Package 'LMD'

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Type Package

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Title A Self-Adaptive Approach for Demodulating Multi-Component Signal

Version 1.0.0

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Description Local Mean Decomposition is an iterative and self-adaptive approach for demodulating, processing, and analyzing multi-component amplitude modulated and frequency modulated signals. This R package is based on the approach suggested by Smith (2005) <doi:10.1098/rsif.2005.0058> and the 'Python' library 'PyLMD'.

License Apache License (>= 2)

Depends R (>= 3.6.0)

BugReports https://github.com/shubhra-opensource/LMD/issues

URL https://github.com/shubhra-opensource/LMD

Encoding UTF-8

RoxygenNote 7.2.1

Suggests knitr, rmarkdown, ggformula, testthat (>= 3.0.0)

Config/testthat/edition 3

VignetteBuilder knitr

Imports EMD, ggplot2, patchwork

NeedsCompilation no

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Repository CRAN

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Contents

`extract_product_function` *Extract Product Function*

Description

Method for extracting product functions

Usage

```
extract_product_function(
  signal,
  max_envelope_iteration = 200,
  envelope_epsilon = 0.01,
  convergence_epsilon = 0.01
)
```

Arguments

`signal`	Signal values (Numeric | vector)
`max_envelope_iteration`	Maximum number of iterations when separating local envelope signals (Integer)
`envelope_epsilon`	Terminate processing when obtaining pure FM signal (Double)
`convergence_epsilon`	Terminate processing when modulation signal converges (Double)

Value

Product Function

Author(s)

Shubhra Prakash, <shubhraprakash279@gmail.com>

References

https://pypi.org/project/PyLMD/

Examples

```
x=1:100
y = (2 / 3 )* sin(x * 30) + (2 / 3) * sin(x * 17.5) + (4 / 5) *cos(x * 2)
plot(y,type="l")
pf=extract_product_function(y)
```

`find_extrema` *Find Extreme Points*

Description

Method for finding Extreme Points

Usage

```
find_extrema(signal, include_endpoints = TRUE)
```

Arguments

`signal`	Signal values (Numeric | vector)
`include_endpoints`	whether to include end points or not (Boolean)

Details

A local extrema is the point at which a maximum or minimum value of the function in some open interval containing the point is obtained.

Value

Indexes of all extrema values (including starting and ending points)

Author(s)

Shubhra Prakash, <shubhraprakash279@gmail.com>

Examples

```
signal=c( 0.841471 ,0.9092974,0.14112,-0.7568025,-0.9589243)
find_extrema(signal)
```

`is_monotonous` *Monotonicity Check*

Description

Method for checking if signal is increasing or decreasing monotonously

Usage

```
is_monotonous(signal)
```

Arguments

`signal`	Signal values (Numeric | vector)

Details

A monotonic signal is a function that keeps increasing or decreasing as its domain variable proceeds.#'

Value

Boolean

Author(s)

Shubhra Prakash, <shubhraprakash279@gmail.com>

References

https://pypi.org/project/PyLMD/

Examples

```
x=1:100
is_monotonous(x)
```

`lmd` *Local Mean Decomposition*

Description

Method for finding Product Functions (PFs)

Usage

```
lmd(
  signal,
  include_endpoints = TRUE,
  max_smooth_iteration = 12,
  max_envelope_iteration = 200,
  envelope_epsilon = 0.01,
  convergence_epsilon = 0.01,
  max_num_pf = 8
)
```

Arguments

`signal`	Signal values (Numeric | vector)
`include_endpoints`	Whether to treat the endpoint of the signal as a pseudo-extreme point (Boolean)
`max_smooth_iteration`	Maximum number of iterations of moving average algorithm (Integer)
`max_envelope_iteration`	Maximum number of iterations when separating local envelope signals (Integer)
`envelope_epsilon`	Terminate processing when obtaining pure FM signal (Double)
`convergence_epsilon`	Terminate processing when modulation signal converges (Double)
`max_num_pf`	The maximum number of PFs generated(Integer)

Details

LMD is a method of decomposing signal into Product Functions (PFs) based on algorithm presented in Jonathan S. Smith. The local mean decomposition and its application to EEG perception data. Journal of the Royal Society Interface, 2005, 2(5):443-454

Value

list(pf,residue) | PFs:The decompose functions arranged from high frequency to low frequency | residue:residual component

Author(s)

Shubhra Prakash, <shubhraprakash279@gmail.com>

References

https://pypi.org/project/PyLMD/

Examples

```
x=1:100
y = (2 / 3 )* sin(x * 30) + (2 / 3) * sin(x * 17.5) + (4 / 5) *cos(x * 2)
plot(y,type="l")
lmd(y)
```

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local_mean_and_envelope

Local Mean and Envelope

Description

Method for finding Local Mean and Envelope

Usage

```
local_mean_and_envelope(signal, extrema)
```

Arguments

signal	Signal values (Numeric | vector)
extrema	indexes for extreme values

Value

mean, envelope and smoothed mean and envelope values

Author(s)

Shubhra Prakash, <shubhraprakash279@gmail.com>

References

https://pypi.org/project/PyLMD/

Examples

```
signal = sin(1:10)
extrema = c(1 , 2,  5,  8, 10)
local_mean_and_envelope(signal, extrema)
```

`moving_average_smooth` *Weighted Moving Average*

Description

Weighted Moving Average Smoothing

Usage

```
moving_average_smooth(signal, window, max_smooth_iteration = 12)
```

Arguments

`signal`	Signal values (Numeric | vector)
`window`	filter weights for smoothing (Numeric | vector)
`max_smooth_iteration`	Maximum number of iterations of moving average algorithm (Integer)

Details

Weighted Moving Average Smoothing is used to smooth en the mean and envelope signal

Value

smooth signal

Author(s)

Shubhra Prakash, <shubhraprakash279@gmail.com>

References

https://pypi.org/project/PyLMD/

Examples

```
x=0:100
y = (2 / 3 )* sin(x * 30) + (2 / 3) * sin(x * 17.5) + (4 / 5) *cos(x * 2)
plot(y,type="l")
wma=moving_average_smooth(y,5)
plot(wma,type="l")
```

plot_lmd *LMD Plot*

Description

Method for plotting Product Functions (PFs) and Residue

Usage

```
plot_lmd(
  lmd_obj,
  max_pf = length(lmd_obj[["pf"]]),
  show_residue = TRUE,
  pricolor_plot = "midnightblue",
  line_size_plot = 1
)
```

Arguments

lmd_obj	LMD object created from LMD function
max_pf	Number of PFs to Plot
show_residue	Whether to plot residue or not
pricolor_plot	color of plots
line_size_plot	Size of line in ggplot

Value

ggplot plot for Product Functions (PFs) and Residue

Author(s)

Shubhra Prakash, <shubhraprakash279@gmail.com>

Examples

```
x=1:100
y = (2 / 3 )* sin(x * 30) + (2 / 3) * sin(x * 17.5) + (4 / 5) *cos(x * 2)
plot_lmd(lmd(y))
```

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