

Package ‘baRulho’

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Type Package

Title Quantifying sound degradation

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Author Marcelo Araya-Salas [aut, cre]

Maintainer Marcelo Araya-Salas <marceloa27@gmail.com>

Description Quantification of environmental degradation of (animal) sounds

License GPL (>= 2)

Imports pbapply, warbleR, utils, stats, seewave, tuneR

Depends R (>= 3.2.1)

LazyData TRUE

URL <https://github.com/maRce10/baRulho>

BugReports <https://github.com/maRce10/baRulho/issues>

NeedsCompilation no

Suggests

RoxygenNote 6.1.1

Repository CRAN

Language en-US

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atmospheric_attenuation

Measure atmospheric attenuation and absorption of sound

Description

atmospheric_attenuation measures atmospheric attenuation and atmospheric absorption of signals referenced in a extended selection table.

Usage

```
atmospheric_attenuation(f, temp, RH, p = 101325,
  formula = 1, spi = NULL, dist = NULL)
```

Arguments

f	numeric vector of length 1 with frequency (in Hertz).
temp	numeric vector of length 1 with frequency (in Celsius).
RH	numeric vector of length 1 with relative humidity
p	numeric vector of length 1 with ambient pressure in Pa (standard: 101325, default).
formula	1 = Bazley 1976 (used by Marc), 2 = Rossing 2007 (p. 116, see details).
spi	numeric vector of length 1 with the initial sound pressure in Pa. Required for calculating atmospheric absorption. Default is NULL.
dist	numeric vector of length 1 with the distance in m through which the sound propagates. Required for calculating atmospheric absorption. Default is NULL.

Details

Calculate the atmospheric attenuation in dependence on temperature, relative humidity, pressure and frequency. The function can applied to formulae based on:

- 1: default. As used by Marc: Bazley (1976), Sound absorption in air at
- 2: as used by Peter: Rossing (2007), Handbook of Acoustics, Springer.

If 'spi' is supplied the function also returns the atmospheric absorption (in dB).

Value

Returns the atmospheric absorption (in dB/m) of sound based on the supplied parameters. I

Author(s)

Marcelo Araya-Salas (<marceloa27@gmail.com>) #' @references Araya-Salas, M. (2019), baRulho: a R package to evaluate habitat-induced degradation of (animal) acoustic signals. R package version 1.0.0

Examples

```
{
# load example data
data("playback_est")

#' # remove noise selections
playback_est <- playback_est[playback_est$signal.id != "noise", ]

# measure atmospheric attenuation formula 1
atmospheric_attenuation(f = 20000, temp = 20, RH = 90, p = 88000, formula = 1)
}
```

baRulho

baRulho: quantifying sound degradation

Description

‘baRulho’ is a package intended to quantify habitat-induced degradation of (animal) acoustic signals. Most functions are based on the metrics provided in Dabelsteen et al (1993).

Details

The main features of the package are:

- The use of loops to apply tasks through acoustic signals referenced in an extended selection table
- The comparison of signals played back and re-recorded at different distances

Most functions allow the parallelization of tasks, which distributes the tasks among several processors to improve computational efficiency.

License: GPL (≥ 2)

Author(s)

Marcelo Araya-Salas

Maintainer: Marcelo Araya-Salas (<marceloa27@gmail.com>)

blur_ratio	<i>Measure blur ratio</i>
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Description

blur_ratio measures blur ratio in signals referenced in a extended selection table.

Usage

```
blur_ratio(X, parallel = 1, pb = TRUE, method = 1,
           ssmooth = NULL, msmooth = NULL, output = "est")
```

Arguments

X	object of class 'selection_table', 'extended_selection_table' created by the function selection_table from the warbleR package.
parallel	Numeric. Controls whether parallel computing is applied. It specifies the number of cores to be used. Default is 1 (i.e. no parallel computing). If NULL (default) then the current working directory is used.
pb	Logical argument to control if progress bar is shown. Default is TRUE. It can also be set globally using the 'pb' option (see warbleR_options).
method	Numeric vector of length 1 to indicate the 'experimental design' for measuring envelope correlation. Two methods are available: <ul style="list-style-type: none"> • 1: compare all signals with their counterpart that was recorded at the closest distance to source (e.g. compare a signal recorded at 5m, 10m and 15m with its counterpart recorded at 1m). This is the default method. • 2: compare all signals with their counterpart recorded at the distance immediately before (e.g. a signal recorded at 10m compared with the same signal recorded at 5m, then signal recorded at 15m compared with same signal recorded at 10m and so on).
ssmooth	Numeric vector of length 1 determining the length of the sliding window used for a sum smooth for amplitude envelope calculation (used internally by env).
msmooth	Numeric vector of length 2 to smooth the amplitude envelope with a mean sliding window for amplitude envelope calculation. The first element is the window length (in number of amplitude values) and the second one the window overlap (used internally by env).
output	Character vector of length 1 to determine if an extended selection table ('est') or a data frame ('data.frame') is returned.

Details

Blur ratio measures the degradation of sound as a function of the change in signal energy in the time domain as described by Dabelsteen et al 1993. The goal of the function is to measure the blur ratio on signals in which a master playback has been re-recorded at different distances. The 'signal.id' column must be used to tell the function to only compare signals belonging to the same category (e.g. song-types). Two methods for calculating excess attenuation are provided

Value

Data frame similar to input data, but also includes a new column (blur.ratio) with the excess attenuation values.

Author(s)

Marcelo Araya-Salas (<marceloa27@gmail.com>) #' @references Dabelsteen, T., Larsen, O. N., & Pedersen, S. B. (1993). Habitat-induced degradation of sound signals: Quantifying the effects of communication sounds and bird location on blur ratio, excess attenuation, and signal-to-noise ratio in blackbird song. *The Journal of the Acoustical Society of America*, 93(4), 2206.

Araya-Salas, M. (2019), baRulho: a R package to evaluate habitat-induced degradation of (animal) acoustic signals. R package version 1.0.0

Examples

```
{
# load example data
data("playback_est")

# remove noise selections
playback_est <- playback_est[playback_est$signal.id != "noise", ]

# using method 1
blur_ratio(X = playback_est)

# using method 2
blur_ratio(X = playback_est, method = 2)
}
```

envelope_correlation *Measure amplitude envelope correlation*

Description

envelope_correlation measures amplitude envelope correlation in signals referenced in a extended selection table.

Usage

```
envelope_correlation(X, parallel = 1, pb = TRUE, method = 1, cor.method = "pearson",
  ssmooth = NULL, msmooth = NULL, output = "est")
```

Arguments

<code>X</code>	object of class 'selection_table', 'extended_selection_table' created by the function selection_table from the warbleR package.
<code>parallel</code>	Numeric. Controls whether parallel computing is applied. It specifies the number of cores to be used. Default is 1 (i.e. no parallel computing). If NULL (default) then the current working directory is used.
<code>pb</code>	Logical argument to control if progress bar is shown. Default is TRUE. It can also be set globally using the 'pb' option (see warbleR_options).
<code>method</code>	Numeric vector of length 1 to indicate the 'experimental design' for measuring envelope correlation. Two methods are available: <ul style="list-style-type: none"> • 1: compare all signals with their counterpart that was recorded at the closest distance to source (e.g. compare a signal recorded at 5m, 10m and 15m with its counterpart recorded at 1m). This is the default method. • 2: compare all signals with their counterpart recorded at the distance immediately before (e.g. a signal recorded at 10m compared with the same signal recorded at 5m, then signal recorded at 15m compared with same signal recorded at 10m and so on).
<code>cor.method</code>	Character string indicating the correlation coefficient to be applied ("pearson", "spearman", or "kendall", see cor).
<code>ssmooth</code>	Numeric vector of length 1 determining the length of the sliding window used for a sum smooth for amplitude envelope calculation (used internally by env).
<code>msmooth</code>	Numeric vector of length 2 to smooth the amplitude envelope with a mean sliding window for amplitude envelope calculation. The first element is the window length (in number of amplitude values) and the second one the window overlap (used internally by env).
<code>output</code>	Character vector of length 1 to determine if an extended selection table ('est', default) or a data frame ('data.frame') is returned.

Details

The correlation of amplitude envelopes is intended to measure the distortion of signals in the time domain. The function measures the envelope correlation on signals in which a master playback has been re-recorded at different distances. The 'signal.id' column must be used to indicate the function to only compare signals belonging to the same category (e.g. song-types). The function will then compared each signal type to its reference. Two methods for calculating envelope correlation are provided (see 'method' argument).

Value

Data frame or extended selection table (depending on 'output' argument) similar to input data, but also includes a new column with the amplitude envelope correlation coefficients.

Author(s)

Marcelo Araya-Salas (<marceloa27@gmail.com>)

References

Araya-Salas, M. (2019), baRulho: a R package to evaluate habitat-induced degradation of (animal) acoustic signals. R package version 1.0.0

Examples

```
{
# load example data
data("playback_est")

# remove noise selections
playback_est <- playback_est[playback_est$signal.id != "noise", ]

# method 1
envelope_correlation(X = playback_est)

# method 2
envelope_correlation(X = playback_est, method = 2)
}
```

excess_attenuation	<i>Measure excess attenuation</i>
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Description

excess_attenuation measures excess attenuation in signals referenced in a extended selection table.

Usage

```
excess_attenuation(X, parallel = 1, pb = TRUE, method = 1,
bp = NULL, wl = 10, output = "est")
```

Arguments

- | | |
|----------|--|
| X | object of class 'selection_table', 'extended_selection_table' created by the function selection_table from the warbleR package. |
| parallel | Numeric. Controls whether parallel computing is applied. It specifies the number of cores to be used. Default is 1 (i.e. no parallel computing). If NULL (default) then the current working directory is used. |
| pb | Logical argument to control if progress bar is shown. Default is TRUE. It can also be set globally using the 'pb' option (see warbleR_options). |
| method | Numeric vector of length 1 to indicate the 'experimental design' for measuring excess attenuation. Two methods are available: <ul style="list-style-type: none"> • 1: compare all signals with their counterpart that was recorded at the closest distance to source (e.g. compare a signal recorded at 5m, 10m and 15m with its counterpart recorded at 1m). This is the default method. |

	<ul style="list-style-type: none"> • 2: compare all signals with their counterpart recorded at the distance immediately before (e.g. a signal recorded at 10m compared with the same signal recorded at 5m, then signal recorded at 15m compared with same signal recorded at 10m and so on).
bp	Numeric vector of length 2 giving the lower and upper limits of a frequency bandpass filter (in kHz). Default is NULL.
wl	A numeric vector of length 1 specifying the window length of the spectrogram for applying bandpass. Default is 10. Ignored if bp = NULL. Note that lower values will increase time resolution, which is more important for amplitude ratio calculations.
output	Character vector of length 1 to determine if an extended selection table ('est', default) or a data frame ('data.frame') is returned.

Details

Excess attenuation is the attenuation of a sound in excess of that due to spherical spreading as described by Dabelsteen et al (1993). The goal of the function is to measure the excess attenuation on signals in which a master playback has been re-recorded at different distances. The 'signal.id' column must be used to indicate which signals belonging to the same category (e.g. song-types). The function will then compared each signal type to its reference. Two methods for calculating excess attenuation are provided (see 'method' argument).

Value

Data frame or extended selection table (depending on 'output' argument) similar to input data, but also includes a new column (excess.attenuation) with the excess attenuation values.

Author(s)

Marcelo Araya-Salas (<marceloa27@gmail.com>) #' @references Dabelsteen, T., Larsen, O. N., & Pedersen, S. B. (1993). Habitat-induced degradation of sound signals: Quantifying the effects of communication sounds and bird location on blur ratio, excess attenuation, and signal-to-noise ratio in blackbird song. The Journal of the Acoustical Society of America, 93(4), 2206.

Araya-Salas, M. (2019), baRulho: a R package to evaluate habitat-induced degradation of (animal) acoustic signals. R package version 1.0.0

Examples

```
{
# load example data
data("playback_est")

# remove noise selections
playback_est <- playback_est[playback_est$signal.id != "noise", ]

# using method 1
excess_attenuation(X = playback_est)

# using method 2
```



```
excess_attenuation(X = playback_est, method = 2)
}
```

playback_est

Extended selection table with re-recorded playbacks

Description

Recordings of *Phaethornis longirostris* (Long-billed Hermit) songs from different song types (column 'signal.id') that were played back and re-recorded at 4 distances (1m, 5m, 10m, 15m, column 'distance'). The data also contains background noise selections for each distance. The data was created by the function [selection_table](#) from the warbleR package.

Usage

```
data(playback_est)
```

Format

Extended selection table object in the [warbleR](#) format, which contains annotations and acoustic data

Source

Marcelo Araya-Salas

snr_attenuation

Measure attenuation as signal-to-noise ratio

Description

snr_attenuation measures attenuation as signal-to-noise ratio of signals referenced in a extended selection table.

Usage

```
snr_attenuation(X, mar, parallel = 1, pb = TRUE, eq.dur = FALSE,
noise.ref = "adjacent", type = 1, bp = NULL, wl = 10, output = "est")
```

Arguments

<code>x</code>	object of class 'selection_table', 'extended_selection_table' created by the function selection_table from the warbleR package.
<code>mar</code>	numeric vector of length 1. Specifies the margins adjacent to the start and end points of selection over which to measure noise.
<code>parallel</code>	Numeric. Controls whether parallel computing is applied. It specifies the number of cores to be used. Default is 1 (i.e. no parallel computing). If NULL (default) then the current working directory is used.
<code>pb</code>	Logical argument to control if progress bar is shown. Default is TRUE. It can also be set globally using the 'pb' option (see warbleR_options).
<code>eq.dur</code>	Logical. Controls whether the noise segment that is measured has the same duration than the signal (if TRUE. Default is FALSE). If TRUE then 'mar' and 'noise.ref' arguments are ignored.
<code>noise.ref</code>	Character vector of length 1 to determined if a noise segment to be used for measuring ambient noise. Two options are available: <ul style="list-style-type: none"> • adjacent: measure ambient noise right before the signal (using argument 'mar' to define duration of noise segments). If several 'noise' selections by sound file are supplied, then the root mean square of the amplitude envelope will be averaged across those selections. • custom: measure noise segments referenced in the selection table (labeled as 'noise' in the 'signal.id' column). Those segments will be used to apply the same noise reference to all signals in a sound file. Therefore, at least one 'noise' selection for each sound file must be provided.
<code>type</code>	Numeric. Determine the formula to be used to calculate the signal-to-noise ratio (S = signal, N = background noise): <ul style="list-style-type: none"> • 1: ratio of S amplitude envelope quadratic mean to N amplitude envelope quadratic mean ($\text{rms}(\text{env}(S))/\text{rms}(\text{env}(N))$) • 2: ratio of the difference between S amplitude envelope quadratic mean and N amplitude envelope quadratic mean ($(\text{rms}(\text{env}(S)) - \text{rms}(\text{env}(N)))/\text{rms}(\text{env}(N))$), as proposed by Dabelsteen et al (1993)
<code>bp</code>	Numeric vector of length 2 giving the lower and upper limits of a frequency bandpass filter (in kHz). Default is NULL.
<code>wl</code>	A numeric vector of length 1 specifying the window length of the spectrogram for applying bandpass. Default is 10. Ignored if <code>bp</code> = NULL. Note that lower values will increase time resolution, which is more important for amplitude ratio calculations.
<code>output</code>	Character vector of length 1 to determine if an extended selection table ('est', default) or a data frame ('data.frame') is returned.

Details

Signal-to-noise ratio is the attenuation is the attenuation of a sound in excess of that due to spherical spreading as described by Dabelsteen et al (1993). The goal of the function is to measure the excess attenuation on signals in which a master playback has been re-recorded at different distances. The

'signal.id' column must be used to indicate which signals belonging to the same category (e.g. song-types). The function will then compared each signal type to its reference. Two methods for calculating excess attenuation are provided (see 'method' argument).

Value

Data frame or extended selection table (depending on 'output' argument) similar to input data, but also includes a new column (snr.attenuation) with the signal-to-noise ratio values.

Author(s)

Marcelo Araya-Salas (<marceloa27@gmail.com>) #' @references Dabelsteen, T., Larsen, O. N., & Pedersen, S. B. (1993). Habitat-induced degradation of sound signals: Quantifying the effects of communication sounds and bird location on blur ratio, excess attenuation, and signal-to-noise ratio in blackbird song. The Journal of the Acoustical Society of America, 93(4), 2206.

Araya-Salas, M. (2019), baRulho: a R package to evaluate habitat-induced degradation of (animal) acoustic signals. R package version 1.0.0

Examples

```
{
# load example data
data("playback_est")

# using noise reference selections
snr_attenuation(X = playback_est, mar = 0.05, noise.ref = 'custom')

#' # remove noise selections
playback_est <- playback_est[playback_est$signal.id != "noise", ]
# using margin for noise of 0.05 and adjacent noise reference
snr_attenuation(X = playback_est, mar = 0.05, noise.ref = 'adjacent')
}
```

xcorr_distortion	<i>Measure spectrographic cross-correlation as a measure of signal distortion</i>
------------------	---

Description

xcorr_distortion Measures spectrographic cross-correlation as a measure of signal distortion in signals referenced in a extended selection table.

Usage

```
xcorr_distortion(X = NULL, parallel = 1, pb = TRUE, method = 1, cor.method = "pearson",
w1 = 512, ovlp = 90, wn = 'hanning', output = "est")
```

Arguments

<code>X</code>	object of class 'selection_table', 'extended_selection_table' created by the function selection_table from the warbleR package.
<code>parallel</code>	Numeric. Controls whether parallel computing is applied. It specifies the number of cores to be used. Default is 1 (i.e. no parallel computing). If NULL (default) then the current working directory is used.
<code>pb</code>	Logical argument to control if progress bar is shown. Default is TRUE. It can also be set globally using the 'pb' option (see warbleR_options).
<code>method</code>	Numeric vector of length 1 to indicate the 'experimental design' for measuring envelope correlation. Two methods are available: <ul style="list-style-type: none"> • 1: compare all signals with their counterpart that was recorded at the closest distance to source (e.g. compare a signal recorded at 5m, 10m and 15m with its counterpart recorded at 1m). This is the default method. • 2: compare all signals with their counterpart recorded at the distance immediately before (e.g. a signal recorded at 10m compared with the same signal recorded at 5m, then signal recorded at 15m compared with same signal recorded at 10m and so on).
<code>cor.method</code>	Character string indicating the correlation coefficient to be applied ("pearson", "spearman", or "kendall", see cor).
<code>wl</code>	A numeric vector of length 1 specifying the window length of the spectrogram, default is 512.
<code>ovlp</code>	Numeric vector of length 1 specifying % of overlap between two consecutive windows, as in spectro . Default is 90. High values of ovlp slow down the function but produce more accurate results.
<code>wn</code>	A character vector of length 1 specifying the window name as in ftwindow .
<code>output</code>	Character vector of length 1 to determine if an extended selection table ('est', default) or a data frame ('data.frame') is returned.

Details

The spectrographic cross-correlation is intended to measure the distortion of signals in the frequency domain. The goal of the function is to measure the cross-correlation on signals in which a master playback has been re-recorded at different distances. The 'signal.id' column must be used to indicate the function to only compare signals belonging to the same category (e.g. song-types). The function will then compared each signal type to its reference. Two methods for calculating cross-correlation are provided (see 'method' argument). The function is a wrapper on warbleR's [xcorr](#) function.

Value

Data frame or extended selection table (depending on 'output' argument) similar to input data, but also includes a new column (env.correlation) with the amplitude envelope correlation coefficients.

Author(s)

Marcelo Araya-Salas (<marceloa27@gmail.com>) #^{*} @references Araya-Salas, M. (2019), baRulho: a R package to evaluate habitat-induced degradation of (animal) acoustic signals. R package version 1.0.0

Examples

```
{  
# load example data  
data("playback_est")  
  
# remove noise selections  
playback_est <- playback_est[playback_est$signal.id != "noise", ]  
  
# method 1  
xcorr_distortion(X = playback_est, method = 1)  
  
# method 2  
xcorr_distortion(X = playback_est, method = 2)  
}
```

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