

Package ‘LMD’

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Type Package

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

Version 1.2.1

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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](https://doi.org/10.1098/rsif.2005.0058)> and the 'Python' library 'PyLMD'.

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Depends R (>= 3.6.0)

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

URL <https://github.com/shubhra-opensource/LMD>,
<https://shubhra-opensource.github.io/LMD/>

Encoding UTF-8

RoxygenNote 7.3.3

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

Config/testthat/edition 3

VignetteBuilder knitr

Imports EMD, ggplot2, patchwork, shiny, utils

NeedsCompilation no

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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	<i>Find Extreme Points</i>
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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)
```

lmd_shiny

LMD Shiny

Description

Shiny Dashboard for plotting Product Functions (PFs) and Residue

Usage

lmd_shiny()

Author(s)

Shubhra Prakash, <shubhraprakash279@gmail.com>

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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