Package 'wearables'

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Type Package

Title Tools to Read and Convert Wearables Data

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Maintainer Peter de Looff <peterdelooff@gmail.com>

Description Package to read Empatica E4, Embrace Plus, and Nowatch data, perform several transformations, perform signal processing and analyses, including batch analyses.

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Depends R (>= 3.6)

Imports cli, dplyr, ggplot2, kernlab, lubridate, magrittr, padr, R.utils, RHRV, rlang, signal, sparklyr, varian, waveslim, xts, jsonlite

Suggests testthat, futile.logger

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Author Peter de Looff [aut, cre], Remko Duursma [aut], Saskia Koldijk [aut], Kees de Schepper [aut], Matthijs Noordzij [ctb], Natasha Jaques [ctb], Sara Taylor [ctb], Veerle van Leemput [ctb]

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`add_chunk_group` *Addition of chunk groups*

Description

partition data into chunks of a fixed number of rows in order to calculate aggregated features per chunk

Usage

```
add_chunk_group(data, rows_per_chunk)
```

Arguments

`data`	df to partition into chunks
`rows_per_chunk`	size of a chunk

aggregate_data *Aggregate data into timesteps*

Description

Aggregate data into timesteps

Aggregate E4 data into timesteps

Aggregate Embrace Plus data into timesteps

Aggregate Nowatch data into timesteps

Usage

```
aggregate_data(x, interval = "1 min")

aggregate_e4_data(x, interval = "1 min")

aggregate_embrace_plus_data(x, interval = "1 min")

aggregate_nowatch_data(x, interval = "1 min")
```

Arguments

x	An object read by read_e4, read_embrace_plus or read_nowatch.
interval	The interval to aggregate the data. Default is 1 min.

as_time *as_time*

Description

Converts Unix time to as.POSIXct

Usage

```
as_time(x, tz = "UTC")
```

Arguments

x	takes a unixtime and converts to as.POSIXct
tz	timezone is set to UTC

as_timeseries *Convert an E4 data stream to a timeseries*

Description

Creates an xts object indexed by time

Usage

```
as_timeseries(data, index = 2, name_col = "V1")
```

Arguments

data	A dataframe, subelements of list as output by read_e4 function
index	Which column (integer) to use as the data in the timeseries. Default: 2.
name_col	Column name to give to the timeseries data.

batch_analysis *Batch analysis*

Description

Read and process all ZIP files in a directory

Usage

```
batch_analysis(path_in = NULL, path_out = ".")
```

Arguments

path_in	input path
path_out	output path

binary_classifier_config

Configuration of the SVM algorithm for binary classification

Description

Configuration of the SVM algorithm for binary classification

Usage

```
binary_classifier_config
```

Format

An object of class `list` of length 4.

Author(s)

Sara Taylor <sataylor@mit.edu>

References

Taylor, S., Jaques, N., Chen, W., Fedor, S., Sano, A., & Picard, R. (2015). Automatic identification of artifacts in electrodermal activity data. In *Proceedings of the 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBS)*.

calculate_RMSSD *RMSSD calculation*

Description

Calculation of RMSSD over 1 minute time periods for plotting

Usage

```
calculate_RMSSD(IBIdata)
```

Arguments

IBIdata	Uses the IBI data frame as created by read_e4

char_clock_systime *Force character datetime variable ("yyyy-mm-dd hh:mm:ss") to system timezone*

Description

Force character datetime variable ("yyyy-mm-dd hh:mm:ss") to system timezone

Usage

```
char_clock_systime(time)
```

Arguments

time	Datetime variable ("yyyy-mm-dd hh:mm:ss")

choose_between_classes *Choice between two classes*

Description

Make choice between two classes based on kernel values

Usage

```
choose_between_classes(class_a, class_b, kernels)
```

Arguments

class_a	Number by which class a is indicated
class_b	Number by which class b is indicated
kernels	Kernel values from SVM

`compute_amplitude_features` *Amplitude features*

Description

Compute amplitude features.

Usage

```
compute_amplitude_features(data)
```

Arguments

`data`	vector of amplitude values

`compute_derivative_features` *Derivative features*

Description

Compute derivative features.

Usage

```
compute_derivative_features(derivative, feature_name)
```

Arguments

`derivative`	vector of derivatives
`feature_name`	name of feature

compute_features2 *Compute Features for SVM*

Description

This function computes features for support vector machines (SVM) analysis. It processes input data, applies wavelet coefficients computation, and aggregates various statistical measures over defined time chunks. The function is designed to work with data frames containing electrodermal activity (EDA) data, filtered EDA, and timestamps.

Usage

```
compute_features2(data)
```

Arguments

data	A data frame with columns for electrodermal activity (eda), filtered electrodermal activity (filtered eda), and timestamps (DateTime). It is assumed that the data frame has already been preprocessed appropriately for feature computation.

Details

The function internally computes wavelet coefficients and then divides the data into chunks of specified durations (1 second, 0.5 seconds, and a custom duration based on amplitude features). For each chunk, it calculates various statistical measures. The resulting data frame includes timestamps and the computed features, which can be used for further analysis or as input to machine learning models like SVM.

Value

A data frame with computed features. Each row corresponds to a time chunk, and columns include statistical measures (like maximum, mean, standard deviation, median, and sum of positive values) of wavelet coefficients computed over different intervals (1 second, 0.5 seconds, and based on amplitude features).

Examples

```
## Not run:
# Assuming 'my_data' is a preprocessed data frame with the necessary columns
features <- compute_features2(my_data)

## End(Not run)
```

`compute_wavelet_coefficients` *Wavelet coefficients*

Description

Compute wavelet coefficients.

Usage

```
compute_wavelet_coefficients(data)
```

Arguments

`data`	data with an EDA element

`compute_wavelet_decomposition` *Wavelet decomposition*

Description

Compute wavelet decomposition.

Usage

```
compute_wavelet_decomposition(data)
```

Arguments

`data`	vector of values

create_e4_output_folder *Output folder*

Description

Create output folder for E4 analysis results

Usage

```
create_e4_output_folder(obj, out_path = ".")
```

Arguments

obj	e4 analysis object
out_path	output folder

create_empty_freq_list *Create an Empty Frequency List*

Description

This function generates a list named 'freq' with predefined fields for frequency measurements. Most fields are initialized with NA values, except for 'type' which is set to "fourier".

Usage

```
create_empty_freq_list()
```

Value

A named list with frequency measurement fields, mostly set to NA.

Examples

```
empty_freq_list <- create_empty_freq_list()
str(empty_freq_list)
```

create_empty_time_list *Create an Empty Time List*

Description

This function generates a list named 'time' with predefined fields, all set to NA. The fields included are related to time-based measurements.

Usage

```
create_empty_time_list()
```

Value

A named list with all fields set to NA.

Examples

```
empty_time_list <- create_empty_time_list()
str(empty_time_list)
```

e4_data *Small example dataset for e4*

Description

Small example dataset for e4

Usage

```
e4_data
```

Format

An object of class "e4data"

Examples

```
data(e4_data)
```

`e4_filecut_intervals` *Filter datasets for a Datetime start + end*

Description

A function to determine how many intervals should be created. The question is at what time do you want the filecut to start, what should be the period that you want separate files for, and what should the interval be?

Usage

```
e4_filecut_intervals(time_start, time_end, interval)
```

Arguments

`time_start`	User input start time in the character format "yyyy-mm-dd hh:mm:ss" / e.g., "2019-11-27 08:32:00". Where do you want the file cut to start?
`time_end`	User input end time (same format as time_start)
`interval`	# Interval: User input interval (in minutes/ e.g., 5) What is the duration of the interval you want to divide the period into? For example, the paper by de Looff et al. (2019) uses 5 minute intervals over a 30 minute period preceding aggressive behavior. The 5 minute interval is chosen as for the calculation of some of the heart rate variability parameters one needs at least 5 minutes of data, but shorter intervals are possible as well, see for instance: Shaffer, Fred, en J. P. Ginsberg. 'An Overview of Heart Rate Variability Metrics and Norms'. Frontiers in Public Health 5 (28 september 2017). https://doi.org/10.3389/fpubh.2017.00258.

`filter_createdir_zip` *Function to filter the data object based on the time period and intervals that are needed for the files to be cut. The function also creates identical Empatica E4 zipfiles in the same directory as where the original zipfile is located.*

Description

Function to filter the data object based on the time period and intervals that are needed for the files to be cut. The function also creates identical Empatica E4 zipfiles in the same directory as where the original zipfile is located.

Usage

```
filter_createdir_zip(
  data,
  time_start,
  time_end,
  interval,
  out_path = NULL,
  fn_name = NULL
)
```

Arguments

data	Object read with read_e4
time_start	User input start time in the character format "yyyy-mm-dd hh:mm:ss" / e.g., "2019-11-27 08:32:00". Where do you want the file cut to start?
time_end	User input end time (same format as time_start)
interval	# Interval: User input interval (in minutes/ e.g., 5) What is the duration of the interval you want to divide the period into? For example, the paper by de Looff et al. (2019) uses 5 minute intervals over a 30 minute period preceding aggressive behavior. The 5 minute interval is chosen as for the calculation of some of the heart rate variability parameters one needs at least 5 minutes of data.
out_path	The directory where to write the cut files; defaults to the input folder.
fn_name	The directory where to write the cut files without the extension.

Value

out_path fn_name

---

filter_datetime *Filter data according to a datetime start and end*

Description

Filter data according to a datetime start and end

Filter all four datasets for a Datetime start + end

Filter all datasets for a Datetime start + end

Usage

```
filter_datetime(data, start, end)

filter_e4data_datetime(data, start, end)

filter_embrace_plus_data_timestamp(data, start, end)
```

Arguments

data	Object read with read_e4 or read_embrace_plus
start	Start Datetime (posixct)
end	End Datetime (posixct)

---

find_peaks *Function to find peaks of an EDA datafile*

Description

This function finds the peaks of an EDA signal and adds basic properties to the datafile.

Usage

```
find_peaks(
  data,
  offset = 1,
  start_WT = 4,
  end_WT = 4,
  thres = 0.005,
  sample_rate = getOption("SAMPLE_RATE", 8)
)
```

Arguments

data	DataFrame with EDA as one of the columns and indexed by a datetimeIndex
offset	the number of rising seconds and falling seconds after a peak needed to be counted as a peak
start_WT	maximum number of seconds before the apex of a peak that is the "start" of the peak
end_WT	maximum number of seconds after the apex of a peak that is the "end" of the peak 50 percent of amp
thres	the minimum microsecond change required to register as a peak, defaults as .005
sample_rate	number of samples per second, default=8

Details

Also, peak_end is assumed to be no later than the start of the next peak. Is that OK?

Value

data frame with several columns peaks 1 if apex peak_start 1 if start of peak peak_end 1 if end of preak peak_start_times if apex then corresponding start timestamp peak_end_times if apex then corresponding end timestamp half_rise if sharp decaying apex then time to halfway point in rise amp if apex then value of EDA at apex - value of EDA at start max_deriv if apex then max derivative within 1 second of apex rise_time if apex then time from start to apex decay_time if sharp decaying apex then time from apex to end SCR_width if sharp decaying apex then time from half rise to end

get_amp *Peak amplitude*

Description

Get the amplitude of the peaks

Usage

```
get_amp(data)
```

Arguments

data	df with peak info

get_apex *Get the eda apex of the signal*

Description

finds the apex of electrodermal activity eda signal within an optional time window

Usage

```
get_apex(eda_deriv, offset = 1)
```

Arguments

eda_deriv	uses the eda derivative to find the apex
offset	minimum number of downward measurements after the apex, in order to be considered a peak (default 1 means no restrictions)

get_decay_time *Decay time*

Description

Get the time (in seconds) it takes to decay for each peak

Usage

```
get_decay_time(data, i_apex_with_decay)
```

Arguments

data	df with peak info
i_apex_with_decay	indexes of relevant peaks

get_derivative *First derivative*

Description

Get the first derivative.

Usage

```
get_derivative(values)
```

Arguments

values	vector of numbers

get_eda_deriv *Electrodermal activity signal derivative*

Description

Finds the first derivatives of the eda signal

Usage

```
get_eda_deriv(eda)
```

Arguments

eda	eda vector

get_half_amp *Half peak amp*

Description

Get the amplitude value halfway between peak start and apex

Usage

```
get_half_amp(data, i)
```

Arguments

data	df with peak info
i	apex index

get_half_rise *Half rise time*

Description

Get the time (in seconds) it takes to get to halfway the rise in a peak

Usage

```
get_half_rise(data, i_apex_with_decay)
```

Arguments

data	df with peak info
i_apex_with_decay	relevant apices

get_i_apex_with_decay *Decaying peaks*

Description

Identify peaks with a decent decay (at least half the amplitude of rise)

Usage

```
get_i_apex_with_decay(data)
```

Arguments

data	df with peak info

get_kernel *SVM kernel*

Description

Generate kernel needed for SVM

Usage

```
get_kernel(kernel_transformation, sigma, columns)
```

Arguments

kernel_transformation	Data matrix used to transform EDA features into kernel values
sigma	The inverse kernel width used by the kernel
columns	Features computed from EDA signal

get_max_deriv *Maximum derivative*

Description

Get the largest slope before apex, interpolated to seconds

Usage

```
get_max_deriv(data, eda_deriv, sample_rate)
```

Arguments

data	df with info on the peaks
eda_deriv	derivative of the signal
sample_rate	sample rate of the signal

get_peak_end *Peak end*

Description

Find the end of the peaks, with some restrictions on the search

Usage

```
get_peak_end(data, max_lookahead)
```

Arguments

data	df with peak info
max_lookahead	max distance from apex to search for end

get_peak_end_times *Peak end times*

Description

Get the end timstamp of the peaks

Usage

```
get_peak_end_times(data)
```

Arguments

data	df with peak info

get_peak_start *Start of peaks*

Description

Provide info for each measurement whether it is the start of a peak (0 or 1)

Usage

```
get_peak_start(data, sample_rate)
```

Arguments

data	df with peak info
sample_rate	sample rate of the signal

get_peak_start_times *Peak start times*

Description

Get the start times of the peaks

Usage

```
get_peak_start_times(data)
```

Arguments

data	df with peak info

get_rise_time *Rise time of peaks*

Description

Calculates the rise time of all peaks

Usage

```
get_rise_time(eda_deriv, apices, sample_rate, start_WT)
```

Arguments

eda_deriv	first derivative of signal
apices	apex status per measurement (0 or 1)
sample_rate	sample rate of the signal
start_WT	window within which to look for rise time (in seconds)

get_SCR_width *Peak width*

Description

Get the width of the peak (in seconds, from halfway the rise until the end)

Usage

```
get_SCR_width(data, i_apex_with_decay)
```

Arguments

data	df with peak info
i_apex_with_decay	relevant apices

get_second_derivative *Second derivative*

Description

Get the second derivative.

Usage

```
get_second_derivative(values)
```

Arguments

values	vector of numbers

`ibi_analysis` *IBI analysis version 2*

Description

The 'ibi_analysis' function is an update to the previous 'ibi_analysis_old' (version 0.8.1) and includes improvements to handle Empatica E4 data more effectively. The updated version tries to mitigate issues with empty IBI files and reduces the likelihood of errors during HRV analysis.

Usage

```
ibi_analysis(IBI)
```

Arguments

`IBI`	IBI data, a dataframe with columns including DateTime and seconds since the start of the recording. This data can be read with read with `read_e4`

Details

This function is an updated approach for the analysis of (IBI) data. Here is a link to the old version `ibi_analysis_old`. It was updated to handle specific errors encountered in the BuildNIHR or InterpolateNIHR functions that resulted from files that were almost empty on IBI data.

This function analyzes IBI data, focusing on time and frequency domain measures. Note that the function imports functions from the RHRV package for HRV (Heart Rate Variability) analysis. Also note that measurements on the wrist are now more often referred to as PRV (Pulse Rate Variability), see for instance https://jphysiolanthropol.biomedcentral.com/articles/10.1186/s40101-020-00233-x.

The function performs several steps in processing IBI data: 1. Initializes HRV data structure using RHRV. 2. Handles potential data discrepancies due to the nature of wrist-worn devices. 3. Implements error handling for BuildNIHR and InterpolateNIHR functions. 4. Processes the data through time and frequency domain analyses. 5. Returns a comprehensive summary of HRV measures.

Value

A list containing the results of the time analysis, frequency analysis (if available), and a summary of HRV measures. The summary includes time domain measures (SDNN, pNN50, etc.), frequency domain measures (HF, LF, LFHF, etc.), and counts of original and accepted beats.

Examples

```
## Not run:
zip_path <- system.file("extdata", "1635148245_A00204.zip", package = "wearables")
Assuming "IBI_data" is your interbeat interval data
result <- read_e4("path to your file")
print(result$IBI)
```

```
## End(Not run)
```

`ibi_analysis_old` *IBI analysis (Old version)*

Description

This function is the older version of IBI (interbeat interval) analysis. It has been replaced by `ibi_analysis`. This version remains available for compatibility, but we want to deprecate the function in future versions of the package.

This function analyzes IBI data, focusing on time and frequency domain measures. Note that the function imports functions from the RHRV package for HRV (Heart Rate Variability) analysis. Also note that measurements on the wrist are now more often referred to as PRV (Pulse Rate Variability), see for instance https://jphysiolanthropol.biomedcentral.com/articles/10.1186/s40101-020-00233-x.

Usage

```
ibi_analysis_old(IBI)
```

Arguments

`IBI`	IBI data, a dataframe with columns including DateTime and seconds since the start of the recording. This data can be read with read with `read_e4`

Details

The function performs several steps in analyzing IBI data: 1. Create an HRV data structure using RHRV. 2. Filter and preprocess the data, including handling of missing values and erroneous readings. 3. Perform time domain and frequency domain analyses. 4. Return a comprehensive list of results, including statistical summaries of the HRV measures.

Value

A list containing time analysis, frequency analysis (commented out in this version), and a summary of the results including time domain measures (SDNN, pNN50, etc.), frequency domain measures (HF, LF, LFHF, etc.), and the number of original and accepted beats.

Note

This function is deprecated and will be removed in future versions. Users should migrate to `ibi_analysis` for ongoing and future analyses.

See Also

`ibi_analysis` for the current version of IBI analysis.

Examples

```
## Not run:
zip_path <- system.file("extdata", "1635148245_A00204.zip", package = "wearables")
Assuming "IBI_data" is your interbeat interval data
result <- read_e4("path to your file")
print(result$IBI)

## End(Not run)
```

`join_eda_bin` *Join EDA Binary Classifier Output to Dataset*

Description

This function joins the output of an EDA binary classifier to a dataset based on rounded 5-second intervals. It is designed to merge two data frames: one containing your main data and another containing EDA binary classifier predictions. The function ensures that each record in the main data is matched with the appropriate classifier output by aligning timestamps to the nearest 5-second interval.

Usage

```
join_eda_bin(data, eda_bin)
```

Arguments

`data`	A data frame containing the main dataset with a 'DateTime' column that represents timestamps.
`eda_bin`	A data frame containing the EDA binary classifier outputs, including an 'id' column that represents timestamps. This data frame is expected to merge with the main data frame based on these timestamps.

Details

The function first uses 'padr::thicken' to extend the main data frame by creating a new column 'DateTime_5_sec', which rounds the 'DateTime' values to 5-second intervals. Then, it performs a left join with the EDA binary classifier data, which has been similarly adjusted using 'lubridate::floor_date' to match these intervals. After the join, unnecessary columns ('DateTime_5_sec' and 'id') are dropped, and the classifier's 'label' column is renamed to 'quality_flag'.

Value

A data frame that combines the main dataset with the EDA binary classifier outputs. The classifier's label is renamed to 'quality_flag'. In cases where a precise match for the 5-second interval is not found in the classifier output, NA values may be introduced in the 'quality_flag' column.

Examples

```
## Not run:
  main_data <- data.frame(DateTime = as.POSIXct(...), ...)
  classifier_data <- data.frame(id = as.POSIXct(...), label = ..., ...)
  joined_data <- join_eda_bin(main_data, classifier_data)

## End(Not run)
```

`max_per_n` *Max value per segment of length n*

Description

Give the maximum value of a vector of values per segment of length n.

Usage

```
max_per_n(values, n, output_length)
```

Arguments

`values`	array of numbers
`n`	length of each segment
`output_length`	argument to adjust for final segment not being full

`multiclass_classifier_config`
Configuration of the SVM algorithm for ternary classification

---

Description

Configuration of the SVM algorithm for ternary classification

Usage

```
multiclass_classifier_config
```

Format

An object of class `list` of length 4.

Author(s)

Sara Taylor <sataylor@mit.edu>

References

Taylor, S., Jaques, N., Chen, W., Fedor, S., Sano, A., & Picard, R. (2015). Automatic identification of artifacts in electrodermal activity data. In *Proceedings of the 37th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBS)*.

`pad_e4` *pad_e4*

Description

function to combine several e4 files, and sets the length of the x-axis

Usage

```
pad_e4(x)
```

Arguments

`x`	index of dataframe

`plot_artifacts` *Artifact plots*

Description

Plot artifacts after eda_data is classified

Usage

```
plot_artifacts(labels, eda_data)
```

Arguments

`labels`	labels with artifact classification
`eda_data`	data upon which the labels are plotted

`predict_binary_classifier` *Binary classifiers*

Description

Generate classifiers (artifact, no artifact)

Usage

```
predict_binary_classifier(data)
```

Arguments

`data`	features from EDA signal

`predict_multiclass_classifier` *Ternary classifiers*

Description

Generate classifiers (artifact, unclear, no artifact)

Usage

```
predict_multiclass_classifier(data)
```

Arguments

`data`	features from EDA signal

prepend_time_column *prepend_time_column*

Description

Column binds a time_column to the dataframe

Usage

```
prepend_time_column(data, timestart, hertz, tz = Sys.timezone())
```

Arguments

data	dataframe
timestart	the start of the recording
hertz	hertz in which the E4 data was recorded
tz	The timezone, defaults to user timezone

print.e4data *Show class of object*

Description

Returns 'object of class'

Usage

```
## S3 method for class 'e4data'
print(x, ...)
```

Arguments

x	An e4 data list
...	Further arguments currently ignored.

process_eda *Process EDA data*

Description

Process EDA data

Usage

```
process_eda(eda_data)
```

Arguments

eda_data	Data read with read_e4

rbind_e4 *Row-bind E4 datasets*

Description

This function takes a list of E4 datasets and row-binds them together.

Usage

```
rbind_e4(data)
```

Arguments

data	An object read in by ‘read_e4

rbind_embrace_plus *Row-bind Embrace Plus datasets*

Description

This function takes a list of Embrace Plus datasets and row-binds them together.

Usage

```
rbind_embrace_plus(data)
```

Arguments

data	An object read in by read_embrace_plus

rbind_nowatch *Row-bind NOWATCH datasets*

Description

This function takes a list of NOWATCH datasets and row-binds them together.

Usage

```
rbind_nowatch(data)
```

Arguments

data	An object read in by read_nowatch

read_and_process_e4 *Read, process and feature extraction of E4 data*

Description

Reads the raw ZIP file using ‘read_e4‘, performs analyses with ‘ibi_analysis‘ and ‘eda_analysis‘.

Usage

```
read_and_process_e4(zipfile, tz = Sys.timezone())

process_e4(data)

process_embrace_plus(data)
```

Arguments

zipfile	zip file with e4 data to be read
tz	timezone where data were recorded (default system timezone)
data	object from read_e4 function

Value

An object with processed data and analyses, object of class ’e4_analysis’.

read_and_process_embrace_plus *Read, process and feature extraction of Embrace Plus data*

Description

Reads the raw ZIP file using ‘read_embrace_plus‘, performs analyses with ‘eda_analysis‘.

Usage

```
read_and_process_embrace_plus(
  zipfile = NULL,
  folder = NULL,
  type = "raw",
  tz = Sys.timezone()
)
```

Arguments

zipfile	zip file with embrace plus data to be read
folder	A folder with the unzipped files. If this is provided, the zipfile is not used.
type	The type of data contained in the zip file. Either "raw" or "aggregated".
tz	timezone where data were recorded (default system timezone)

Value

An object with processed data and analyses, object of class ’embrace_plus_analysis’.

read_e4 *Read E4 data*

Description

Reads in E4 data as a list (with EDA, HR, Temp, ACC, BVP, IBI as dataframes), and prepends timecolumns

Usage

```
read_e4(zipfile = NULL, tz = Sys.timezone())
```

Arguments

zipfile	A zip file as exported by the instrument
tz	The timezone used by the instrument (defaults to user timezone).

Details

This function reads in a zipfile as exported by Empatica Connect. Then it extracts the zipfiles in a temporary folder and unzips the csv files in the temporary folder.

The EDA, HR, BVP, and TEMP csv files have a similar structure in which the starting time of the recording is read from the first row of the file (in unix time). The frequency of the measurements is read from the second row of the recording (in Hz). Subsequently, the raw data is read from row three onward.

The ACC csv file contain the acceleration of the Empatica E4 on the three axes x,y and z. The first row contains the starting time of the recording in unix time. The second row contains the frequency of the measurements in Hz. Subsequently, the raw x, y, and z data is read from row three onward.

The IBI file has a different structure, the starting time in unix is in the first row, first column. The firs column contins the number of seconds past since the start of the recording. The number of seconds past since the start of the recording represent a heartbeat as derived from the algorithms from the photo plethysmogrophy sensor. The second column contains the duration of the interval from one heartbeat to the next heartbeat.

ACC.csv = 32 Hz BVP.csv = 64 Hz EDA.csv = 4 HZ HR.csv = 1 HZ TEMP.csv = 4 Hz

Please also see the info.txt file provided in the zip file for additional information.

The function returns an object of class "e4_data" with a prepended datetime columns that defaults to user timezone. The object contains a list with dataframes from the physiological signals.

Examples

```
library(wearables)
# read_e4()
```

`read_embrace_plus` *Read Embrace Plus data*

Description

Reads in Embrace Plus data as a list (with EDA, HR, Temp, ACC, BVP, IBI as dataframes), and prepends timecolumns

Usage

```
read_embrace_plus(
  zipfile = NULL,
  folder = NULL,
  type = "raw",
  tz = Sys.timezone()
)
```

Arguments

zipfile	A zip file as exported by the instrument. Can be aggregated data, or raw data.
folder	A folder with the unzipped files. If this is provided, the zipfile is not used.
type	The type of data contained in the zip file or folder. Either "raw" or "aggregated".
tz	The timezone used by the instrument (defaults to user timezone).

Details

This function reads in a zipfile with data from the Embrace Plus device, or a folder with unzipped files. The unzipped files are avro or csv files.

The unzipped files are avro or csv files, where avro files are read in with using ‘sparklyr‘, which sets up a local Spark cluster.

The function returns an object of class "embrace_plus_data" with a prepended datetime columns. The object contains a list with dataframes from the physiological signals.

Examples

```
## Not run:
 library(wearables)
 read_embrace_plus(zipfile = "yourpathtohezipfile.zip")
 read_embrace_plus(folder = "/path/to/folder/with/files", type = "aggregated")

## End(Not run)
```

---

read_nowatch *Read Nowatch data*

Description

Reads in Nowatch data as a list, and prepends timecolumns

Usage

```
read_nowatch(zipfile = NULL, folder = NULL, tz = Sys.timezone())
```

Arguments

zipfile	A zip file as exported by the instrument. Only aggregated data supported.
folder	A folder with the unzipped files. If this is provided, the zipfile is not used.
tz	The timezone used by the instrument (defaults to user timezone).

Details

This function reads in a zipfile with files exported by the Nowatch instrument, or a folder with the unzipped files. The files are expected to be csv files.

The unzipped files are csv files.

The function returns an object of class "nowatchdata" with a prepended datetime columns. The object contains a list with dataframes from the physiological signals.

Examples

```
## Not run:
 library(wearables)
 read_nowatch("yourpathtohezipfile.zip")
 read_nowatch(folder = "/path/to/folder/with/files")

## End(Not run)
```

---

remove_small_peaks *Small peaks removal*

Description

Remove peaks with a small rise from start to apex are removed

Usage

```
remove_small_peaks(data, thres = 0)
```

Arguments

data	df with info on peaks
thres	threshold of amplitude difference in order to be removed (default 0 means no removals)

---

upsample_data_to_8Hz *Upsample EDA data to 8 Hz*

Description

Upsample EDA data to 8 Hz

Usage

```
upsample_data_to_8Hz(eda_data)
```

Arguments

eda_data	Data read with read_e4

`write_processed_e4` *Write CSV files of the output*

Description

Slow!

Usage

```
write_processed_e4(obj, out_path = ".")
```

Arguments

`obj`	e4 analysis object
`out_path`	output folder

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