

# Package ‘zeitgebr’

February 16, 2020

**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 periodograms (Sokolove and Bushell (1978) <DOI:10.1016/0022-5193(78)90022-X>), Lomb-Scargle periodograms (Lomb (1976) <DOI:10.1007/BF00648343>, Scargle (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

**License** GPL-3

**Encoding** UTF-8

**LazyData** true

**URL** <https://github.com/rethomics/zeitgebr>

**BugReports** <https://github.com/rethomics/zeitgebr/issues>

**RoxygenNote** 6.1.0

**Roxygen** list(markdown = TRUE)

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|-----------------|---|
| cwt_spectrogram | <i>Computes a spectrogram using CWT</i> |
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**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**

|                     |  |
|---------------------|--|
| 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)   |
| resolution          | the period resolution of the CWT (i.e. the number of suboctaves)   |
| summary_time_window | the sampling period after post-processing. Values of power are avegraged over this time window, for each period. |

**See Also**

- [spectrogram](#) – to apply this fucntion to all indivvidual, with some preprocessing.
- [WaveletComp::analyze.wavelet](#) – the orginal function for cwt\_spectrogram

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|             |   |
|-------------|---|
| dams_sample | <i>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)).</i> |
|-------------|---|

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### Description

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)).

### Usage

```
dams_sample
```

### Format

An object of class behavr (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](https://github.com/rethomics/zeitgebr/tree/master/raw_data)

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|            |                                    |
|------------|------------------------------------|
| find_peaks | <i>Find peaks in a periodogram</i> |
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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    | <a href="#">behavr::behavr</a> table representing a periodogram, as returned by <a href="#">periodogram</a> |
| n_peaks | maximal numbers of peak to be detected  |

**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]
```

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|             |                              |
|-------------|------------------------------|
| periodogram | <i>Computes periodograms</i> |
|-------------|------------------------------|

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**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**

|                            |   |
|----------------------------|---|
| <code>var</code>           | variable to analyse   |
| <code>data</code>          | <code>behavr</code> table   |
| <code>period_range</code>  | vector of size 2 defining minimal and maximal range of period to study (in seconds) |
| <code>resample_rate</code> | frequency to resample (up or down) the data at (in hertz)                           |
| <code>alpha</code>         | significance level  |
| <code>FUN</code>           | function used to compute periodogram (see <a href="#">periodogram_methods</a> )     |
| <code>...</code>           | additional arguments to be passed to <code>FUN</code>                               |

**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()
```

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periodogram\_methods      *Methods For Computing Periodograms*

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**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))
```

```
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 <a href="#">WaveletComp::analyze.wavelet</a> ) |
| oversampling    | the oversampling factor (see <a href="#">lomb::lsp</a> )  |

### 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 orginal function for ls\_periodogram
- [xsp::chiSqPeriodogram](#) – code modified from
- [stats::acf](#) – the orginal function for ac\_periodogram
- [WaveletComp::analyze.wavelet](#) – the orginal function for cwt\_periodogram

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|             |                             |
|-------------|-----------------------------|
| spectrogram | <i>Computes spectrogram</i> |
|-------------|-----------------------------|

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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          | <a href="#">behavr</a> 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 <a href="#">cwt_spectrogram</a> ) |
| ...           | 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

**See Also**

- [periodogram](#) – to compute periodogram instead
- [cwt\\_spectrogram](#) – The dunction use to compute individual spectrograms
- [ggetho::ggspectro](#) – to plot spectrograms

**Examples**

```
data(dams_sample)
dt <- dams_sample[id %in% dams_sample[meta=TRUE, ,id[1:5]]]
spect_dt <- spectrogram(activity, dt)
```

```
require(ggetho)
ggspectro(spect_dt) +
  stat_tile_etho() +
  scale_y_log10() +
  facet_wrap(~ id)
```



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