R documentation

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R topics documented:

`dcb_emd` *Empirical Mode Decomposition*

Description

This function performs empirical mode decomposition. It is the `emd` function in the EMD package with the S stoppage rule added.

Usage

```
emd(xt, tt=NULL, tol=sd(xt)*0.1^2, max.sift=20, stoprule="type1",
    boundary="periodic", smlevels=c(1), sm="none", spar=NA, weight=20,
    check=FALSE, max.imf=10, plot.imf=TRUE, interm=NULL, S=5)
```

Arguments

`xt`	observation or signal observed at time `tt`
`tt`	observation index or time index
`tol`	tolerance for stopping rule of sifting
`max.sift`	the maximum number of sifting
`stoprule`	stopping rule of sifting: "type1" (envelope mean <=tol), "type2" (standard deviation between two siftings <= tol), "type3" (S stoppage criterion)
`boundary`	specifies boundary condition from "none" "wave", "symmetric", "periodic" or "evenodd".
`smlevels`	specifies which level of the IMF is obtained by smoothing other than interpolation.
`sm`	specifies whether envelop is constructed by smoothing spline.
`spar`	specifies user-supplied smoothing parameter of spline.

weight	the smoothness of spline is determined by weight times smoothing parameter of GCV.
check	specifies whether the sifting process is displayed. If check=TRUE, click the plotting area to start the next step.
max.imf	the maximum number of IMF's
plot.imf	specifies whether each IMF is displayed. If plot.imf=TRUE, click the plotting area to start the next step.
interm	specifies vector of periods to be excluded from the IMF's.
S	The S stoppage criterion, for use with the "type3" stop rule

Details

This function performs empirical mode decomposition.

Value

imf	IMFs
residue	residue signal after extracting IMFs from observations xt
nimf	the number of IMFs

References

Huang, N. E., Shen, Z., Long, S. R., Wu, M. L. Shih, H. H., Zheng, Q., Yen, N. C., Tung, C. C. and Liu, H. H. (1998) The empirical mode decomposition and Hilbert spectrum for nonlinear and nonstationary time series analysis. *Proceedings of the Royal Society London A*, **454**, 903–995.

Huang, N. E. and Wu Z. A. (2008) A review on Hilbert-Huang Transform: Method and its applications to geophysical studies. *Reviews of Geophysics*, **46**, RG2006.

See Also

dcb_extractimf, eemd, plot_imfs

Examples

```
### Empirical Mode Decomposition
ndata <- 3000
tt2 <- seq(0, 9, length=ndata)
xt2 <- sin(pi * tt2) + sin(2* pi * tt2) + sin(6 * pi * tt2)  + 0.5 * tt2

par(mfrow=c(3,1), mar=c(2,1,2,1))
try <- emd(xt2, tt2, boundary="wave")

### Ploting the IMF's
par(mfrow=c(3,1), mar=c(2,1,2,1))
X11(); par(mfrow=c(try$nimf+1, 1), mar=c(2,1,2,1))
rangeimf <- range(try$imf)
for(i in 1:try$nimf) {
    plot(tt2, try$imf[,i], type="l", xlab="", ylab="", ylim=rangeimf,
    main=paste(i, "-th IMF", sep="")); abline(h=0)
}
plot(tt2, try$residue, xlab="", ylab="", main="residue", type="l",
axes=FALSE); box()
```

dcb_extractimf *Intrinsic Mode Function*

Description

This function extracts intrinsic mode function from a signal. Most of this code is from the "extractimf" function in the EMD package.

Usage

```
dcb_extractimf(residue, tt=NULL, tol=sd(residue)*0.1^2, max.sift=20,
    stoprule="type1", boundary="periodic", sm="none", spar=NA,
    S=5, weight=20, check=FALSE)
```

Arguments

residue	observation or signal observed at time tt
tt	observation index or time index
tol	tolerance for stopping rule of sifting
max.sift	the maximum number of sifting
stoprule	stopping rule of sifting: "type1" (envelope mean <=tol), "type2" (standard deviation between two siftings <= tol), "type3" (S stoppage criterion)
boundary	specifies boundary condition from "none", "wave", "symmetric", "periodic" or "evenodd".
sm	specifies whether envelop is constructed by smoothing spline.
spar	specifies user-supplied smoothing parameter of spline.
S	The S stoppage criterion, for use with the "type3" stop rule
weight	the smoothness of spline is determined by weight times smoothing parameter of GCV.
check	specifies whether the sifting process is displayed. If check=TRUE, click the plotting area to start the next step.

Details

This function extracts intrinsic mode functions from a signal.

Value

imf	imf
residue	residue signal after extracting the finest imf from residue
niter	the number of iteration to obtain the imf

Author(s)

Donghoh Kim <donghoh.kim@gmail.com>, Hee-Seok Oh, Daniel Bowman <daniel.bowman@unc.edu>

References

Huang, N. E., Shen, Z., Long, S. R., Wu, M. L. Shih, H. H., Zheng, Q., Yen, N. C., Tung, C. C. and Liu, H. H. (1998) The empirical mode decomposition and Hilbert spectrum for nonlinear and nonstationary time series analysis. *Proceedings of the Royal Society London A*, **454**, 903–995.

Huang, N. E. and Wu Z. A. (2008) A review on Hilbert-Huang Transform: Method and its applications to geophysical studies. *Reviews of Geophysics*, **46**, RG2006.

See Also

dcb_emd

Examples

```
### Generating a signal
ndata <- 3000
X11(); par(mfrow=c(1,1), mar=c(1,1,1,1))
tt2 <- seq(0, 9, length=ndata)
xt2 <- sin(pi * tt2) + sin(2* pi * tt2) + sin(6 * pi * tt2)  + 0.5 * tt2
plot(tt2, xt2, xlab="", ylab="", type="l", axes=FALSE); box()

### Extracting the first IMF by sifting process
tryimf <- dcb_extractimf(xt2, tt2, check=FALSE)
```

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eemd *Ensemble Empirical Mode Decomposition*

Description

This function performs ensemble empirical mode decomposition.

Usage

```
eemd(sig, dt, trials, nimf, noise_amp, emd_config, trials_dir=NULL)
```

Arguments

sig	a time series to be decomposed (vector)
dt	The sample rate of sig
trials	Number of times to run EMD
nimf	Number of IMFs to record, IMFs past this number will not be saved
noise_amp	Amplitude of white noise to use in denoising algorithm
emd_config	Configuration parameters for emd algorithm, consisting of fields:

- emd_config$max_sift - maximum number of IMF sifts, see dcb_extractimf
- emd_config$max_imf - maximum number of IMFs that can be returned, see dcb_extractimf
- emd_config$tol - Sifting stop criterion, see dcb_extractimf
- emd_config$stop_rule - EMD stop rules, see dcb_extractimf
- emd_config$boundary - How the start and stop of the time series are handled in the splining process, see dcb_extractimf

- emd_config$sm - spline smoothing, see dcb_extractimf
- emd_config$spar - smoothing parameter, see dcb_extractimf
- emd_config$weight - spline weight, see dcb_extractimf
- emd_config$S - S stoppage criterion, see dcb_extractimf

trials_dir Directory where EEMD trial files will be stored, defaults to "trials." This will create a directory if none exists.

Details

This function performs ensemble empirical mode decomposition, a noise assisted version of the EMD algorithm. The EEMD works by adding a certain amplitude of white noise to a time series, decomposing it via EMD, and saving the result. If this is done enough times, the averages of the noise perturbed IMFs will approach the "true" IMF set. The EEMD can ameliorate mode mixing and intermittancy problems (see references section).

This EEMD algorithm creates a directory trials_dir and saves each EMD trial into this directory. The number of trials is defined using trials. The trial files in this directory can then be processed using eemd_compile to produce the averaged IMF set, or to plot the Hilbert spectrogram of the data. Keep in mind that the EEMD is an expensive algorithm and may take significant time to run.

Value

emd_result The result of each individual EMD trial, saved to file in directory trials_dir

Author(s)

Daniel Bowman <daniel.bowman@unc.edu>

References

Wu, Z. A. and Huang, N. E. (2009) Ensemble empirical mode decomposition: A noise assisted data analysis method. *Advances in Adaptive Data Analysis*, **1**, 1-41.

See Also

sig2imf, dcb_emd, eemd_compile, plot_imfs.

Examples

```
data(port_foster_event)

emd_config=list()
emd_config$max_sift=200
emd_config$max_imf=100
emd_config$tol=0.2
emd_config$stop_rule="type3"
emd_config$boundary="wave"
emd_config$sm="none"
emd_config$spar=NA
emd_config$weight=20
emd_config$S=5

trials=10
nimf=10
```

```
noise_amp=6.4e-07
trials_dir="test"

#Run EEMD (this may take some time)
## Not run: eemd(sig, dt, trials, nimf, noise_amp, emd_config, trials_dir)

#Compile the results
## Not run: eemd_result=eemd_compile(trials_dir, trials, nimf)

#Plot the IMFs
time_span=c(5, 10)
imf_list=1:3
os=TRUE
res=TRUE
## Not run: plot_imfs(eemd_result, time_span, imf_list, os, res)
```

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