Package 'BTO'

May 26, 2019

Title Finding bivariate temporal orders in the data/signals/time series

Version 0.9

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Description The package contains the main function, enabling to estimate bivariate temporal orders (BTO) in the data/signals/time series (both statistical and causal approaches), depending on the settings. Furthermore, the R implementation of IGCI function, is included as it is necessary to perform calculation related to the causal approach.

Depends R (>= 3.5.0)

Encoding UTF-8

LazyData true

RoxygenNote 6.1.1

Imports ggplot2,
quantmod,
seewave,
signal,
TSdist

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`BTO` *BTO*

Description

The main function, enabling to estimate bivariate temporal orders (BTO) in the data/signals/time series (both statistical and causal approaches), depending on the settings

Usage

```
BTO(sig1, sig2, method, thr, scaling, sig_length, max_shift, fs,
  point_time_res = 1, shift_time_res = 1, td_type, estim = 1, ...)
```

Arguments

sig1	First data/signal/time series (stands still during the analysis)
sig2	Second data/signal/time series (is being moved during the analysis)
method	Selection of the method ("LM", "TD", and "IGCI" are possible, none is default)
thr	Threshold, when the estimate of "LM" and "TD" is used when determining the curve of maximum or minumum values, respectively; or for "IGCI" it sets which values are presented; negative value means no threshold; none is default.
scaling	Standarization type: 0 - no standarization; 1 - uniform standarization; 2 - Gaussian standarization; none is default.
sig_length	Length of the signal part (in seconds); none is default.
max_shift	Maximal shifts in both sides as 2-element numeric vector (in seconds); none is default.
fs	Sampling frequency (in Hz).
point_time_res	Time resolution of points, 1 by default.
shift_time_res	Time resolution of shifts (as a multiple of the sampling period), 1 by default.
td_type	Type of distance to calculate: "euclidean", "manhattan", "minkowski", "infnorm", "ccor", "sts", "edr", "erp", "lcss", "fourier", "tquest", "dissim" can be used without any additional package; dtw package required: "dtw", "keogh.lb"; TSclust package required: "acf", "pacf", "ar.lpc.ceps", "ar.mah", "ar.mah.statistic", "ar.mah.pvalue", "ar.pic", "cdm", "cid", "cor", "cort", "wav", "int.per", "per", "mindist.sax", "ncd", "pred", "spec.glk", "spec.isd", "spec.llr"; pdc package required: "pdc"; longitudinalData package required: "frechet".
estim	Estimator type (only when "IGCI" kernel is chosen): 1 - entropy (default); 2 - integral approximation.
...	Additional parameters for time series distances functions.

Value

1) Output parameters in an array form; 2) Output parameters in a data frame form; 3) Figure prepared using ggplot function; 4) The curve of maximum or minimum values (only for LM and TD kernels).

References

Function uses TSdist package (authors: Usue Mori, Alexander Mendiburu, Jose A. Lozano); and R implementation of the IGCI function P. Daniušis, D. Janzing, J. Mooij, J. Zscheischler, B. Steudel, K. Zhang, B. Schölkopf: Inferring deterministic causal relations.

Examples

```
require(ggplot2)
fs <- 25
fsig <- 16/60
t <- seq(from=1/fs, to=6000/fs, length.out=6000)
data <- data.frame(TV = 2*sin(2*pi*fsig*t)+rnorm(6000,sd=0.1),
                   RR = 1.2*sin(2*pi*fsig*t + pi)+rnorm(6000,sd=0.1))
btos <- BTO(data$RR,data$TV,"LM",0.95,2,10,c(-2,2),fs,fs,1)
btos$Fig
```

IGCI *IGCI*

Description

IGCI algorithm function (transformed from Matlab code). Performs causal inference in a deterministic scenario.

Usage

```
IGCI(x, y, estimator)
```

Arguments

x	First data/signal/time series (at least 20 observations)
y	Second data/signal/time series (at least 20 observations; equal to number of x ones)
estimator	1: entropy estimator (eq. (12) in the Reference), 2: integral approximation estimator (eq. (13) in the Reference).

Value

f < 0: the method prefers the causal direction x -> y; f > 0: the method prefers the causal direction y -> x

References

Function is a R implementation of the IGCI method prepared originally for Matlab and described in: P. Daniušis, D. Janzing, J. Mooij, J. Zscheischler, B. Steudel, K. Zhang, B. Schölkopf: Inferring deterministic causal relations.

Examples

```
fs <- 25
fsig <- 16/60
t <- seq(from=1/fs, to=6000/fs, length.out=6000)
data <- data.frame(TV = 2*sin(2*pi*fsig*t)+rnorm(6000,sd=0.1),
                   RR = 1.2*sin(2*pi*fsig*t + pi)+rnorm(6000,sd=0.1))
IGCI(data$RR,data$TV,1)
```

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