# Package 'zeitgebr'

November 21, 2019

```
Title Analysis of Circadian Behaviours
Date 2018-10-04
Version 0.3.4
Description Use behavioural variables to compute period, rhythmicity and other circadian parameters.
     Methods include computation of chi square peri-
     odograms (Sokolove and Bushell (1978) <DOI:10.1016/0022-5193(78)90022-X>),
     Lomb-Scargle periodograms (Lomb (1976) < DOI:10.1007/BF00648343>, Scar-
     gle (1982) <DOI:10.1086/160554>, Ruf (1999) <DOI:10.1076/brhm.30.2.178.1422>),
     and autocorrelation-based periodograms.
Depends R (>= 3.00),
     behavr
Imports data.table,
     lomb,
     pracma,
     WaveletComp
Suggests testthat,
     covr,
     knitr,
     ggetho,
     damr
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BugReports https://github.com/rethomics/zeitgebr/issues
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cwt\_spectrogram

Computes a spectrogram using CWT

## **Description**

A port of Continuous Wavelet transform to rethomics. This function is intended to be used as an argument in the spectrogram wrapper.

# Usage

```
cwt_spectrogram(x, period_range = c(hours(1), hours(32)),
  sampling_rate = 1/mins(1), resolution = 1/64,
  summary_time_window = mins(30))
```

## **Arguments**

# See Also

- spectrogram to apply this fucntion to all indivvidual, with some preprocessing.
- WaveletComp::analyze.wavelet the original function for cwt\_spectrogram

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dams_sample	A behavr table with approximately ten days of DAM2 recording for 32 fruit flies. The first 10, the following 11 and the last 11 animals have long, short and wild type period, respectively (see
	meta(dams_sample)).

# Description

A behave table with approximately ten days of DAM2 recording for 32 fruit flies. The first 10, the following 11 and the last 11 animals have long, short and wild type period, respectively (see meta(dams\_sample)).

## Usage

dams\_sample

## **Format**

An object of class behave (inherits from data.table, data.frame) with 415040 rows and 3 columns.

## Author(s)

Luis Garcia

#### References

Raw data stored at https://github.com/rethomics/zeitgebr/tree/master/raw\_data

find_peaks	Find peaks in a periodogram	
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## **Description**

This function locates the peaks in a pregenerated periodogram. Detection is based on pracma::findpeaks. Only the significant (i.e. power > signif\_threshold) peaks are extracted.

## Usage

```
find_peaks(data, n_peaks = 3)
```

# Arguments

data	behavr::behavr table representing a periodogram, as returned by periodogram
n peaks	maximal numbers of peak to be detected

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## Value

behavr::behavr table that is data with an extra column peak. peak is filled with zeros except for rows match a peak. In which case, rows have an integer value corresponding to the rank of the peak (e.g. 1 for the first peak).

#### References

• zeitgebr tutorial – the relevant rehtomics tutorial

## See Also

- periodogram to generate a periodogram in a first place
- ggetho::geom\_peak a layer to show peaks on a periodogram

## **Examples**

```
data(dams_sample)
# only a half of the individuals for the sake of the example
dt <- dams_sample[xmv(region_id) %in% (1:16 * 2)]
per_dt_xs <- periodogram(activity, dt, FUN = chi_sq_periodogram)
per_dt_xs_with_peaks <- find_peaks(per_dt_xs)
per_dt_xs_with_peaks[peak == 1]</pre>
```

periodogram

Computes periodograms

## **Description**

This function builds periodograms, with one of several methods, for each individual of a behavr table

# Usage

```
periodogram(var, data, period_range = c(hours(16), hours(32)),
  resample_rate = 1/mins(15), alpha = 0.01, FUN = chi_sq_periodogram,
  ...)
```

## **Arguments**

var	variable to analyse
data	behavr table
period_range	vector of size 2 defining minimal and maximal range of period to study (in seconds)
resample_rate	frequency to resample (up or down) the data at (in hertz)
resample_rate	requeries to resample (up of down) the data at (in hertz)
alpha	significance level
•	

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#### Value

A behavr::behavr table. In addition to the metadata, it contains data that encodes a periodogram (i.e. power vs period). The data contains the columns:

- power the power the or equivalent (according to FUN)
- period the period at which power is computed (in seconds)
- p\_value the p value associated to the power estimation
- signif threshold the threshold above which power is considered significant

#### References

• zeitgebr tutorial – the relevant rehtomics tutorial

## See Also

- periodogram\_methods the list of built-in methods
- find\_peaks to find peaks in the periodogram
- ggetho::ggperio to plot periodograms

## **Examples**

```
data(dams_sample)
# only a half of the individuals for the sake of the example
dt <- dams_sample[xmv(region_id) %in% (1:16 * 2)]
pdt <- periodogram(activity, dt, FUN = ls_periodogram, oversampling = 4)
pdt <- periodogram(activity, dt, FUN = chi_sq_periodogram)
require(ggetho)
ggperio(pdt, aes(colour=period_group)) + stat_pop_etho()</pre>
```

periodogram\_methods

Methods For Computing Periodograms

## **Description**

These functions provides a series of methods to assess periodicity of circadian processes.

# Usage

```
ac_periodogram(x, period_range = c(hours(16), hours(32)),
    sampling_rate = 1/mins(1), alpha = 0.05)

chi_sq_periodogram(x, period_range = c(hours(16), hours(32)),
    sampling_rate = 1/mins(1), alpha = 0.05,
    time_resolution = hours(0.1))
```

periodogram\_methods

```
cwt_periodogram(x, period_range = c(hours(16), hours(32)),
    sampling_rate = 1/mins(1), alpha = 0.05, resolution = 1/512,
    n_sim = 10)

fourier_periodogram(x, period_range = c(hours(16), hours(32)),
    sampling_rate = 1/mins(1), alpha = 0.05)

ls_periodogram(x, period_range = c(hours(16), hours(32)),
    sampling_rate = 1/mins(1), alpha = 0.05, oversampling = 8)
```

## **Arguments**

x numeric vector

period\_range vector of size 2 defining minimal and maximal range of period to study (in

seconds)

sampling\_rate the – implicitly regular – sampling rate of x (in hertz)

alpha significance level

time\_resolution

the resolution of periods to scan

resolution the period resolution of the CWT (i.e. the number of suboctaves)

n\_sim the number of shuffling simulation to compute p-value (see WaveletComp::analyze.wavelet)

oversampling the oversampling factor (see lomb::lsp)

## Value

a data.table with the columns:

- period the period (in s)
- power the power (or equivalent) for a given period
- p\_value the significance of the power
- signif\_threshold the significance threshold of the power (at alpha)

#### References

• zeitgebr tutorial – the relevant rehtomics tutorial

#### See Also

- lomb::lsp the orignal function for ls\_periodogram
- xsp::chiSqPeriodogram code modified from
- stats::acf the orignal function for ac\_periodogram
- WaveletComp::analyze.wavelet the original function for cwt\_periodogram

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# **Description**

This function builds spectrogram, using CWT, for each individual of a behavr table

# Usage

```
spectrogram(var, data, period_range = c(hours(16), hours(32)),
  resample_rate = 1/mins(15), FUN = cwt_spectrogram, ...)
```

#### **Arguments**

var	variable to analyse
data	behavr table
period_range	vector of size 2 defining minimal and maximal range of period to study (in seconds)
resample_rate	frequency to resample (up or down) the data at (in hertz)
FUN	function used to compute spectrograms (so far, only CWT is implemented via cwt_spectrogram)
	additional arguments to be passed to FUN

### **Details**

A spectrogram is a estimation of the local periodicity of a signal at a given time. In the context of circadian rhythm, it can be useful to understand how infradian rhythms change along the day or, for instance, how circadian rhythm change ver the course of an multi-day experiment.

## Value

A behavr::behavr table. In addition to the metadata, it contains data that encodes a spectrogram (i.e. power vs period). The data contains the columns:

- t the time (in s) (same range the input time)
- period the period at which the power is computed, for a given t (in s)
- power the power the or equivalent (according to FUN)
- ridge a logical defining whether the point (t and period) is a ridge

#### References

• spectrogram tutorial – the relevant rehtomics tutorial

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# See Also

- periodogram to compute periodogram instead
- cwt\_spectrogram The dunction use to compute individual spectrograms
- ggetho::ggspectro to plot spectrograms

# **Examples**

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