The Source Information Flow Toolbox

Practicum

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Experimental Data

Two-back with feedback continuous performance task

Match

Response Auditory feedback

Non-match

One trial

Letter presentation Response (360 ± 50 ms) Auditory feedback Letter presentation

- 600 ± 100 ms - 850 ms
- 1450 ± 100 ms
Error-Related Negativity (ERN)

Medial-Frontal Negativity (MFN)

Coherence Magnitude
Starting
EEGLAB/SIFT

SIFT Requirements:

• Matlab 2008b (or greater) *
• Signal Processing Toolbox
• Statistics Toolbox
• EEGLAB
• SIFT 1.5

* SIFT 1.5+ required for compatibility with Matlab 2014a or greater
If you can’t install SIFT via plugin manager…

Copy <USB-key>/.../SIFT_1.5 to EEGLAB plugins folder (unzipped)
Starting EEGLAB/SIFT

If you don't have SIFT Installed

1. Clear the Matlab Path
1. Starting EEGLAB/SIFT

2. Add EEGLAB+SIFT to path
3. Start EEGLAB
4. Check EEGLAB memory options
2 Loading Data

<USB Key>/SIFT/Data/
Preprocessing: Select Data Range

Select data in: 
- Time range [min max] (s): [-1 1.25]
- Input desired range
- on->remove these

Select data using events
Select epochs or events
Copy current dataset
Append datasets
Delete dataset(s)
Edit events & mark bad channels

Dataset info -- pop_newset()

What do you want to do with the new dataset?
- Name it: RespWrong
- Edit description
- Save it as file:

What do you want to do with the old dataset (not modified since last saved)?
- Overwrite it in memory (set=yes; unset=create a new dataset)

Help Cancel Ok

Scroll dataset

Help Cancel Ok

...
3 Preprocessing: Select Components

- Select Components
- Remove components from data
- Component(s) to remove from data:
- Component(s) to retain (overwrites "Component(s) to remove")
- 8, 11, 13, 19, 20, 23, 38, 39

- Accept
- Dataset info -- pop_newset()
Preprocessing: SIFT

EEGLAB v12.0.0.0b

File | Edit | Tools | Plot | Study | Datasets | Help
---|---|---|---|---|---|---
Change sampling rate | Filter the data | Re-reference | Interpolate electrodes | Reject continuous data by eye | 
Extract epochs | Remove baseline | 
Run ICA | Remove components | 
Automatic channel rejection | Automatic epoch rejection | Reject data epochs | Reject data using ICA | 
CleanLine | SIFT | Pre-processing | Simulation | Locate dipoles using DIPFIT 2.x | Peak detection using EEG toolbox | FMRIB Tools | Locate dipoles using LORETA | 

Preprocessing Options

- Miscellaneous
  - VerbosityLevel
  - ResetConfigs
- SignalType
  - VariableNames
  - Components
- Filtering
  - DifferenceData
  - Detrend
    - DetrendingMethod
    - SegmentLength
    - StepSize
- Plot
  - AmplitudeEnvelope
- Normalization
  - NormalizeData
    - Method
      - time; ensemble

SignalType
Type of signal to analyze. If 'Components', data in EEG.icaact will be processed. If 'Channels' EEG.data will be processed. If 'Sources' EEG.srcpot will be processed.

OK

Dataset info -- pop_newset()

What do you want to do with the new dataset?
Name it: RespWrong

Some changes have not been saved. What do you want to do with the old dataset?
- Overwrite it in memory (set=yes; unset=create a new dataset)
  - Save it as file:
    - /Users/timmullen/Documents/WORK/

Ok
Model Order Selection

- EEGLAB v12.0.0.0b
- Tools menu options:
  - Change sampling rate
  - Filter the data
  - Re-reference
  - Interpolate electrodes
  - Reject continuous data by eye
  - Extract epochs
  - Remove baseline
  - Run ICA
  - Remove components
  - Automatic channel rejection
  - Automatic epoch rejection
  - Reject data epochs
  - Reject data using ICA
  - CleanLine
  - SIFT
    - Locate dipoles using DIPFIT 2.x
    - Peak detection using EEG toolbox
- Model Order Selection Assistant window:
  - Model Order Range: [1 30]
  - Information Criteria: sbc; aic; fpe; hq
  - Algorithm: Vieira-Morf
  - Description:

- Simulation menu options:
  - Pre-processing
  - Model fitting and validation
  - Model Order Selection
    - Fit AMVAR Model
    - Validate model
Some warnings were generated (see below), Continue?

============================================================================

MVAR PARAMETER SUMMARY FOR CONDITION: RespWrong

============================================================================

WARNING: Two model orders specified [1 30]
I assume you are providing a [min max] range for model order selection.
I will use p=(30) for the remaining checks...

WARNING: Ratio of number of parameters to datapoints is 0.174.
If using an unconstrained (unregularized) model fitting appraoch: For best results, ratio of number of parameters to datapoints should be < 0.1.
I recommend using window length of at least 0.610 sec

OK: Time-Frequency Product is 993.712. This should be greater than p=30

OK: Given your model order of p=30, a maximum of p/2=15.0 frequency components (spectral peaks) can be estimated for each pair of variables

[Progress Bar: Fitting VAR[30] model (Vieira-Morf)... (13%) 53 secs]
Figure 2: RespWrong - Model Order Selection Results (min ic)

Mean Info. Criteria across sampled windows
Optimal order determined by min of mean curve

Information criteria (bics)

sbc (4)
aic (18)
fpe (18)
hq (10)

model order

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

Figure 4

Histories:

Order: 14

Do you want to proceed to model fitting?
A Model-fitting GUI will be generated for you based on the options you selected above

No Yes
5 Model Fitting
Model Fitting

MVAR PARAMETER SUMMARY FOR CONDITION: RespWrong

OK: Ratio of number of parameters to datapoints is 0.081.

OK: Time-Frequency Product is 993.712. This should be greater than p=14

OK: Given your model order of p=14, a maximum of p/2=7.0 frequency components (spectral peaks) can be estimated for each pair of variables

Ok

Fitting VAR[14] model (Vieira-Morfo) (23%) 47 secs
Model Validation

Simulation
Pre-processing
Model fitting and validation
   - Model Order Selection
   - Fit AMVAR Model
Connectivity
Statistics
Visualization
Help

Validated Fitted VAR Model

Validation Methods
- CheckResidualWhiteness
  - SignificanceLevel: 0.05
- MultipleComparisonsCorrection: none
- NumberOfAutocorrelationLags: 50
- WhitenessCriteria: Ljung-Box; ACF; Box-
- CheckConsistency
- CheckStability
- Data Reduction
  - WindowSamplePercent: 70%
- Miscellaneous
  - VerbosityLevel: 2
  - PlotResults

WhitenessCriteria
Whiteness criteria. These are the statistical tests used to test for uncorrelated residuals

Progress
- Validating Model for RespWrong... (Progress: 100%)
- Checking stability for RespWrong... (Progress: 100%)
Model Validation

ACF statistic should be above this line

Portmanteau statistics should be above this line

Stability index should be < 0
Connectivity

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Connectivity

Simulation
✓ Pre-processing
  Model fitting and validation
  Connectivity
Statistics
Visualization
Help

Connectivity Measures

Select measures to estimate.

Measures are categorized as follows:
+ DIRECTED TRANSFER FUNCTION MEASURES
  DTF: Directed Transfer Function
  nDTF: Normalized DTF
  dDTF: Direct DTF
  dDTFO8: Direct DTF (with full causal normalization)
  fDTF: Full-frequency DTF
+ PARTIAL DIRECTED COHERRCE MEASURES
  PDC: Partial Directed Coherence
  nPCC: Normalized PDC
  GPD C: Generalized Partial Directed Coherence
  PDT: Partial Directed Coherence Factor
  RPDC: Renormalized Partial Directed Coherence
+ GRANGER-Geweke CAUSALITY MEASURES
  GCC: Granger-Geweke Causality
+ SPECTRAL COHERENCE MEASURES
  Coh: Complex Coherence
  iCoh: Imaginary Coherence
  pCoh: Partial Coherence
  mCoh: Multiple Coherence
+ SPECTRAL DENSITY MEASURES
  S: Complex Spectral Density

Connectivity estimation will require 2.7344 MB of memory (p mod)
Make sure you have enough memory available.

Estimating connectivity for RespWrong... (14%) 33 secs

OK
Visualization: Time-Frequency Grid

- MatrixLayout
- UpperTriangle
- LowerTriangle
- Diagonal
- D_ColorLimits
- AllColorLimits
- TimesToPlot
- FrequenciesToPlot
- PlotContour
- PlotOrder
- SourceMarginPlot
- NodeLabels
- EventMarkers
- FrequencyScale
- ColorMap
- Thresholding
- PercentileThreshold
- AbsoluteThreshold
- DataProcessing
- Baseline
- Smooth2D
- Miscellaneous
- DipolePlottingOptions
- FrequencyMarkers
- FrequencyMarkerColor

Baseline:
Time range of baseline [Min Max] (sec). Will subtract baseline from each point. Leave blank for no baseline.
Granger Causality on off-diagonal
ERSP on diagonal
Granger Causality on off-diagonal
ERSP on diagonal
Increase in event-related information flow from IC1 --> IC4 relative to baseline. This pixel indicates increased dDTF at 5 Hz and 0.5 seconds following the event.
Event-related Spectral Perturbation
Visualization:
Causal BrainMovie3D
Visualization: Causal BrainMovie3D

- Simulation
- Pre-processing
- Model fitting and validation
- Connectivity
- Statistics
- Visualization

Time-Frequency Grid

BrainMovie3D Control Panel

Data Processing:
- Connectivity Method: dDTF08
- Movie Time Range: [-0.826171875, 1.06055]
- Frequencies To Collapse: 1:5
- Freq Collapse Method: max
- Resampling Factor: 1
- Subtract Conditions: 0
- Baseline

Display Properties:
- Show Node Labels: Yes
- Node Labels: 1 2 3 4 5 6 7 8
- Nodes To Exclude: A1; A2; A6; A7; A8; B1; B2; B3; B4; B5; B6; B7; B8
- Edge Color Mapping: Power
- Edge Size Mapping: Connectivity
- Node Color Mapping: Outflow
- Node Size Mapping: Power

Footer Panel Display Spec:
- ICA_ERPEnvelope
- ICs: 1; 2; 3; 4; 5; 6; 7; 8
- Back Project To Chans: A1; A2; A6; A7; A8; B1; B2; B3; B4; B5; B6; B7; B8
- Plot Mode: on
- Envelope Color: yellow

Brain Movie Options:
- Image Size: [800 800]
- Visibility: on
- Show Camera Menu: Yes
- Rotation Path 3D: [122 36]
- Make Compass: Yes
- Project Graph On MRI: off
- Theme: theme
- Layers: Yes
- Scalp: Yes
- Skull: Yes

Footer Panel Display Spec:
- Configure footer panel displayed at the bottom of the figure. If 'off', don't render footer. If 'ICA_ERP_Envelope', then display the ERP envelope of backprojected.
Visualization: Causal BrainMovie3D
1. Explore changing some of the Time-Frequency Grid parameters. Try plotting the TF-Grid with logarithmic frequency spacing (option: FrequencyScale). Change the SourceMarginPlot to “topoplot” to see your ICA topographic plots.

2. Explore different parameters for the BrainMovie3D. What is different between delta (1-3 Hz) and theta (3-7 Hz) band connectivity?

3. Recompute connectivity for the RespWrong condition, selecting the Coherence (Coh) and Partial Coherence (pCoh) methods in addition to the original nPDC, nDTF, dDTF08, and S methods. Create a Time-Frequency Grid laying out Coherence (Coh) on the UpperTriangle, Partial Coherence (pCoh), on the LowerTriangle and the ERSP (S) on the diagonal. Use a baseline of [-1 -0.25]. What is different between coherence and partial coherence? Create another Time-Frequency Grid with dDTF08 on the Upper and Lower Triangles. What is different between coherence and dDTF (Granger-Causality)?

4. Redo the entire pipeline (Steps 1-9) for the RespCorrect condition (located in same /Data folder as RespWrong). Select both conditions in EEGLAB (Datasets-->Select Multiple Datasets). Create a Time-Frequency Grid. Choose to plot the difference RespWrong-RespCorrect (option: PlotConditionDifference->ConditionOrder) with the dDTF08 on the Upper and Lower Triangle and ERSP on the diagonal.

5. Advanced Users: Try executing the previous pipeline entirely from the command line. Consult <sift_root>/scripts/ScriptingExample_1_0b.m for guidance.
Visualization of condition differences

Select RespWrong and RespCorrect datasets
Visualization of condition differences
Granger Causality on off-diagonal 
ERSP on Diagonal
Increase in event-related information flow from IC8 -> IC19 in Error condition relative to Correct condition. This pixel indicates GC at 5 Hz and 0.5 sec post-event.
Event-related Spectral Perturbation