Package 'earlywarnings'

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Type Package

Title Early Warning Signals Toolbox for Detecting Critical Transitions in Timeseries

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Author Vasilis Dakos <vasilis.dakos@gmail.com>, with contributions from S.R. Carpenter, T. Cline, L. Lahti

Maintainer Vasilis Dakos <vasilis.dakos@gmail.com>

Description The Early-Warning-Signals Toolbox provides methods for estimating statistical changes in timeseries that can be used for identifying nearby critical transitions. Based on Dakos et al (2012) Methods for Detecting Early Warnings of Critical Transitions in Time Series Illustrated Using Simulated Ecological Data. PLoS ONE 7(7):e41010

Depends R (>= 2.14.0), lmtest, nortest, stats, som, Kendall,KernSmooth, moments, fields, spam, tseries, quadprog, akima,ggplot2

LazyLoad yes

URL
http://www.early-warning-signals.org, http://www.vasilisdakos.net

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Collate 'data.R' 'BDSboot.R' 'bdstest_ews.R' 'ch_ews.R' 'ddjnonparam_ews.R' 'earlywarnings-internal.R' 'generic_ews.R' 'sensitivity_ews.R' 'surrogates_ews.R' 'potential_ews.R'

R topics documented:

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bdstest_ews   *Description: BDS test Early Warning Signals*

Description

`bdstest_ews` is used to estimate the BDS statistic to detect nonlinearity in the residuals of a timeseries after first-difference detrending, fitting an ARMA(p,q) model, and fitting a GARCH(0,1) model. The function is making use of `bds.test` from the tseries package.

Usage

```
bdstest_ews(timeseries, ARMAoptim = TRUE,
   ARMAorder = c(1, 0), GARCHorder = c(0, 1), embdim = 3,
   epsilon = c(0.5, 0.75, 1), boots = 1000,
   logtransform = FALSE, interpolate = FALSE)
```

Arguments

timeseries	a numeric vector of the observed univariate timeseries values or a numeric matrix where the first column represents the time index and the second the observed timeseries values. Use vectors/matrices with headings.
ARMAoptim	is the order of the `ARMA(p,q)` model to be fitted on the original timeseries. If TRUE the best ARMA model based on AIC is applied. If FALSE the `ARMAorder` is used.
ARMAorder	is the order of the `AR(p)` and `MA(q)` process to be fitted on the original timeseries. Default is `p=1 q=0`.
GARCHorder	fits a GARCH model on the original timeseries where `GARCHorder[1]` is the GARCH part and `GARCHorder[2]` is the ARCH part.
embdim	is the embedding dimension (2, 3,... `embdim`) up to which the BDS test will be estimated (must be numeric). Default value is 3.
epsilon	is a numeric vector that is used to scale the standard deviation of the timeseries. The BDS test is computed for each element of epsilon. Default is 0.5, 0.75 and 1.
boots	is the number of bootstraps performed to estimate significance p values for the BDS test. Default is 1000.
logtransform	logical. If TRUE data are logtransformed prior to analysis as log(X+1). Default is FALSE.
interpolate	logical. If TRUE linear interpolation is applied to produce a timeseries of equal length as the original. Default is FALSE (assumes there are no gaps in the timeseries).

Details

See also `bds.test{tseries}` for more details. The function requires the installation of packages `tseries` and `quadprog` that are not available under Linux and need to be manually installed under Windows.

Value

`bdstest_ews` returns output on the R console that summarizes the BDS test statistic for all embedding dimensions and `epsilon` values used, and for first-differenced data, ARMA(p.q) residuals, and GARCH(0,1) residuals). Also the significance p values are returned estimated both by comparing to a standard normal distribution and by bootstrapping.

In addition, `bdstest_ews` returns a plot with the original timeseries, the residuals after first-differencing, and fitting the ARMA(p,q) and GARCH(0,1) models. Also the autocorrelation `acf` and partial autocorrelation `pacf` functions are estimated serving as guides for the choice of lags of the linear models fitted to the data.

Author(s)

S. R. Carpenter, modified by V. Dakos

References

J. B. Cromwell, W. C. Labys and M. Terraza (1994): Univariate Tests for Time Series Models, Sage, Thousand Oaks, CA, pages 32-36.

Dakos, V., et al (2012)."Methods for Detecting Early Warnings of Critical Transitions in Time Series Illustrated Using Simulated Ecological Data." *PLoS ONE* 7(7): e41010. doi:10.1371/journal.pone.0041010

See Also

`generic_ews`; `ddjnonparam_ews`; `bdstest_ews`; `sensitivity_ews`; `surrogates_ews`; `ch_ews`; `movpotential_ews`; `livpotential_ews`

Examples

```
#
data(foldbif)
bdstest_ews(foldbif,ARMAoptim=FALSE,ARMAorder=c(1,0),embdim=3,epsilon=0.5, boots=200,logt
```

---

ch_ews   *Description: Conditional Heteroskedasticity*

Description

`ch_ews` is used to estimate changes in conditional heteroskedasticity within rolling windows along a timeseries

Usage

```
ch_ews(timeseries, winsize = 10, alpha = 0.1,
  optim = TRUE, lags = 4, logtransform = FALSE,
  interpolate = FALSE)
```

Arguments

timeseries	a numeric vector of the observed timeseries values or a numeric matrix where the first column represents the time index and the second the observed timeseries values. Use vectors/matrices with headings.
winsize	is length of the rolling window expressed as percentage of the timeseries length (must be numeric between 0 and 100). Default is 10%.
alpha	is the significance threshold (must be numeric). Default is 0.1.
optim	logical. If TRUE an autoregressive model is fit to the data within the rolling window using AIC optimization. Otherwise an autoregressive model of specific order lags is selected.
lags	is a parameter that determines the specific order of an autoregressive model to fit the data. Default is 4.
logtransform	logical. If TRUE data are logtransformed prior to analysis as log(X+1). Default is FALSE.
interpolate	logical. If TRUE linear interpolation is applied to produce a timeseries of equal length as the original. Default is FALSE (assumes there are no gaps in the timeseries).

Details

see ref below

Value

ch_ews returns a matrix that contains:

time	the time index.
r.squared	the R2 values of the regressed residuals.
critical.value	
	the chi-square critical value based on the desired alpha level for 1 degree of freedom divided by the number of residuals used in the regression.
test.result	logical. It indicates whether conditional heteroskedasticity was significant.
ar.fit.order	the order of the specified autoregressive model- only informative if optim FALSE was selected.

In addition, ch_ews plots the original timeseries and the R2 where the level of significance is also indicated.

Author(s)

T. Cline, modified by V. Dakos

References

Seekell, D. A., et al (2011). "Conditional heteroscedasticity as a leading indicator of ecological regime shifts." *American Naturalist* 178(4): 442-451

Dakos, V., et al (2012)."Methods for Detecting Early Warnings of Critical Transitions in Time Series Illustrated Using Simulated Ecological Data." *PLoS ONE* 7(7): e41010. doi:10.1371/journal.pone.0041010

See Also

`generic_ews`; `ddjnonparam_ews`; `bdstest_ews`; `sensitivity_ews`; `surrogates_ews`; `ch_ews`; `movpotential_ews`; `livpotential_ews`

Examples

```
data(foldbif)
out=ch_ews(foldbif, winsize=50, alpha=0.05, optim=TRUE, lags)
```

`circulation`	*circulation data set*

Description

circulation data set

Format

TBA

Source

TBA

References

See citation("earlywarnings")

Examples

```
#
```

`ddjnonparam_ews`	*Description: Drift Diffusion Jump Nonparametrics Early Warning Signals*

Description

`ddjnonparam_ews` is used to compute nonparametrically conditional variance, drift, diffusion and jump intensity in a timeseries. It also interpolates to obtain the evolution of the nonparametric statistics in time.

Usage

```
ddjnonparam_ews(timeseries, bandwidth = 0.6, na = 500,
   logtransform = TRUE, interpolate = FALSE)
```

Arguments

`timeseries`	a numeric vector of the observed univariate timeseries values or a numeric matrix where the first column represents the time index and the second the observed timeseries values. Use vectors/matrices with headings.
`bandwidth`	is the bandwidht of the kernel regressor (must be numeric). Default is 0.6.
`na`	is the number of points for computing the kernel (must be numeric). Default is 500.
`logtransform`	logical. If TRUE data are logtransformed prior to analysis as log(X+1). Default is FALSE.
`interpolate`	logical. If TRUE linear interpolation is applied to produce a timeseries of equal length as the original. Default is FALSE (assumes there are no gaps in the timeseries).

Details

The approach is based on estimating terms of a drift-diffusion-jump model as a surrogate for the unknown true data generating process: [1] $dx = f(x, \theta)dt + g(x, \theta)dW + dJ$ Here x is the state variable, f() and g() are nonlinear functions, dW is a Wiener process and dJ is a jump process. Jumps are large, one-step, positive or negative shocks that are uncorrelated in time.

Value

`ddjnonparam_ews` returns an object with elements:

`avec`	is the mesh for which values of the nonparametric statistics are estimated.
`S2.vec`	is the conditional variance of the timeseries `x` over `avec`.
`TotVar.dx.vec`	
	is the total variance of `dx` over `avec`.
`Diff2.vec`	is the diffusion estimated as `total variance - jumping intensity` vs `avec`.
`LamdaZ.vec`	is the jump intensity over `avec`.
`Tvec1`	is the timeindex.
`S2.t`	is the conditional variance of the timeseries `x` data over `Tvec1`.
`TotVar.t`	is the total variance of `dx` over `Tvec1`.
`Diff2.t`	is the diffusion over `Tvec1`.
`Lamda.t`	is the jump intensity over `Tvec1`.

In addition, `ddjnonparam_ews` returns a first plot with the original timeseries and the residuals after first-differencing. A second plot shows the nonparametric conditional variance, total variance, diffusion and jump intensity over the data, and a third plot the same nonparametric statistics over time.

Author(s)

S. R. Carpenter, modified by V. Dakos

References

Carpenter, S. R. and W. A. Brock (2011). "Early warnings of unknown nonlinear shifts: a nonparametric approach." *Ecology* 92(12): 2196-2201

Dakos, V., et al (2012)."Methods for Detecting Early Warnings of Critical Transitions in Time Series Illustrated Using Simulated Ecological Data." *PLoS ONE* 7(7): e41010. doi:10.1371/journal.pone.0041010

See Also

```
generic_ews; ddjnonparam_ews; bdstest_ews; sensitivity_ews; surrogates_ews;
ch_ews; movpotential_ews; livpotential_ews
```

Examples

```
data(foldbif)
output<-ddjnonparam_ews(foldbif,bandwidth=0.6,na=500,
logtransform=TRUE,interpolate=FALSE)
```

---

foldbif   *foldbif data set*

Description

foldbif data set

Format

TBA

Source

TBA

References

See citation("earlywarnings")

Examples

```
#
```

---

generic_ews   *Description: Generic Early Warning Signals*

Description

`generic_ews` is used to estimate statistical moments within rolling windows along a timeserie

Usage

```
generic_ews(timeseries, winsize = 50,
    detrending = c("no", "gaussian", "linear", "first-diff"),
    bandwidth = NULL, logtransform = FALSE,
    interpolate = FALSE, AR_n = FALSE,
    powerspectrum = FALSE)
```

Arguments

timeseries   a numeric vector of the observed univariate timeseries values or a numeric matrix where the first column represents the time index and the second the observed timeseries values. Use vectors/matrices with headings. If the powerspectrum is to be plotted as well, the timeseries lenght should be even number.

winsize   is the size of the rolling window expressed as percentage of the timeseries length (must be numeric between 0 and 100). Default is 50%.

bandwidth   is the bandwidth used for the Gaussian kernel when gaussian filtering is applied. It is expressed as percentage of the timeseries length (must be numeric between 0 and 100). Alternatively it can be given by the bandwidth selector `bw.nrd0` (Default).

detrending   the timeseries can be detrended/filtered prior to analysis. There are four options: `gaussian` filtering, `linear` detrending and `first-differencing`. Default is `no` detrending.

logtransform   logical. If TRUE data are logtransformed prior to analysis as log(X+1). Default is FALSE.

interpolate   logical. If TRUE linear interpolation is applied to produce a timeseries of equal length as the original. Default is FALSE (assumes there are no gaps in the timeseries).

AR_n   logical. If TRUE the best fitted AR(n) model is fitted to the data. Default is FALSE.

powerspectrum

                logical. If TRUE the power spectrum within each rolling window is plotted. Default is FALSE.

Details

see ref below

Value

`generic_ews` returns a matrix that contains:

`tim`	the time index.
`ar1`	the `autoregressive coefficient ar(1)` of a first order AR model fitted on the data within the rolling window.
`sd`	the `standard deviation` of the data estimated within each rolling window.
`sk`	the `skewness` of the data estimated within each rolling window.
`kurt`	the `kurtosis` of the data estimated within each rolling window.
`cv`	the `coefficient of variation` of the data estimated within each rolling window.
`returnrate`	the return rate of the data estimated as `1-ar(1)` cofficient within each rolling window.
`densratio`	the `density ratio` of the power spectrum of the data estimated as the ratio of low frequencies over high frequencies within each rolling window.
`acf1`	the `autocorrelation at first lag` of the data estimated within each rolling window.

In addition, `generic_ews` returns three plots. The first plot contains the original data, the detrending/filtering applied and the residuals (if selected), and all the moment statistics. For each statistic trends are estimated by the nonparametric Kendall tau correlation. The second plot, if asked, quantifies resilience indicators fitting AR(n) selected by the Akaike Information Criterion. The third plot, if asked, is the power spectrum estimated by `spec.ar` for all frequencies within each rolling window.

Author(s)

Vasilis Dakos `<vasilis.dakos@gmail.com>`

References

Ives, A. R. (1995). "Measuring resilience in stochastic systems." *Ecological Monographs* 65: 217-233

Dakos, V., et al (2008). "Slowing down as an early warning signal for abrupt climate change." *Proceedings of the National Academy of Sciences* 105(38): 14308-14312

Dakos, V., et al (2012)."Methods for Detecting Early Warnings of Critical Transitions in Time Series Illustrated Using Simulated Ecological Data." *PLoS ONE* 7(7): e41010. doi:10.1371/journal.pone.0041010

See Also

`generic_ews`; `ddjnonparam_ews`; `bdstest_ews`; `sensitivity_ews`; `surrogates_ews`; `ch_ews`; `movpotential_ews`; `livpotential_ews`;

Examples

```
data(foldbif)
out=generic_ews(foldbif,winsize=50,detrending="gaussian",
bandwidth=5,logtransform=FALSE,interpolate=FALSE)
```

---

livpotential_ews   *Description: Potential Analysis*

Description

`livpotential_ews` performs one-dimensional potential estimation derived from a uni-variate timeseries

Usage

```
livpotential_ews(x, std = 1, bw = -1, xi = NULL,
   weights = c(), grid.size = 200)
```

Arguments

x	data vector
std	the standard deviation of the noise (defaults to 1, so then you use scaled potentials
bw	bandwidth for kernel estimation
xi	x values at which the potential is estimated
weights	optional weights in ksdensity (used by movpotentials).
grid.size	grid size

Details

see ref below

Value

`livpotential` returns a list with the following elements:

xi	the grid of points on which the potential is estimated
pot	the actual value of the potential
minima	the grid points at which the potential has minimum values
maxima	the grid points at which the potential has maximum values
bw	bandwidth of kernel used

Author(s)

Based on Matlab code from Egbert van Nes modified by Leo Lahti. Implemented in early warnings package by V. Dakos.

References

Livina, VN, F Kwasniok, and TM Lenton, 2010. Potential analysis reveals changing number of climate states during the last 60 kyr . *Climate of the Past*, 6, 77-82.

Dakos, V., et al (2012)."Methods for Detecting Early Warnings of Critical Transitions in Time Series Illustrated Using Simulated Ecological Data." *PLoS ONE* 7(7): e41010. doi:10.1371/journal.pone.0041010

See Also

```
generic_ews;ddjnonparam_ews;bdstest_ews;sensitivity_ews;surrogates_ews;
ch_ews;movpotential_ews
```

Examples

```
data(foldbif)
res <- livpotential_ews(foldbif)
plot(res$xi, res$pot)
```

---

  movpotential_ews   *Description: Moving Average Potential*

Description

`movpotential_ews` reconstructs a potential derived from data along a gradient of a given parameter the `movpotential_ews` calculates the potential for values that correspond to a particular parameter. see ref below

Usage

```
movpotential_ews(X, param, sdwindow = NULL, bw = -1,
  minparam = NULL, maxparam = NULL, npoints = 50,
  thres = 0.002, std = 1, grid.size = 200, cutoff = 0.5)
```

Arguments

X	a vector of the X observations of the state variable of interest
param	parameter values that correspond to the X observations
sdwindow	window for smoothing kernels (over the `param` axis)
bw	bandwidth used for smoothing kernels
minparam	minimum value of parameter on which to estimate potential
maxparam	maximum value of parameter on which to estimate potential
npoints	number of potentials
thres	threshold for local minima to be discarded
std	std
grid.size	number of evaluation points
cutoff	the cuttof value to estimate minima and maxima in the potential
	Returns:

Value

A list with the following elements:

pars	values of the covariate parameter as matrix
xis	values of the x as matrix
pots	smoothed potentials
mins	minima in the densities (-potentials; neglecting local optima)
maxs	maxima in densities (-potentials; neglecting local optima)
plot	an object that displays the potential estimated in 2D

Author(s)

Based on Matlab code from Egbert van Nes modified by Leo Lahti. Implemented in early warnings package by V. Dakos.

References

Hirota, M., Holmgren, M., van Nes, E.H. & Scheffer, M. (2011). Global resilience of tropical forest and savanna to critical transitions. *Science*, 334, 232-235.

See Also

```
generic_ews; ddjnonparam_ews; bdstest_ews; sensitivity_ews; surrogates_ews;
ch_ews; livpotential_ews
```

Examples

```
X = c(rnorm(1000, mean = 0), rnorm(1000, mean = -2), rnorm(1000, mean = 2))
 param = seq(0,5,length=3000)
 res <- movpotential_ews(X, param, npoints = 100, thres = 0.003)
```

---

   sensitivity_ews   *Description: Sensitivity Early Warning Signals*

Description

`sensitivity_ews` is used to estimate trends in statistical moments for different sizes of rolling windows along a timeseries. The trends are estimated by the nonparametric Kendall tau correlation coefficient.

Usage

```
sensitivity_ews(timeseries,
  indicator = c("ar1", "sd", "acf1", "sk", "kurt", "cv", "returnrate", "densra
  winsizerange = c(25, 75), incrwinsize = 25,
  detrending = c("no", "gaussian", "linear", "first-diff"),
  bandwidthrange = c(5, 100), incrbandwidth = 20,
  logtransform = FALSE, interpolate = FALSE)
```

Arguments

timeseries	a numeric vector of the observed univariate timeseries values or a numeric matrix where the first column represents the time index and the second the observed timeseries values. Use vectors/matrices with headings.
indicator	is the statistic (leading indicator) selected for which the sensitivity analysis is perfomed. Currently, the indicators supported are: `ar1` autoregressive coefficient of a first order AR model, `sd` standard deviation, `acf1` autocorrelation at first lag, `sk` skewness, `kurt` kurtosis, `cv` coeffcient of variation, `returnrate`, and `densratio` density ratio of the power spectrum at low frequencies over high frequencies.
winsizerange	is the range of the rolling window sizes expressed as percentage of the timeseries length (must be numeric between 0 and 100). Default is 25% - 75%.

incrwinsize   increments the rolling window size (must be numeric between 0 and 100). Default is 25.

detrending   the timeseries can be detrended/filtered. There are three options: `gaussian` filtering, `linear` detrending and `first-differencing`. Default is `no` detrending.

bandwidthrange

is the range of the bandwidth used for the Gaussian kernel when gaussian filtering is selected. It is expressed as percentage of the timeseries length (must be numeric between 0 and 100). Default is 5% - 100%.

incrbandwidth

is the size to increment the bandwidth used for the Gaussian kernel when gaussian filtering is applied. It is expressed as percentage of the timeseries length (must be numeric between 0 and 100). Default is 20.

logtransform   logical. If TRUE data are logtransformed prior to analysis as log(X+1). Default is FALSE.

interpolate   logical. If TRUE linear interpolation is applied to produce a timeseries of equal length as the original. Default is FALSE (assumes there are no gaps in the timeseries).

Details

see ref below

Value

`sensitivity_ews` returns a matrix that contains the Kendall tau rank correlation estimates for the rolling window sizes (rows) and bandwidths (columns), if `gaussian filtering` is selected.

In addition, `sensitivity_ews` returns a plot with the Kendall tau estimates and their p-values for the range of rolling window sizes used, together with a histogram of the distributions of the statistic and its significance. When `gaussian filtering` is chosen, a contour plot is produced for the Kendall tau estimates and their p-values for the range of both rolling window sizes and bandwidth used. A reverse triangle indicates the combination of the two parameters for which the Kendall tau was the highest

Author(s)

Vasilis Dakos <vasilis.dakos@gmail.com>

References

Dakos, V., et al (2008). "Slowing down as an early warning signal for abrupt climate change." *Proceedings of the National Academy of Sciences* 105(38): 14308-14312

Dakos, V., et al (2012)."Methods for Detecting Early Warnings of Critical Transitions in Time Series Illustrated Using Simulated Ecological Data." *PLoS ONE* 7(7): e41010. doi:10.1371/journal.pone.0041010

See Also

`generic_ews`; `ddjnonparam_ews`; `bdstest_ews`; `sensitivity_ews`; `surrogates_ews`; `ch_ews`; `movpotential_ews`; `livpotential_ews`

Examples

```
data(foldbif)
output=sensitivity_ews(foldbif,indicator="sd",detrending="gaussian",
incrwinsize=25,incrbandwidth=20)
```

---

surrogates_ews	*Description: Surrogates Early Warning Signals*

Description

`surrogates_ews` is used to estimate distributions of trends in statistical moments from different surrogate timeseries generated after fitting an ARMA(p,q) model on the data. The trends are estimated by the nonparametric Kendall tau correlation coefficient and can be compared to the trends estimated in the original timeseries to produce probabilities of false positives.

Usage

```
surrogates_ews(timeseries,
  indicator = c("ar1", "sd", "acf1", "sk", "kurt", "cv", "returnrate", "densra
  winsize = 50,
  detrending = c("no", "gaussian", "linear", "first-diff"),
  bandwidth = NULL, boots = 100, logtransform = FALSE,
  interpolate = FALSE)
```

Arguments

timeseries	a numeric vector of the observed univariate timeseries values or a numeric matrix where the first column represents the time index and the second the observed timeseries values. Use vectors/matrices with headings.
indicator	is the statistic (leading indicator) selected for which the surrogate timeseries are produced. Currently, the indicators supported are: `ar1` autoregressive coefficient of a first order AR model, `sd` standard deviation, `acf1` autocorrelation at first lag, `sk` skewness, `kurt` kurtosis, `cv` coeffcient of variation, `returnrate`, and `densratio` density ratio of the power spectrum at low frequencies over high frequencies.
winsize	is the size of the rolling window expressed as percentage of the timeseries length (must be numeric between 0 and 100). Default valuise 50%.
detrending	the timeseries can be detrended/filtered prior to analysis. There are three options: `gaussian` filtering, `linear` detrending and `first-diff`erencing. Default is `no` detrending.
bandwidth	is the bandwidth used for the Gaussian kernel when gaussian filtering is selected. It is expressed as percentage of the timeseries length (must be numeric between 0 and 100). Alternatively it can be given by the bandwidth selector `bw.nrd0` (Default).
boots	the number of surrogate data. Default is 100.
logtransform	logical. If TRUE data are logtransformed prior to analysis as log(X+1). Default is FALSE.
interpolate	logical. If TRUE linear interpolation is applied to produce a timeseries of equal length as the original. Default is FALSE (assumes there are no gaps in the timeseries).

Details

see ref below

Value

`surrogates_ews` returns a matrix that contains:

`Kendall tau estimate original`
the trends of the original timeseries.

`Kendall tau p-value original`
the p-values of the trends of the original timeseries.

`Kendall tau estimate surrogates`
the trends of the surrogate timeseries.

`Kendall tau p-value surrogates`
the associated p-values of the trends of the surrogate timeseries.

`significance p`
the p-value for the original Kendall tau rank correlation estimate compared to
the surrogates.

In addition, `surrogates_ews` returns a plot with the distribution of the surrogate Kendall tau estimates and the Kendall tau estimate of the original series. Vertical lines indicate the 5% and 95% significance levels.

Author(s)

Vasilis Dakos `<vasilis.dakos@gmail.com>`

References

Dakos, V., et al (2008). "Slowing down as an early warning signal for abrupt climate change." *Proceedings of the National Academy of Sciences* 105(38): 14308-14312

Dakos, V., et al (2012)."Methods for Detecting Early Warnings of Critical Transitions in Time Series Illustrated Using Simulated Ecological Data." *PLoS ONE* 7(7): e41010. doi:10.1371/journal.pone.0041010

See Also

`generic_ews`; `ddjnonparam_ews`; `bdstest_ews`; `sensitivity_ews`; `surrogates_ews`; `ch_ews`; `movpotential_ews`; `livpotential_ews`

Examples

```
data(foldbif)
output=surrogates_ews(foldbif,indicator="sd",winsize=50,detrending="gaussian",
bandwidth=10,boots=200,logtransform=FALSE,interpolate=FALSE)
```

`YD2PB_grayscale`   *YD2PB_grayscale data set*

Description

YD2PB_grayscale data set

Format

TBA

Source

TBA

References

See citation("earlywarnings")

Examples

#