Package 'FreSpeD'

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Type Package

Title Change-point detection for multi-channel EEG data

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Author Blinded Here

Maintainer Blinded Here <Blinded@Here.Anonymous>

Description Frequency-specific change-point detection for autospectra and cross-coherences of multi-channel EEG data using a nonparametric approach. Blinded version for submission to JASA ACS.

License GPL-3

Depends foreach, doParallel

R topics documented:

`FreSpeD-package` *Frequency-Specific Change-Point Detection in Multi-Channel EEG Data*

Description

A change-point detection procedure for multivariate EEG data that is based on frequency-specific changes in the autospectrum and cross-coherence. Blinded version for submission to JASA ACS.

Details

Package:	FreSpeD
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Version:	0.1
Date:	2015-09-04
License:	GPL-3

First, basic implementation of the FreSpeD algorithm as used in our submitted paper.

Author(s)

Blinded Here

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References

Blinded Here and Blinded Here (2015). FreSpeD: Frequency-Specific Change-Point Detection in Epileptic Seizure Multi-Channel EEG Data, submitted.

Examples

```
data(testdataD20N1)
cp<-FreSpeD(testdataD20N1, channelNames = names(testdataD20N1), windowLen=200)
FreSpeD_plot(X=testdataD20N1, cp=cp, id=1, windowLen=200)
```

`FreSpeD` *Frequency-specific change-point detection*

Description

The FreSpeD algorithm detects change points in the autospectra and cross-coherences of multi-channel EEG traces.

Usage

```
FreSpeD(X, channelNames = 1:dim(X)[2], windowLen, nFB = .round_right(windowLen/20),
overlap = 0, normalize = FALSE, padEnd = TRUE, logScale = FALSE, transform = "FZ",
plot = FALSE, check_neighborhood = TRUE, threshFun = function(Tv) { 0.8 * log(Tv)^(1.1)},
deltaPer = 0.03, nCores = 1)
```

Arguments

`X`	Numeric two-dimensional data input, rows: observations in time, columns: channels.
`channelNames`	List of channel names; if not specified, channels are enumerated.
`windowLen`	Number of observations used for the estimation of localized spectral quantities.
`nFB`	Number of (equally sized) frequency bands used in the analysis. WindowLen should be an even multiple (e.g., nFB=10, `windowLen`=200).
`overlap`	Number of observations by which localized spectral estimates can overlap. Default is zero.

normalize	Normalize spectrum (dividing by total localized variance)?
padEnd	Pad time series with zeros at end (if number of observations in time is not a multiple of windowLen).
logScale	Use log scale for spectra?
transform	Transformation of coherence estimate. Fisher-z transform is default and provides consistent change-point estimates.
plot	Plot all autospectra and cross-coherences?
check_neighborhood	Within the change-point detection, should the neighbourhood around a change-point candidate be tested to reduce the risk of spurious detections?
threshFun	Threshold function; see publication for theoretical requirements.
deltaPer	Percentage (of total observations in time) of minimum change-point distance.
nCores	Number of cores used to run FreSpeD. Requires additional packages.

Value

List:

1	Matrix (nFB x T/windowLen) of first channel. Change-point locations correspond to positive entries (which are CUSUM statistics). Change points can be identified in time and frequency and change sizes can be judged by exceedance of matrix entries over threshold
2	Matrix (nFB x T/windowLen) of second channel. ...

After all individual channels, the evolutionary coherence of all possible channel-combinations are listed. See names(out) or access specific channels by out$ChannelNameor pairs by out$ChannelName1.ChannelName2

Author(s)

Blinded Here

Examples

```
data(testdataD20N1)
FreSpeD(testdataD20N1, channelNames = names(testdataD20N1), windowLen=200)
```

FreSpeD_plot *Plots the FreSpeD output for a specified channel or channel pair*

Description

Plots the time-varying spectrum for a specified channel or coherence for a channel pair and the by FreSpeD estimated change points in time and frequency

Usage

```
FreSpeD_plot(X,cp,id,channelNames=1:dim(X)[2],
                        windowLen, nFB=.round_right(windowLen/20), overlap=0,
                        normalize=FALSE, padEnd=TRUE)
```

Arguments

X	Data.
cp	List of change points per channel/channel pair.
id	Which list entry should be plotted? See names(cp)
channelNames	Channel names.
windowLen	Number of observations used for the estimation of localized spectral quantities.
nFB	Number of (equally sized) frequency bands used in the analysis. WindowLen should be an even multiple (e.g., nFB=10, windowLen=200).
overlap	Number of observations by which localized spectral estimates can overlap. Default is zero.
normalize	Normalize spectrum (dividing by total localized variance)?
padEnd	Pad time series with zeros at end (if number of observations in time is not a multiple of windowLen).

Value

No output returned

Author(s)

Blinded Here

See Also

FreSpeD

Examples

```
data(testdataD20N1)
cp<-FreSpeD(testdataD20N1, channelNames = names(testdataD20N1), windowLen=200)
names(cp)[1]
FreSpeD_plot(X=testdataD20N1, cp=cp, id=1, windowLen=200)
```

FreSpeD_postprocessing

Postprocessing FreSpeD output

Description

Optional postprocessing to account for information of channel clusters or change-point sparsity

Usage

```
FreSpeD_postprocessing(X, cp, windowLen, singleTimeSeries = TRUE, allTimeSeries = TRUE,
clusterradius = c(), deltaPer = 0.03, nFB = .round_right(windowLen/20), overlap = 0,
normalize = FALSE, logScale = FALSE, padEnd = TRUE, transform = "FZ",
threshFun = function(Tv) {0.8 * log(Tv)^(1.1)})
```

Arguments

X	Data.
cp	List of change points per channel/channel pair.
windowLen	Number of observations used for the estimation of localized spectral quantities.
singleTimeSeries	Check individual channels and channel pairs? This tests every change point of a given channel/channel pair versus its adjacent change-point neighbors. The test statistic is consistent with the initial thresholded CUSUM statistic.
allTimeSeries	Merge change points over all channels and channel pairs into global clusters. A cluster is defined as group of change points of which each is at most clusterradius distant from the nearest cluster member. The resulting merged change point is the median of all cluster members
clusterradius	Maximum distance allowed between members of the clusters defined through allTimeSeries
deltaPer	Percentage (of total observations in time) of minimum change-point distance.
nFB	Number of (equally sized) frequency bands used in the analysis. WindowLen should be an even multiple (e.g., nFB=10, windowLen=200).
overlap	Number of observations by which localized spectral estimates can overlap. Default is zero.
normalize	Normalize spectrum (dividing by total localized variance)?
logScale	Use log scale for spectra?
padEnd	Pad time series with zeros at end (if number of observations in time is not a multiple of windowLen).
transform	Transformation of coherence estimate. Fisher-z transform is default and provides consistent change-point estimates.
threshFun	Threshold function; see publication for theoretical requirements.

Value

If only individual tests are conducted, the output is a list similar to that of FreSpeD(). Otherwise, a single vector of merged change points is provided. In both cases, frequency resolution is lost, i.e. change points cannot be assigned in the frequency domain anymore.

Author(s)

Blinded Here

See Also

FreSpeD

Examples

```
data(testdataD20N1)
cp<-FreSpeD(testdataD20N1, channelNames = names(testdataD20N1), windowLen=200)
cpS<-FreSpeD_postprocessing(testdataD20N1,cp,windowLen=200,
singleTimeSeries=TRUE,allTimeSeries=FALSE)
cpA<-FreSpeD_postprocessing(testdataD20N1,cp,windowLen=200,
singleTimeSeries=FALSE,allTimeSeries=TRUE)
cpSA<-FreSpeD_postprocessing(testdataD20N1,cp,windowLen=200,
singleTimeSeries=TRUE,allTimeSeries=TRUE)
```

FreSpeD_summary *Summary of change-point detection via FreSpeD*

Description

Various tables and plots showing change point distribution in time, frequency and for individual channels and channel pairs.

Usage

```
FreSpeD_summary(cp, channelNames = c(), windowLen = 1, plot = TRUE)
```

Arguments

cp	List of change points per channel/channel pair.
channelNames	Channel names.
windowLen	Number of observations used for the estimation of localized spectral quantities.
plot	Should global summary plots be provided?

Value

List:

1	Total no change points
2	Total no change points in autospectra
3	Change points over time
4	Autospectral change points over time
5	Change points over frequency bands
6	Autospectral change points over frequency bands
7	Change points per channel/channel pair

Author(s)

Blinded Here

See Also

FreSpeD

Examples

```
data(testdataD20N1)
cp<-FreSpeD(testdataD20N1, channelNames = names(testdataD20N1), windowLen=200)
FreSpeD_summary(cp, channelNames=names(testdataD20N1))
```

name_identifiers *Naming function*

Description

Names of channels and channel-pair combinations, for easy identifiability and interpretation of FreSpeD output

Usage

```
name_identifiers(n)
```

Arguments

n	Channel names.

Value

Names of channels, followed by names of channel pairs of the form "ChannelName1.ChannelName2"

Author(s)

Blinded Here

Examples

```
name_identifiers(c("A","B","C"))
```

testdataD20N0 *Test data set with D=20 components and N=0 (no) change points*

Description

Randomly generated data set with no change in autospectra or cross-coherences. The data is structured as a TxD array with T=50000 and D=20.

Usage

```
data("testdataD20N0")
```

Format

A data frame with 50000 observations on 20 EEG channels:

`ChannelA` a numeric vector

`ChannelB` a numeric vector

`ChannelC` a numeric vector

`ChannelD` a numeric vector

`ChannelE` a numeric vector

ChannelF a numeric vector

ChannelG a numeric vector

ChannelH a numeric vector

ChannelI a numeric vector

ChannelJ a numeric vector

ChannelK a numeric vector

ChannelL a numeric vector

ChannelM a numeric vector

ChannelN a numeric vector

ChannelO a numeric vector

ChannelP a numeric vector

ChannelQ a numeric vector

ChannelR a numeric vector

ChannelS a numeric vector

ChannelT a numeric vector

Examples

```
data(testdataD20N0)
names(testdataD20N0)
cp<-FreSpeD(testdataD20N0, channelNames=names(testdataD20N0), windowLen=200)
FreSpeD_summary(cp, channelNames=names(testdataD20N0))
```

---

testdataD20N1 *Test data set with D=20 components and N=1 change point*

Description

Randomly generated data set with one change in autospectra of all components and no change in cross-coherences. The data is structured as a TxD array with T=50000 and D=20. The change point is located at T/2.

Usage

```
data("testdataD20N0")
```

Format

A data frame with 50000 observations on 20 EEG channels:

ChannelA a numeric vector

ChannelB a numeric vector

ChannelC a numeric vector

ChannelD a numeric vector

ChannelE a numeric vector

ChannelF a numeric vector

ChannelG a numeric vector

ChannelH a numeric vector

ChannelI a numeric vector

ChannelJ a numeric vector

ChannelK a numeric vector

ChannelL a numeric vector

ChannelM a numeric vector

ChannelN a numeric vector

ChannelO a numeric vector

ChannelP a numeric vector

ChannelQ a numeric vector

ChannelR a numeric vector

ChannelS a numeric vector

ChannelT a numeric vector

Examples

```
data(testdataD20N1)
names(testdataD20N1)
cp<-FreSpeD(testdataD20N1, channelNames=names(testdataD20N1), windowLen=200)
FreSpeD_summary(cp, channelNames=names(testdataD20N1))
```

Index