Package 'waveclock'

January 2, 2012

Version 1.0-4

Date 2009-11-20

Title Time-frequency analysis of cycling cell luminescence data

Author Tom Price <t0mpr1c3@gmail.com>

Maintainer Tom Price <t0mpr1c3@gmail.com>

Depends R (>= 2.7.0), Rwave

Description waveclock is an R function designed to assess the period and amplitude of cycling cell luminescence data. The function reconstructs the modal frequencies from a continuous wavelet decomposition of the luminescence data using the 'crazy climbers' algorithm described in ''Practical Time-Frequency Analysis: Gabor and Wavelet Transforms with an Implementation in S'', by Rene Carmona, Wen L. Hwang and Bruno Torresani,Academic Press, 1998.

License GPL (>= 2)

URL http://sgdp.iop.kcl.ac.uk/tprice/software.html

Repository CRAN

Date/Publication 2009-11-20 11:25:23

R topics documented:

U2OS — *Luminescence measurements from U2-OS osteosarcoma cells*

Description

This data set contains luminescence traces from osteosarcoma cells stably expressing a Bmal1-luciferase reporter. In each experiment the cells were transfected with siRNAs against circadian clock components.

Usage

```
U2OS
```

Format

A list containing the following time series objects: Fig.S1, Fig.S2AB, Fig.S2C, Fig.S2D, Fig.S2E, Fig.S2F, Fig.S2GI, Fig.S2H, siBmal1, siBmal1_Cry1, siClock, siCry1_Cry2, siCry1Cry2. Each column of these objects contains 721 measurements spaced 10 minutes apart. A very small proportion of missing data points (less than 1 per 4,000) have been imputed by linear interpolation.

References

Baggs, J. E., Price, T. S., DeHaro L., Panda, S., FitzGerald, G. A., and Hogenesch, J. B. *Elucidating network structures of the circadian clock underlying robustness.* Manuscript submitted for publication.

waveclock — *Reconstruction of the modal frequencies in a time series using continuous wavelet transformation and the "crazy climbers" algorithm*

Description

This function can be used to reconstruct the modal frequencies in a time series such as cycling cell luminescence data. First the continuous wavelet transform is calculated using the (complex-valued) Morlet wavelet. Next, the modal frequencies are identified from the time-frequency decomposition using the "crazy climbers" algorithm from package **Rwave**.

Usage

```
waveclock( x, period = c( 6, 48 ), time.limits = NULL, extend = "reflect",
noctave = NULL, nvoice = 96, mask.coi = TRUE,
crc.args = list( seed = 0, nbclimb = 50 ),
cfamily.args = list( ptile = 0.005, bstep = 5, nbchain = 400 ),
crcrec.args = list( compr = 3, epsilon = 0, para = 3, plot = FALSE ),
xlab = "Time (h)", ylab = "Period (h)", png = NULL,
color.palette = heat.colors, mode.col = "green", mode.lty = "solid",
mode.lwd = 2, ... )
```

Arguments

x	Numeric or complex vector or time series. Input signal (possibly complex-valued).
period	Numeric vector. Range defining lower and upper period limits. The default values may be useful for detecting circadian rhythmicity in data with time units measured in hours
time.limits	Numeric vector. Time range for truncation of series
extend	NULL or character string. Ameliorate edge effects by reflecting data series at time limits or repeating the time series. Must be NULL or an abbreviation of "reflect" or "repeat".
mask.coi	Logical. Is the "cone of influence" masked from the output?
noctave	Numeric. Number of powers of 2 for the scale variable in the wavelet decomposition. Defaults to the maximum number possible
nvoice	Numeric. Number of scales in each octave (i.e., between two consecutive powers of 2)
crc.args	List. Arguments provided to "crazy climbers" function crc
cfamily.args	List. Arguments provided to chaining function cfamily
crcrec.args	List. Arguments provided to modal frequency reconstruction function crcrec
xlab	Character string. x axis label for plot of continuous wavelet transform scalogram
ylab	Character string. y axis label for plot of continuous wavelet transform scalogram
png	NULL (default) or character string. Name of png filename for plot output. The default value plots to the default device
color.palette	Color palette function used in scalogram plot
mode.col	Color of line marking modal frequency
mode.lty	Type of line marking modal frequency
mode.lwd	Width of line marking modal frequency
...	Additional parameters passed to filled.contour plot function

Details

original.signal Contains the original signal provided to the function.

modified.signal Contains the modified signal (after truncation and reflection) used in the analysis.

cwt Contains the (complex) values of the continuous wavelet transform of the input signal. Since Morlet's wavelet is not strictly speaking a wavelet (it is not of vanishing integral), artifacts may occur for certain signals.

crc Modal frequencies identified by "crazy climbers" algorithm

cfamily Output of procedure to remove short discontinuities in the modal frequencies

modes Matrix containing information about the modal frequencies. The first column gives an index for the modal frequency that corresponds to the row number in cfamily\$chain. The next three columns identify the median voice of the modal signal, excluding the *cone of influence* (region subject to edge effects). Each voice corresponds to a range of periods: columns 2, 3, and 4 give

the midpoint, lower limit, and upper limit of periods under the median voice. The next three columns summarize the period lengths of each mode by averaging over time, again excluding the cone of influence. Columns 5, 6, and 7 give the mean of the midpoints, lower limits, and upper limits. The last column gives the variance of the reconstructed wave. The rows correspond to the modes identified. The final row gives the the statistics for all the modal frequencies combined and can be useful when a single mode is split into segments, as in the example.

rec Modal frequencies reconstructed as time series.

per The instantaneous period of the modes, as measured by the logarithmic midpoint of the wavelet scale, or 0 outside the cone of influence; NA within the cone of influence.

amp The instantaneous amplitude of the modes as measured by the modulus of the Morlet wavelet at each time point, or 0 outside the cone of influence; NA within the cone of influence.

phase The instantaneous phase of the modes, as measured by the argument of the Morlet wavelet at each time point, or 0 outside the cone of influence; NA within the cone of influence.

mask Voice numbers for the modal frequencies, or 0 outside the cone of influence; NA within the cone of influence.

Author(s)

T.S.Price

References

"Practical Time-Frequency Analysis: Gabor and Wavelet Transforms with an Implementation in S", by Rene Carmona, Wen L. Hwang and Bruno Torresani, Academic Press, 1998. http://sgdp.iop.kcl.ac.uk/tprice/software.html

See Also

See `cwt` for the continuous wavelet transform, `crc` and `cfamily` for the estimation of modal frequencies from the continuous wavelet transform, `crcrec` for the reconstruction of the modal frequencies, and `waveclock.auto` to run `waveclock` in another instance of R.

Examples

```
set.seed( 1 )
freq <- 6 # data point every 10 minutes
T <- 24 * 5 * freq
t <- ( 0:T ) / freq

# models an initial 'spike' and slow background trend
spike <- 0.5 * dgamma( t / 24, 2, 10 )
trend <- rowSums( poly( t, 2 ) %*% rnorm( 2 ) )
background <- spike + trend

# exponentially damped circadian signal with random phase
amplitude <- sqrt( 2 ) * exp( -t / ( 24 * 2 ) )
period <- 24
phase <- runif( 1 ) * 2 * pi
```

```
signal <- amplitude * sin( t / period * 2 * pi + phase )

# Gaussian noise
noise <- 0.15 * rnorm( T + 1 )

# simulated luminescence trace
luminescence.trace <- ts( signal + background + noise, start = 0, freq = freq )
plot( luminescence.trace )

# wavelet analysis
result <- waveclock( luminescence.trace )
result$modes
reconstructed.trace <- ts( rowSums( result$rec, na.rm = TRUE ), start = 0, freq = freq )

# plot reconstructed wave
# code not run
##plot( luminescence.trace )
##lines( reconstructed.trace, col = 2 )
##abline( h = 0, lty = 2, col = 2 )
```

`waveclock.auto` *Run the waveclock function in another instance of R*

Description

Performs the waveclock function in another instance of R. This may be desirable when running waveclock over many datasets in a loop.

Usage

```
waveclock.auto( ... )
```

Arguments

`...`	Parameters passed to `waveclock`

Details

The function returns the output from `waveclock`

Author(s)

T.S.Price

References

"Practical Time-Frequency Analysis: Gabor and Wavelet Transforms with an Implementation in S", by Rene Carmona, Wen L. Hwang and Bruno Torresani, Academic Press, 1998. http://sgdp.iop.kcl.ac.uk/tprice/software.html

See Also

waveclock

Index