

Package ‘RHRV’

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Type Package

Title Heart rate variability analysis of ECG data

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Description This is a package for developing heart rate variability studies of ECG records

License GPL-2

Depends tcltk(>= 2.4.1), tkrplot(>= 0.0-18)

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RHRV-package	<i>RHRV: An R-based software package for the heart rate variability analysis of ECG recordings</i>
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Description

RHRV offers functions for performing power spectral analysis of heart rate data. We will use this package for the study of several diseases, such as obstructive sleep apnoea or chronic obstructive pulmonary disease.

Details

Package:	RHRV
Type:	Package
Version:	2.5
Date:	2010-07-30
License:	GPL-2
LazyLoad:	yes

This is a package for developing heart rate variability studies of ECG records. Data are read from an ascii file containing a column with beat positions in seconds. A function is included in order to build this file from an ECG record in WFDB format (visit the site <http://www.physionet.org> for more information).

Note

An example including all the necessary steps to obtain and to analyze by episodes the power bands of a wfdb register is giving below:

```
##Reading a wfdb register and storing into a data structure:
md = CreateHRVData(Verbose = TRUE)
md = LoadBeatWFDB(md, RecordName = "register_name", RecordPath = "register_path")
##Loading information of episodes of apnea:
md = LoadApneaWFDB(md, RecordName = "register_name", RecordPath = "register_path", Tag = "APN")
##Generating new episodes before and after previous episodes of apnea:
md = GenerateEpisodes(md, NewBegFrom = "Beg", NewEndFrom = "Beg", DispBeg = -600, DispEnd = -120, OldTag = "APN", NewTag = "PREV_APN")
md = GenerateEpisodes(md, NewBegFrom = "End", NewEndFrom = "End", DispBeg = 120, DispEnd = 600, OldTag = "APN", NewTag = "POST_APN")
##Calculating heart rate signal:
md = BuildNIHR(md)
##Filtering heart rate signal:
md = FilterNIHR(md)
##Interpolating heart rate signal:
md = InterpolateNIHR(md)
##Calculating spectrogram and power per band:
md = CreateFreqAnalysis(md)
md = CalculatePowerBand(md, indexFreqAnalysis = 1, size = 120, shift = 10, sizesp = 1024)
##Plotting power per band, including episodes information:
PlotPowerBand(md, indexFreqAnalysis = 1, hr = TRUE, ymax = 2400000, ymaxratio = 3, Tag = "all")
##Splitting power per band using episodes before and after episodes of apnea:
PrevAPN = SplitPowerBandByEpisodes(md, indexFreqAnalysis = 1, Tag = "PREV_APN")
PostAPN = SplitPowerBandByEpisodes(md, indexFreqAnalysis = 1, Tag = "POST_APN")
##Performing Student's t-test:
result = t.test(PrevAPN$InEpisodes$ULF, PostAPN$InEpisodes$ULF)
print(result)
```

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

Maintainer: A. Mendez <mrarthur@uvigo.es>

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

AddEpisodes

Adds new episodes manually

Description

Adds information of episodes manually, or annotated physiological events, and stores it into the data structure containing the beat positions

Usage

```
AddEpisodes(HRVData, InitTimes, Tags, Durations, Values, verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
InitTimes	Vector containing init times in seconds
Tags	Vector containing types of episodes
Durations	Vector containing durations in seconds
Values	Vector containing numerical values for episodes
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns HRVData, the structure that contains beat positions register and new episodes information

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

AnalyzeHRbyEpisodes *Analyzes Heart Rate using episodes information*

Description

Analyzes Heart Rate allowing to evaluate the application of a desired function inside and outside episodes

Usage

```
AnalyzeHRbyEpisodes(HRVData, Tag = "", func, verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
Tag	Type of episode
func	Function to be applied to Heart Rate Data inside and outside episodes
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns a list with two objects, that is, the values of the application of the selected function inside and outside episodes

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

See Also

[SplitHRbyEpisodes](#) for splitting in two parts Heart Rate Data using an specific episode type

AvgIntegralCorrelation

Calculates the average of the Integral Correlations

Description

The Integral correlation is calculated for every vector of the m-dimensional space, and then the average of all these values is calculated

Usage

```
AvgIntegralCorrelation(HRVData, Data, m, tau, r)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
Data	Portion of HRVData to be analyzed
m	Value of the dimension of the expansion of data
tau	Delay of the expansion of data
r	Distance for calculating correlation

Value

Returns the value of the average of IntegralCorrelations

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573 (2008)

See Also

[IntegralCorrelation](#)

BuildNIHR	<i>Builds the instantaneous heart rate signal from a beat position array</i>
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Description

The instantaneous heart rate can be defined as the inverse of the time separation between two consecutive heart beats. Once the beats have been identified, and since the only valid values contributing to the heart rate signal are the corresponding to normal beats preceded by other normal beats, a further operation should be performed for the calculation of the instantaneous heart rate.

Usage

```
BuildNIHR(HRVData, verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns HRVData, the structure that contains beat positions register and now associated heart rate instantaneous values also

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573 (2008)

BuildTakensVector	<i>Calculates Takens expanded vectors</i>
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Description

In order to calculate de Fractal Dimension and Approximate Entropy (or others properties of the data) a representation of the data in a space m-dimensional is needed

Usage

```
BuildTakensVector(HRVData, Data, m, tau)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
Data	Portion of HRVData to be analyzed
m	Value of the dimension of the expansion of data
tau	Delay of the expansion of data

Value

Returns a matrix with the Expanded Data with $N-(m-1)*\tau$ rows (N is the length of the Data to be analyzed) and m columns

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573 (2008)

CalculateApEn	<i>Calculates Approximate Entropy</i>
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Description

Calculates Approximate Entropy as indicated by Pincus

Usage

```
CalculateApEn(HRVData, indexNonLinearAnalysis = -1, m = 2, tau = 1, r = 0.2, N = 1000, verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
indexNonLinearAnalysis	Reference to the data structure that will contain the non linear analysis
m	Value of the dimension of the expansion of data
tau	Delay of the expansion of data
r	Distance for calculating correlation
N	Number of points of the portion of signal to be analyzed
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns HRVData, the structure that contains beat positions register and now associated heart rate instantaneous values also, including the value of the Approximate Entropy

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573 (2008) S. M. Pincus, "Approximate entropy as a measure of system complexity," Mathematics 88, 2297-2301 (1991)

See Also

[BuildTakensVector](#) for expand data [IntegralCorrelation](#) for correlation calculations [AvgIntegralCorrelation](#) for averaging correlation calculations

CalculateFracDim	<i>Calculates Fractal Dimension</i>
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Description

Calculates Fractal Dimension as indicated by Pincus

Usage

```
CalculateFracDim(HRVData, indexNonLinearAnalysis = -1, m = 10, tau = 3, Cra = 0.005, Crb = 0.75, N = 1000)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
indexNonLinearAnalysis	Reference to the data structure that will contain the non linear analysis
m	Value of the dimension of the expansion of data
tau	Delay of the expansion of data
Cra	Minimum value of correlation for calculating Fractal Dimension
Crb	Maximum value of correlation for calculating Fractal Dimension
N	Number of points of the portion of signal to be analyzed
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns HRVData, the structure that contains beat positions register and now associated heart rate instantaneous values also, including the value of the Fractal Dimension

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573 (2008) S. M. Pincus, "Approximate entropy as a measure of system complexity," Mathematics 88, 2297-2301 (1991)

See Also

[CalculateRfromCorrelation](#) for finding r distance at which the correlation has a certain value

CalculatePowerBand *Calculates power per band*

Description

Calculates the spectrogram of the heart rate signal and the power of the spectrogram of the heart rate signal at the HF, LF, VLF bands

Usage

```
CalculatePowerBand(HRVData, indexFreqAnalysis = -1, size, shift, sizesp = 1024, scale = "linear", ULFmi
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
indexFreqAnalysis	Reference to the data structure that will contain the variability analysis
size	Size of window for calculating spectrogram (seconds)
shift	Displacement of window for calculating spectrogram (seconds)
sizesp	Seconds for calculating spectrogram (zero padding)
scale	Scale used to plot spectrogram, linear or logarithmic
ULFmin	Lower limit ULF band
ULFmax	Upper limit ULF band
VLFmin	Lower limit VLF band
VLFmax	Upper limit VLF band

LFmin	Lower limit LF band
LFmax	Upper limit LF band
HFmin	Lower limit HF band
HFmax	Upper limit HF band
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns HRVData, the structure that contains beat positions register, associated heart rate instantaneous values, filtered heart rate signal equally spaced, and the analysis structure including the power of the spectrogram at different bands of the heart rate signal

Note

An example including all the necessary steps to obtain the power bands of a wfdb register is giving below:

```
##Reading a wfdb register and storing into a data structure:
md = CreateHRVData(Verbose = TRUE)
md = LoadBeatWFDB(md, RecordName = "register_name", RecordPath = "register_path")
##Calculating heart rate signal:
md = BuildNIHR(md)
##Filtering heart rate signal:
md = FilterNIHR(md)
##Interpolating heart rate signal:
md = InterpolateNIHR(md)
##Calculating spectrogram and power per band:
md = CreateFreqAnalysis(md)
md = CalculatePowerBand(md, indexFreqAnalysis = 1, size = 120, shift = 10, sizesp = 1024)
```

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

See Also

[CalculateSpectrogram](#) for spectrogram calculation

CalculateRfromCorrelation

Calculates ra and rb from Correlation

Description

Calculates ra and rb distances that verify that their correlation values are Cra and Crb

Usage

```
CalculateRfromCorrelation(HRVData, Data, m, tau, Cra, Crb)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
Data	Portion of HRVData to be analyzed
m	Value of the dimension of the expansion of data
tau	Delay of the expansion of data
Cra	Minimum value of correlation for calculating Fractal Dimension
Crb	Maximum value of correlation for calculating Fractal Dimension

Value

Returns a 2 by 2 matrix containing ra and rb distance in the first row and their exact correlation values in the second row

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573 (2008) S. M. Pincus, "Approximate entropy as a measure of system complexity," Mathematics 88, 2297-2301 (1991)

See Also

[CalculateFracDim](#)

CalculateSpectrogram *Calculates the spectrogram of a signal*

Description

Calculates the spectrogram of the heart rate signal after filtering and interpolation in a window of a certain size

Usage

```
CalculateSpectrogram(HRVData, size, shift, sizesp = 1024, verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
size	Size of window for calculating spectrogram (seconds)
shift	Displacement of window for calculating spectrogram (seconds)
sizesp	Points for calculating spectrogram (zero padding)
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns the spectrogram of the heart rate signal

Note

An example including all the necessary steps to obtain the spectrogram of a wfdb register is giving below:

```
##Reading a wfdb register and storing into a data structure:
md = CreateHRVData(Verbose = TRUE)
md = LoadBeatWFDB(md, RecordName = "register_name", RecordPath = "register_path", verbose
= TRUE)
##Calculating heart rate signal:
md = BuildNIHR(md)
##Filtering heart rate signal:
md = FilterNIHR(md)
##Interpolating heart rate signal:
md = InterpolateNIHR(md)
##Calculating spectrogram:
CalculateSpectrogram(md, size = 120, shift = 10, sizesp = 1024)
```

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

CreateFreqAnalysis *Creates data analysis structure for frequency analysis calculations*

Description

Creates data analysis structure that stores the information extracted from a variability analysis of heart rate signal and joins it to HRVData as a member of a list

Usage

```
CreateFreqAnalysis(HRVData, verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns HRVData, the structure that contains beat positions register, associated heart rate instantaneous values, filtered heart rate signal equally spaced, and a new analysis structure as a member of a list

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

See Also

[CreateHRVData](#)

CreateHRVData	<i>Creates data structure for all the calculations</i>
---------------	--

Description

Creates data structure that stores the beats register and all the information obtained from it

Usage

```
CreateHRVData(Verbose = FALSE)
```

Arguments

Verbose	Boolean argument that allows to specify if the function returns additional information
---------	--

Value

Returns HRVData, the structure that will contain beat positions register, associated heart rate instantaneous values, filtered heart rate signal equally spaced, and one or more analysis structures

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

See Also

[CreateFreqAnalysis](#), [CreateTimeAnalysis](#), [CreateNonLinearAnalysis](#)

CreateNonLinearAnalysis	<i>Creates data analysis structure for non linear analysis calculations</i>
-------------------------	---

Description

Creates data analysis structure that stores the information extracted from a non linear analysis of ECG signal and joins it to HRVData as a member of a list

Usage

```
CreateNonLinearAnalysis(HRVData, verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns HRVData, the structure that contains beat positions register, associated heart rate instantaneous values, filtered heart rate signal equally spaced, and a new analysis structure as a member of a list

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

See Also

[CreateHRVData](#)

CreateTimeAnalysis	<i>Creates data analysis structure for time analysis calculations</i>
--------------------	---

Description

Creates data analysis structure that stores the information extracted from a time analysis of ECG signal and joins it to HRVData as a member of a list

Usage

```
CreateTimeAnalysis(HRVData, size = 300, numofbins = 20, interval = 7.8125, verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
size	Size of window (seconds)
numofbins	Number of bins in histogram
interval	Width of bins in histogram (milliseconds)
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns HRVData, the structure that contains beat positions register, associated heart rate instantaneous values, filtered heart rate signal equally spaced, and a new analysis structure as a member of a list

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

See Also

[CreateHRVData](#)

EditNIHR

Manually edition of non-interpolated instantaneous heart rate

Description

Plots non-interpolated instantaneous heart rate for manual removing of outliers

Usage

```
EditNIHR(HRVData, scale = 1, verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
scale	Allows scaling for small screens
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns Data, the structure that contains beat positions register, and manually edited associated heart rate instantaneous values

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

FilterNIHR

Artefact filter based in an adaptive threshold

Description

An algorithm that uses adaptive thresholds for rejecting those beats different from the given threshold more than a certain value. The rule for beat acceptance or rejection is to compare with previous, following and with the updated mean. We apply also a comparison with acceptable physiological values (default values 25 and 200 bpm).

Usage

```
FilterNIHR(HRVData, long=50, last=13, minbpm=25, maxbpm=200, mini=NULL, maxi=NULL, fixed=NULL, verbose)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
long	Number of beats to calculate the updated mean
last	Initial threshold
minbpm	Minimum physiologically acceptable value for HR
maxbpm	Maximum physiologically acceptable value for HR
mini	Deprecated argument maintained for compatibility
maxi	Deprecated argument maintained for compatibility
fixed	Deprecated argument maintained for compatibility
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns HRVData, the structure that contains beat positions register, associated heart rate instantaneous values also, and now filtered heart rate signal

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

X. Vila, F. Palacios, J. Presedo, M. Fernandez-Delgado, P. Felix, S. Barro, "Time-Frequency analysis of heart-rate variability," IEEE Eng. Med. Biol. Magazine 16, 119-125 (1997) L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573 (2008)

GenerateEpisodes	<i>Creates new episodes from old ones</i>
------------------	---

Description

Creates new episodes, or annotated physiological events, from existing ones and stores them into the data structure containing the beat positions

Usage

```
GenerateEpisodes(HRVData, NewBegFrom, NewEndFrom, DispBeg, DispEnd, OldTag = "", NewTag = "", verbose=N
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
NewBegFrom	Source of new beginning of episodes ("Beg" for indicating the beginning as the beginning of the old episode, "End" for end)
NewEndFrom	Source of new end of episodes ("Beg" for indicating the end as the beginning of the old episode, "End" for end)
DispBeg	Absolute displacement from the beginning for new episodes in seconds
DispEnd	Absolute displacement from the end for new episodes in seconds
OldTag	Tag of old episodes
NewTag	Tag for new episodes (if empty, copies OldTag)
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns HRVData, the structure that contains beat positions register and new episodes information

Note

```
##Example of arguments for creating episodes displaced one minute before old ones:
##NewBegFrom = "Beg", NewEndFrom = "End", DispBeg = -60, DispEnd = -60
##Example of arguments for creating episodes just after previous ones of 1 minute length:
##NewBegFrom = "End", NewEndFrom = "End", DispBeg = 0, DispEnd = 60
```

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

IntegralCorrelation *Calculates the Integral Correlation*

Description

The Integral correlation is calculated for every vector of the m-dimensional space

Usage

```
IntegralCorrelation(HRVData, Data, m, tau, r)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
Data	Portion of HRVData to be analyzed
m	Value of the dimension of the expansion of data
tau	Delay of the expansion of data
r	Distance for calculating correlation

Value

Returns the value of the average of IntegralCorrelations

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573 (2008)

See Also

[BuildTakensVector](#)

InterpolateNIHR *Spline interpolator for build the sample heart rate signal*

Description

An algorithm to obtain a heart rate signal with equally spaced values at a certain sampling frequency

Usage

```
InterpolateNIHR(HRVData, freqhr = 4, verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
freqhr	Sampling frequency
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns HRVData, the structure that contains beat positions register, associated heart rate instantaneous values also, and filtered heart rate signal equally spaced

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

LoadApneaWFDB *Loads apnea episodes for WFDB record*

Description

Loads the information of apnea episodes and stores it into the data structure containing the beat positions and other related information

Usage

```
LoadApneaWFDB(HRVData, RecordName, RecordPath = ".", Tag = "APNEA", verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
RecordName	The WFDB file to be used
RecordPath	The path of the WFDB file
Tag	to include APNEA episodes
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns HRVData, the structure that contains beat positions register and other related information and apnea episodes information

Note

On Windows and MacOSx operating systems is necessary to define a .Renviron file in the user workspace indicating the directory of the wfdbtools commands. Examples for both OS are given below:

```
## .Renviron on Windows
PATH = "c:\\cygwin\\bin"
DYLD_LIBRARY_PATH = "c:\\cygwin\\lib"

## .Renviron on MacOSx
PATH = "/opt/local/bin"
DYLD_LIBRARY_PATH = "/opt/local/bin"
```

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

LoadBeatAscii

Builds an array of beats positions from and ascii file

Description

Reads an ascii file with data of beat positions and stores the values in a data structure

Usage

```
LoadBeatAscii(HRVData, FileName, scale = 1, datetime = "1/1/1900 0:0:0", verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
FileName	The ascii file to be read
scale	1 if beat positions in seconds
datetime	Date and time (DD/MM/YYYY HH:MM:SS)
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns Data, the structure that contains beat positions register

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

LoadBeatWFDB

Imports data from a record in wfdb format

Description

Initially, the heart beats of the ECG recordings had to be identified and labelled. For this task, an automated function downloaded from the Physionet website and written in C language was used and incorporated to our R software package. Basically, this algorithm reads the annotation file for the ECG register, and stores the information obtained in a data structure.

Usage

```
LoadBeatWFDB(HRVData, RecordName, RecordPath = ".", annotator = "qrs", verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
RecordName	The ECG file to be used
RecordPath	The path of the ECG file
annotator	The type of annotation wished
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns Data, the structure that contains beat positions register

Note

On Windows and MacOSx operating systems is necessary to define a .Renviron file in the user workspace indicating the directory of the wfdtools commands. Examples for both OS are given below:

```
## .Renviron on Windows
PATH = "c:\\cygwin\\bin"
DYLD_LIBRARY_PATH = "c:\\cygwin\\lib"
```

```
## .Renviron on MacOSx
PATH = "/opt/local/bin"
DYLD_LIBRARY_PATH = "/opt/local/bin"
```

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

LoadEpisodesAscii *Loads episodes file*

Description

Loads the information of episodes, or annotated physiological events, and stores it into the data structure containing the beat positions

Usage

```
LoadEpisodesAscii(HRVData, FileName, Tag = "", InitTime = "0:0:0", verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
FileName	The episodes file to be used
Tag	Type of episode
InitTime	Time (HH:MM:SS)
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns HRVData, the structure that contains beat positions register and episodes information

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

 LoadHeaderWFDB

Imports header information from a record in wfdb format

Description

Reads the header file for the ECG register, and stores the information obtained in a data structure

Usage

```
LoadHeaderWFDB(HRVData, RecordName, RecordPath = ".", verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
RecordName	The ECG file to be used
RecordPath	The path of the ECG file
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns Data, the structure that contains beat positions register and data extracted from header file

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

PlotHR	<i>Simple plot of interpolated heart rate with configurable size and colour</i>
--------	---

Description

Plots in a simple way the interpolated instantaneous heart rate signal

Usage

```
PlotHR(HRVData, Tag = NULL, verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
Tag	Boolean argument that allows to specify if episodes, apnoea or oxygen desaturation, contained in Data are represented by means of red boxes
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

PlotNIHR	<i>Simple plot of non-interpolated heart rate with configurable size and colour</i>
----------	---

Description

Plots in a simple way the non-interpolated instantaneous heart rate signal

Usage

```
PlotNIHR(HRVData, Tag = NULL, verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
Tag	Boolean argument that allows to specify if episodes, as apnoea or oxygen desaturation, contained in Data are represented by means of red boxes
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

PlotPowerBand	<i>Plots power determined by CalculatePowerBand function</i>
---------------	--

Description

Plots the power of the heart rate signal at different bands of interest.

Usage

```
PlotPowerBand(HRVData, indexFreqAnalysis, normalized = FALSE, hr = FALSE, ymax = 160000, ymaxratio = 10,
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
indexFreqAnalysis	Reference to the data structure that will contain the variability analysis
normalized	Plots normalized powers if TRUE
hr	Plots heart rate signal if TRUE
ymax	Maximum value for y axis (unnormalized plots)
ymaxratio	Maximum value for y axis in LF/HF band (normalized and unnormalized plots)
ymaxnorm	Maximum value for y axis (normalized plots)
Tag	Argument that allows to specify if episodes contained in Data are represented by means of coloured boxes, for example apnoea or oxygen desaturation, "ALL" for all episodes
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Note

An example including all the necessary steps to obtain the power bands of a wfdb register is giving below:

```
##Reading a wfdb register and storing into a data structure:
md = CreateHRVData(Verbose = TRUE)
md = LoadBeatWFDB(md, RecordName = "register_name", RecordPath = "register_path")
##Calculating heart rate signal:
md = BuildNIHR(md)
##Filtering heart rate signal:
md = FilterNIHR(md)
##Interpolating heart rate signal:
md = InterpolateNIHR(md)
##Calculating spectrogram and power per band:
md = CreateFreqAnalysis(md)
md = CalculatePowerBand(md, indexFreqAnalysis = 1, size = 120, shift = 10, sizesp = 1024)
## Plotting Power per Band
PlotPowerBand(md, hr = TRUE, ymax = 700000, ymaxratio = 4)
```

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

See Also

[CalculatePowerBand](#) for power calculation

PlotSpectrogram

Calculates and Plots spectrogram

Description

Plots spectrogram of the heart rate signal as calculated by CalculateSpectrogram() function

Usage

```
PlotSpectrogram(HRVData, size, shift, sizesp = 1024, scale = "linear", verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
size	Size of window for calculating spectrogram (seconds)
shift	Displacement of window for calculating spectrogram (seconds)
sizesp	Seconds for calculating spectrogram (zero padding)
scale	Scale used to plot spectrogram, linear or logarithmic
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Note

An example including all the necessary steps to obtain the power bands of a wfdb register is giving below:

```
##Reading a wfdb register and storing into a data structure:
md = CreateHRVData(Verbose = TRUE)
md = LoadBeatWFDB(md, RecordName = "register_name", RecordPath = "register_path")
##Calculating heart rate signal:
md = BuildNIHR(md)
##Filtering heart rate signal:
md = FilterNIHR(md)
##Interpolating heart rate signal:
md = InterpolateNIHR(md)
##Calculating and Plotting Spectrogram
PlotSpectrogram(md, size = 120, shift = 10, sizesp = 1024)
```

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

See Also

[CalculateSpectrogram](#) for spectrogram calculation

ReadFromFile	<i>Reads data structure from file</i>
--------------	---------------------------------------

Description

Reads the data structure containing beat positions and all derived calculations from file

Usage

```
ReadFromFile(HRVData, name, verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
name	The name of the file to be used
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns the data structure

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

SetVerbose	<i>Sets verbose mode on or off</i>
------------	------------------------------------

Description

Sets verbose mode on or off, verbose is a boolean component of the data structure HRVData that allows to specify if all the functions return additional information

Usage

```
SetVerbose(HRVData, Verbose)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
Verbose	Boolean argument that allows to specify if the function returns additional information

Value

Returns HRVData, the structure that will contain beat positions register, associated heart rate instantaneous values, filtered heart rate signal equally spaced, and one or more analysis structures

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

SplitHRbyEpisodes

Splits Heart Rate Data using Episodes information

Description

Splits Heart Rate Data in two parts using an specific episode type: data inside episodes and data outside episodes

Usage

```
SplitHRbyEpisodes(HRVData, Tag = "", verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
Tag	Type of episode
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns a list with two vectors that is, the values of Heart Rate Data inside and outside episodes

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

See Also

[AnalyzeHRbyEpisodes](#) for processing Heart Rate Data using an specific episode type

SplitPowerBandByEpisodes

Splits Power Per Band using Episodes information

Description

Splits Power per Band in two lists using an specific episode type: data inside episodes and data outside episodes

Usage

```
SplitPowerBandByEpisodes(HRVData, indexFreqAnalysis, Tag = "", verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
indexFreqAnalysis	Reference to the data structure that will contain the variability analysis
Tag	Type of episode
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Value

Returns a list with two lists: InEpisodes and OutEpisodes, both lists include ULF, VLF, LF and HF bands

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

See Also

[CalculatePowerBand](#) for power calculation

WriteToFile	<i>Writes data structure to a file</i>
-------------	--

Description

Writes the data structure containing beat positions and all derived calculations to a file

Usage

```
WriteToFile(HRVData, name, overwrite = TRUE, verbose=NULL)
```

Arguments

HRVData	Data structure that stores the beats register and information related to it
name	The name of the file to be used
overwrite	Boolean argument for indicating what to do if the file already exists
verbose	Deprecated argument maintained for compatibility, use SetVerbose() instead

Author(s)

M. Lado, A. Mendez, D. Olivieri, L. Rodriguez, X. Vila

References

L. Rodriguez-Linares, X. Vila, A. Mendez, M. Lado, D. Olivieri, "RHRV: An R-based software package for heart rate variability analysis of ECG recordings," 3rd Iberian Conference in Systems and Information Technologies (CISTI 2008), Proceedings I, 565-573, ISBN: 978-84-612-4476-8 (2008)

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