Package 'RTransferEntropy'

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Type Package

Title Measuring Information Flow Between Time Series with Shannon and Renyi Transfer Entropy

Version 0.2.8

Description Measuring information flow between time series with Shannon and Rényi transfer entropy. See also Dimpfl and Peter (2013) <doi:10.1515/snde-2012-0044> and Dimpfl and Peter (2014) <doi:10.1016/j.intfin.2014.03.004> for theory and applications to financial time series. Additional references can be found in the theory part of the vignette.

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URL https://github.com/BZPaper/RTransferEntropy

BugReports https://github.com/BZPaper/RTransferEntropy/issues

Encoding UTF-8

Depends R (>= 3.1.2)

Imports future, future.apply, Rcpp

LazyData true

RoxygenNote 6.1.1

LinkingTo Rcpp

Suggests data.table, ggplot2, gridExtra, knitr, quantmod, rmarkdown, testthat, vars, xts, zoo

VignetteBuilder knitr

NeedsCompilation yes

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R topics documented:

`calc_ete` *Calculates the Effective Transfer Entropy for two time series*

Description

Calculates the Effective Transfer Entropy for two time series

Usage

```
calc_ete(x, y, lx = 1, ly = 1, q = 0.1, entropy = "Shannon",
  shuffles = 100, type = "quantiles", quantiles = c(5, 95),
  bins = NULL, limits = NULL, burn = 50, seed = NULL)
```

Arguments

`x`	a vector of numeric values, ordered by time. Also allowed are `xts`, `zoo`, or `ts` objects.
`y`	a vector of numeric values, ordered by time. Also allowed are `xts`, `zoo`, or `ts` objects.
`lx`	Markov order of x, i.e. the number of lagged values affecting the current value of x. Default is `lx = 1`.
`ly`	Markov order of y, i.e. the number of lagged values affecting the current value of y. Default is `ly = 1`.
`q`	a weighting parameter used to estimate Renyi transfer entropy, parameter is between 0 and 1. For `q = 1`, Renyi transfer entropy converges to Shannon transfer entropy. Default is `q = 0.1`.
`entropy`	specifies the transfer entropy measure that is estimated, either 'Shannon' or 'Renyi'. The first character can be used to specify the type of transfer entropy as well. Default is `entropy = 'Shannon'`.
`shuffles`	the number of shuffles used to calculate the effective transfer entropy. Default is `shuffles = 100`.

type	specifies the type of discretization applied to the observed time series:'quantiles', 'bins' or 'limits'. Default is `type = 'quantiles'`.
quantiles	specifies the quantiles of the empirical distribution of the respective time series used for discretization. Default is `quantiles = c(5,95)`.
bins	specifies the number of bins with equal width used for discretization. Default is `bins = NULL`.
limits	specifies the limits on values used for discretization. Default is `limits = NULL`.
burn	the number of observations that are dropped from the beginning of the bootstrapped Markov chain. Default is `burn = 50`.
seed	a seed that seeds the PRNG (will internally just call set.seed), default is `seed = NULL`.

Value

a single numerical value for the effective transfer entropy

See Also

calc_te and transfer_entropy

Examples

```
# construct two time-series
set.seed(1234567890)
n <- 1000
x <- rep(0, n + 1)
y <- rep(0, n + 1)

for (i in seq(n)) {
  x[i + 1] <- 0.2 * x[i] + rnorm(1, 0, 2)
  y[i + 1] <- x[i] + rnorm(1, 0, 2)
}

x <- x[-1]
y <- y[-1]

# calculate the X->Y transfer entropy value
calc_ete(x, y)

# calculate the Y->X transfer entropy value
calc_ete(y, x)


  # Compare the results
  # even with the same seed, transfer_entropy might return slightly different
  # results from calc_ete
  calc_ete(x, y, seed = 123)
  calc_ete(y, x, seed = 123)
  transfer_entropy(x, y, nboot = 0, seed = 123)
```

calc_te *Calculates the Transfer Entropy for two time series*

Description

Calculates the Transfer Entropy for two time series

Usage

```
calc_te(x, y, lx = 1, ly = 1, q = 0.1, entropy = "Shannon",
  shuffles = 100, type = "quantiles", quantiles = c(5, 95),
  bins = NULL, limits = NULL, burn = 50, seed = NULL)
```

Arguments

x	a vector of numeric values, ordered by time. Also allowed are xts, zoo, or ts objects.
y	a vector of numeric values, ordered by time. Also allowed are xts, zoo, or ts objects.
lx	Markov order of x, i.e. the number of lagged values affecting the current value of x. Default is lx = 1.
ly	Markov order of y, i.e. the number of lagged values affecting the current value of y. Default is ly = 1.
q	a weighting parameter used to estimate Renyi transfer entropy, parameter is between 0 and 1. For q = 1, Renyi transfer entropy converges to Shannon transfer entropy. Default is q = 0.1.
entropy	specifies the transfer entropy measure that is estimated, either 'Shannon' or 'Renyi'. The first character can be used to specify the type of transfer entropy as well. Default is entropy = 'Shannon'.
shuffles	the number of shuffles used to calculate the effective transfer entropy. Default is shuffles = 100.
type	specifies the type of discretization applied to the observed time series:'quantiles', 'bins' or 'limits'. Default is type = 'quantiles'.
quantiles	specifies the quantiles of the empirical distribution of the respective time series used for discretization. Default is quantiles = c(5,95).
bins	specifies the number of bins with equal width used for discretization. Default is bins = NULL.
limits	specifies the limits on values used for discretization. Default is limits = NULL.
burn	the number of observations that are dropped from the beginning of the bootstrapped Markov chain. Default is burn = 50.
seed	a seed that seeds the PRNG (will internally just call set.seed), default is seed = NULL.

Value

a single numerical value for the transfer entropy

See Also

calc_ete andtransfer_entropy

Examples

```
# construct two time-series
set.seed(1234567890)
n <- 1000
x <- rep(0, n + 1)
y <- rep(0, n + 1)

for (i in seq(n)) {
  x[i + 1] <- 0.2 * x[i] + rnorm(1, 0, 2)
  y[i + 1] <- x[i] + rnorm(1, 0, 2)
}

x <- x[-1]
y <- y[-1]

# calculate the X->Y transfer entropy value
calc_te(x, y)

# calculate the Y->X transfer entropy value
calc_te(y, x)


  # Compare the results
  calc_te(x, y, seed = 123)
  calc_te(y, x, seed = 123)
  transfer_entropy(x, y, nboot = 0, seed = 123)
```

---

coef.transfer_entropy *Extract the Coefficient Matrix from a transfer_entropy*

Description

Extract the Coefficient Matrix from a transfer_entropy

Usage

```
## S3 method for class 'transfer_entropy'
coef(object, ...)
```

Arguments

object	a transfer_entropy
...	additional arguments, currently not in use

Value

a Matrix containing the coefficients

Examples

```
set.seed(1234567890)
n <- 500
x <- rep(0, n + 1)
y <- rep(0, n + 1)

for (i in seq(n)) {
  x[i + 1] <- 0.2 * x[i] + rnorm(1, 0, 2)
  y[i + 1] <- x[i] + rnorm(1, 0, 2)
}

x <- x[-1]
y <- y[-1]

te_result <- transfer_entropy(x, y, nboot = 100)
coef(te_result)
```

---

is.transfer_entropy *Checks if an object is a transfer_entropy*

Description

Checks if an object is a transfer_entropy

Usage

```
is.transfer_entropy(x)
```

Arguments

x	an object

Value

a boolean value if x is a transfer_entropy

Examples

```
# see ?transfer_entropy
```

print.transfer_entropy *Prints a transfer-entropy result*

Description

Prints a transfer-entropy result

Usage

```
## S3 method for class 'transfer_entropy'
print(x, digits = 4, boot = TRUE,
  probs = c(0, 0.25, 0.5, 0.75, 1), ...)
```

Arguments

x	a transfer_entropy
digits	the number of digits to display, defaults to 4
boot	if the bootstrapped results should be printed, defaults to TRUE
probs	numeric vector of quantiles for the bootstraps
...	additional arguments, currently not in use

Value

invisible the text

Examples

```
# construct two time-series
set.seed(1234567890)
n <- 500
x <- rep(0, n + 1)
y <- rep(0, n + 1)

for (i in seq(n)) {
  x[i + 1] <- 0.2 * x[i] + rnorm(1, 0, 2)
  y[i + 1] <- x[i] + rnorm(1, 0, 2)
}

x <- x[-1]
y <- y[-1]

# Calculate Shannon's Transfer Entropy
te_result <- transfer_entropy(x, y, nboot = 100)

print(te_result)

# change the number of digits
```

```
print(te_result, digits = 10)

# disable boot-print
print(te_result, boot = FALSE)

# specify the quantiles of the bootstraps
print(te_result, probs = c(0, 0.1, 0.4, 0.5, 0.6, 0.9, 1))
```

`set_quiet` *Set the quiet-parameter for all RTransferEntropy Calls*

Description

Set the quiet-parameter for all RTransferEntropy Calls

Usage

```
set_quiet(quiet)
```

Arguments

`quiet`	if FALSE, the functions will give feedback on the progress

Value

nothing

Examples

```
# see ?transfer_entropy
```

`stocks` *Daily stock data for 10 stocks from 2000-2017*

Description

A dataset containing the daily stock returns for 10 stocks and the S&P 500 market returns for the time-period 2000-01-04 until 2017-12-29

Usage

```
stocks
```

Format

A data frame (or data.table if loaded) with 46940 rows and 4 variables:

date date of the observation

ticker ticker of the stock

ret Return of the stock

sp500 Return of the S&P 500 stock market index

Source

yahoo finance using `getSymbols`

---

summary.transfer_entropy

Prints a summary of a transfer-entropy result

Description

Prints a summary of a transfer-entropy result

Usage

```
## S3 method for class 'transfer_entropy'
summary(object, digits = 4, probs = c(0,
  0.25, 0.5, 0.75, 1), ...)
```

Arguments

`object`	a transfer_entropy
`digits`	the number of digits to display, defaults to 4
`probs`	numeric vector of quantiles for the bootstraps
`...`	additional arguments, passed to `printCoefmat`

Value

invisible the object

Examples

```
# construct two time-series
set.seed(1234567890)
n <- 500
x <- rep(0, n + 1)
y <- rep(0, n + 1)

for (i in seq(n)) {
```

```
  x[i + 1] <- 0.2 * x[i] + rnorm(1, 0, 2)
  y[i + 1] <- x[i] + rnorm(1, 0, 2)
}

x <- x[-1]
y <- y[-1]

# Calculate Shannon's Transfer Entropy
te_result <- transfer_entropy(x, y, nboot = 100)

summary(te_result)
```

`transfer_entropy` *Function to estimate Shannon and Renyi transfer entropy between two time series x and y.*

Description

Function to estimate Shannon and Renyi transfer entropy between two time series x and y.

Usage

```
transfer_entropy(x, y, lx = 1, ly = 1, q = 0.1,
  entropy = "Shannon", shuffles = 100, type = "quantiles",
  quantiles = c(5, 95), bins = NULL, limits = NULL, nboot = 300,
  burn = 50, quiet = NULL, seed = NULL)
```

Arguments

`x`	a vector of numeric values, ordered by time. Also allowed are `xts`, `zoo`, or `ts` objects.
`y`	a vector of numeric values, ordered by time. Also allowed are `xts`, `zoo`, or `ts` objects.
`lx`	Markov order of x, i.e. the number of lagged values affecting the current value of x. Default is `lx = 1`.
`ly`	Markov order of y, i.e. the number of lagged values affecting the current value of y. Default is `ly = 1`.
`q`	a weighting parameter used to estimate Renyi transfer entropy, parameter is between 0 and 1. For `q = 1`, Renyi transfer entropy converges to Shannon transfer entropy. Default is `q = 0.1`.
`entropy`	specifies the transfer entropy measure that is estimated, either 'Shannon' or 'Renyi'. The first character can be used to specify the type of transfer entropy as well. Default is `entropy = 'Shannon'`.
`shuffles`	the number of shuffles used to calculate the effective transfer entropy. Default is `shuffles = 100`.

type	specifies the type of discretization applied to the observed time series:'quantiles', 'bins' or 'limits'. Default is `type = 'quantiles'`.
quantiles	specifies the quantiles of the empirical distribution of the respective time series used for discretization. Default is `quantiles = c(5,95)`.
bins	specifies the number of bins with equal width used for discretization. Default is `bins = NULL`.
limits	specifies the limits on values used for discretization. Default is `limits = NULL`.
nboot	the number of bootstrap replications for each direction of the estimated transfer entropy. Default is `nboot = 300`.
burn	the number of observations that are dropped from the beginning of the bootstrapped Markov chain. Default is `burn = 50`.
quiet	if FALSE (default), the function gives feedback.
seed	a seed that seeds the PRNG (will internally just call set.seed), default is `seed = NULL`.

Value

an object of class transfer_entropy, containing the transfer entropy estimates in both directions, the effective transfer entropy estimates in both directions, standard errors and p-values based on bootstrap replications of the Markov chains under the null hypothesis of statistical independence, an indication of statistical significance, and quantiles of the bootstrap samples (if `nboot > 0`).

See Also

coef, print.transfer_entropy

Examples

```
# construct two time-series
set.seed(1234567890)
n <- 500
x <- rep(0, n + 1)
y <- rep(0, n + 1)

for (i in seq(n)) {
  x[i + 1] <- 0.2 * x[i] + rnorm(1, 0, 2)
  y[i + 1] <- x[i] + rnorm(1, 0, 2)
}

x <- x[-1]
y <- y[-1]

# Calculate Shannon's Transfer Entropy
te_result <- transfer_entropy(x, y, nboot = 100)
te_result

summary(te_result)


  # Parallel Processing using the future-package
```

```
library(future)
plan(multiprocess)

te_result2 <- transfer_entropy(x, y, nboot = 100)
te_result2

# revert back to sequential execution
plan(sequential)

te_result2 <- transfer_entropy(x, y, nboot = 100)
te_result2

# General set of quiet
set_quiet(TRUE)
a <- transfer_entropy(x, y, nboot = 0)

set_quiet(FALSE)
a <- transfer_entropy(x, y, nboot = 0)
```

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