_ttest*: bootstrap 2 samples t-tests

*limo\_lateralization*: compute and test lateralization

*limo\_trimci* one sample t-test using trimmed mean

*limo\_ttest*: one sample, paired and two samples t-tests

*limo\_ttest\_permute* one sample t-test using permutation

*limo\_yuen\_ttest*: 2 samples t-test using trimmed means

*limo\_yuend\_ttest*: paired t-test using trimmed means

*limo\_robust\_1way\_anova:* 1 way ANOVA based on trimmed means

**Robust estimators**

*limo\_boot\_se*: compute bootstrapped standard error of the median or Harrell-Davis

*limo\_harrell\_davis*: compute Harrell Davis estimate of the quintile and 95% CI

*limo\_median* Compute a median and 95% CI from 3D matrix

*limo\_pbci* one-sample percentile bootstrap confidence interval

*limo\_robust\_ci* create estimators and their 95% CI

*limo\_trimmed\_mean* compute trimmed mean and 95% CI

*limo\_winvar* winsorized variance

**Multiple comparison correction**

*limo\_cluster\_attributes*: return various attributes of clusters (height, size, mass)

*limo\_cluster\_test2*: returns mask and corrected p values of significant clusters

*limo\_ecluster\_make*: get threshold for clusters

*limo\_ecluster\_test*: get significant temporal clusters

*limo\_get\_cluster\_sum*: compute cluster mass

*limo\_FDR*: returns thresholds to correct for multiple comparisons using false discovery rate

*limo\_tfce* compute tfce scores

+ in the limo\_cluster\_functions folder all relevant fieldtrip functions

1. **Others**

*cell2csv*: export cell values to csv format

*exportfig*: high quality export for figures

*limo\_contrast\_checking*: allows 1 – to automatically add zeros to a contrast and 2 – check if a contrast is valid

*limo\_create\_boot\_table*: create a table (cell) for resampling data – each cell maps onto an electrode such as the same resampling is applied across electrode with few changes when data are missing

*limo\_create\_files*: allows creating separate raw or modelled data based on the design matrix

*limo\_design\_matrix*: create design matrix and return outputs for limo\_glm1 + create few files on the disk

*limo\_expected\_chanlocs*: try to build the expected\_chanlocs file looping through subjects

*limo\_get\_channeighbstructmat*: create neighbouring matrice

*limo\_make\_interaction*: from the data and a set of factors, create the interaction terms

*limo\_nb\_items*: return de nb of items for each column of categorical variables

*limo\_neighbourdist* compute the distance matrix between channels

*limo\_path\_update*: allows to automatically update LIMO paths

*limo\_review*: display design, orthogonality of regressors and covariance