Package ‘vectorwavelet’

October 12, 2022

Type Package
Title Vector Wavelet Coherence for Multiple Time Series
Version 0.1.0
Date 2021-01-04
Author Tunc Oygur [aut, cre],
Gazanfer Unal [aut],
Tarik C. Gouhier [ctb],
Aslak Grinsted [ctb],
Viliam Simko [ctb]
Maintainer Tunc Oygur <info@tuncoygur.com.tr>
to handle dynamic co-movements of multivariate time series via extending multiple and quadruple wavelet coherence methodologies.
This package can be used to perform multiple wavelet coherence, quadruple wavelet coherence, and n-dimensional vector wavelet coherence analyses.
License GPL (>= 2)
URL https://github.com/toygur/vectorwavelet
BugReports https://github.com/toygur/vectorwavelet/issues
Depends biwavelet (>= 0.20.19)
Imports iterators, spam, maps, fields, foreach, Rcpp
Suggests knitr, rmarkdown, devtools
Encoding UTF-8
LazyData TRUE
RoxygenNote 7.1.1
NeedsCompilation no
Repository CRAN
Date/Publication 2021-01-13 10:50:02 UTC
R topics documented:

vectorwavelet-package .................................................. 2
ar1nv ................................................................. 3
mwc ................................................................. 3
n.check.data ....................................................... 6
n.check.datum ................................................... 7
plot.vectorwavelet ............................................... 7
qmwc ............................................................ 10
vwc .............................................................. 12

Index

vectorwavelet-package   Vector wavelet coherence for multiple time series

Description

Description: This package can be used to perform multiple wavelet coherence (mwc), quadruple wavelet coherence (qmwc), and n-dimensional vector wavelet coherence (vwc) analyses.

Author(s)

Tunc Oygur, Gazanfer Unal
Maintainer: Tunc Oygur <info@tuncoygur.com.tr>
Code based on biwavelet package written by Tarik C. Gouhier, Aslak Grinsted, Viliam Simko.

References

T. Oygur, G. Unal.. The large fluctuations of the stock return and financial crises evidence from Turkey: using wavelet coherency and VARMA modeling to forecast stock return. Fluctuation and Noise Letters, 2017
**ar1nv**

| ar1nv          | AR1NV - Estimate the parameters for an AR(1) model |

**Description**

AR1NV - Estimate the parameters for an AR(1) model

**Usage**

```
ar1nv(x)
```

**Arguments**

- `x` One dimensional time series vector

**Value**

Return a list containing:

- `g` estimate of the lag-one autocorrelation.
- `a` estimate of the noise variance.

**Author(s)**

Tunc Oygur (info@tuncoygur.com.tr)

Code based on a cross wavelet and wavelet coherence toolbox MATLAB package written by Eric Breitenberger

**References**


**mwc**

| mwc          | Compute multiple wavelet coherence |

**Description**

Compute multiple wavelet coherence
Usage

mwc(
  y,
  x1,
  x2,
  pad = TRUE,
  dj = 1/12,
  s0 = 2 * dt,
  J1 = NULL,
  max.scale = NULL,
  mother = "morlet",
  param = -1,
  lag1 = NULL,
  sig.level = 0.95,
  sig.test = 0,
  nrands = 300,
  quiet = FALSE
)

Arguments

y  
time series 1 in matrix format (m rows x 2 columns). The first column should contain the time steps and the second column should contain the values.

x1  
time series 2 in matrix format (m rows x 2 columns). The first column should contain the time steps and the second column should contain the values.

x2  
time series 3 in matrix format (m rows x 2 columns). The first column should contain the time steps and the second column should contain the values.

pad  
pad the values will with zeros to increase the speed of the transform. Default is TRUE.

dj  
spacing between successive scales. Default is 1/12.

s0  
smallest scale of the wavelet. Default is 2*dt.

J1  
number of scales - 1.

max.scale  
maximum scale. Computed automatically if left unspecified.

mother  
type of mother wavelet function to use. Can be set to morlet, dog, or paul. Default is morlet. Significance testing is only available for morlet wavelet.

param  
nondimensional parameter specific to the wavelet function.

lag1  
vector containing the AR(1) coefficient of each time series.

sig.level  
significance level. Default is 0.95.

sig.test  
type of significance test. If set to 0, use a regular $\chi^2$ test. If set to 1, then perform a time-average test. If set to 2, then do a scale-average test.

nrands  
number of Monte Carlo randomizations. Default is 300.

quiet  
Do not display progress bar. Default is FALSE.
Value

Return a `vectorwavelet` object containing:

- `coi` matrix containing cone of influence
- `rsq` matrix of wavelet coherence
- `phase` matrix of phases
- `period` vector of periods
- `scale` vector of scales
- `dt` length of a time step
- `t` vector of times
- `xaxis` vector of values used to plot xaxis
- `s0` smallest scale of the wavelet
- `dj` spacing between successive scales
- `mother` mother wavelet used
- `type` type of `vectorwavelet` object created (`mwc`)
- `signif` matrix containing significance percentiles of wavelet coherence based on the Monte Carlo AR(1) time series

Author(s)

Tunc Oygur (info@tuncoygur.com.tr)

Code based on MWC MATLAB package written by Eric K. W. Ng and Johnny C. L. Chan.

References


Ng, Eric KW and Chan, Johnny CL. 2012. Geophysical applications of partial wavelet coherence and multiple wavelet coherence. *Journal of Atmospheric and Oceanic Technology* 29-12:1845–1853.

Examples

```r
old.par <- par(no.readonly=TRUE)

t <- (-100:100)

y <- sin(t*2*pi)+sin(t*2*pi/4)+sin(t*2*pi/8)+sin(t*2*pi/16)+sin(t*2*pi/32)+sin(t*2*pi/64)
x1 <- sin(t*2*pi/8)
x2 <- sin(t*2*pi/32)
y <- cbind(t,y)
```
n.check.data

Description

Check the format of multivariate time series

Usage

n.check.data(y, x = NULL)

Arguments

y  
  time series y in matrix format (m rows x 2 columns). The first column should contain the time steps and the second column should contain the values.

x  
  multivariate time series x in matrix format (m rows x (1 + (n-1)) columns). The first column should contain the time steps and the other columns should contain the values.

Value

Returns a named list containing:

t  time steps

dt  size of a time step

n.obs  number of observations

Author(s)

Tunc Oygur (info@tuncoygur.com.tr)

Code based on biwavelet package written by Tarik C. Gouhier.
Examples

#Example 1:
t1 <- cbind(1:100, rnorm(100))
n.check.data(y = t1)

#Example 2:
t1 <- cbind(1:100, rnorm(100))
t2 <- cbind(1:100, rnorm(100), rnorm(100), rnorm(100))
n.check.data(y = t1, x = t2)

n.check.datum

Helper function

Description

Helper function

Usage

n.check.datum(x)

Arguments

x  matrix

Value

list(t, dt, n.obs)

Note

This function is not exported

plot.vectorwavelet

Plot vectorwavelet objects

Description

Plot vectorwavelet objects which are multiple wavelet coherence, quadruple wavelet coherence and n-dimensional vector wavelet coherence.
Usage

```r
## S3 method for class 'vectorwavelet'
plot(
  x,
  ncol = 1024,
  fill.cols = NULL,
  xlab = "Time",
  ylab = "Period",
  tol = 1,
  plot.cb = FALSE,
  plot.coi = TRUE,
  lwd.coi = 1,
  col.coi = "white",
  lty.coi = 1,
  alpha.coi = 0.5,
  plot.sig = TRUE,
  lwd.sig = 4,
  col.sig = "black",
  lty.sig = 1,
  bw = FALSE,
  legend.loc = NULL,
  legend.horiz = FALSE,
  arrow.len = min(par()$pin[2]/30, par()$pin[1]/40),
  arrow.lwd = arrow.len * 0.3,
  arrow.cutoff = 0.7,
  arrow.col = "black",
  xlim = NULL,
  ylim = NULL,
  zlim = c(0, 1),
  xaxt = "s",
  yaxt = "s",
  form = "%Y",
  ...
)
```

Arguments

- `x` : vectorwavelet object generated by `mwc`, `qmec`, or `vwc`.
- `ncol` : number of colors to use. Default is 1024.
- `fill.cols` : Vector of fill colors to be used. Users can specify color vectors using `colorRampPalette` or `brewer.pal` from package `RColorBrewer`. Default is NULL and will generate MATLAB's jet color palette.
- `xlab` : xlabel of the figure. Default is "Time"
- `ylab` : ylabel of the figure. Default is "Period"
- `tol` : tolerance level for significance contours. Significance contours will be drawn around all regions of the spectrum where `spectrum/percentile` >= `tol`. De-
fault is 1. If strict $i^{th}$ percentile regions are desired, then $tol$ must be set to 1.

plot.cb  plot color bar if TRUE. Default is FALSE.
plot.coi plot cone of influence (COI) as a semi-transparent polygon if TRUE. Default is TRUE. Areas that fall within the polygon can be affected by edge effects.
lwd.coi Line width of COI. Default is 1.
col.coi Color of COI. Default is white.
lty.coi Line type of COI. Default is 1 for solid lines.
alpha.coi Transparency of COI. Range is 0 (full transparency) to 1 (no transparency). Default is 0.5.

plot.sig plot contours for significance if TRUE. Default is TRUE.
lwd.sig Line width of significance contours. Default is 4.
col.sig Color of significance contours. Default is black.
lty.sig Line type of significance contours. Default is 1.
bw plot in black and white if TRUE. Default is FALSE.
legend.loc legend location coordinates as defined by image.plot. Default is NULL.
legend.horiz plot a horizontal legend if TRUE. Default is FALSE.
arrow.len size of the arrows. Default is based on plotting region (min(par)$pin[2]/30,par)$pin[1]/40).
arow.lwd width/thickness of arrows. Default is arrow.len*0.3.
arow.cutoff cutoff value for plotting phase arrows. Phase arrows will be plotted in regions where the significance of the zvalues exceeds arrow.cutoff. If the object being plotted does not have a significance field, regions whose zvalues exceed the arrow.cutoff quantile will be plotted. Default is 0.7.
arow.col Color of arrows. Default is black.
xlim the x limits. The default is NULL.
ylim the y limits. The default is NULL.
zlim the z limits. The default is NULL.
xaxt Add x-axis? The default is s; use n for none.
yaxt Add y-axis? The default is s; use n for none.
form format to use to display dates on the x-axis. Default is '%Y' for 4-digit year. See ?date for other valid formats.
... other parameters.

Value

No return value, shows the objects plot.

Author(s)

Tunc Oygur (info@tuncoygur.com.tr)

Code based on biwavelet package written by Tarik C. Gouhier.
qmwc

Compute quadruple wavelet coherence

Description

Compute quadruple wavelet coherence

Usage

qmwc(
  y, 
  x1, 
  x2, 
  x3, 
  pad = TRUE, 
  dj = 1/12, 
  s0 = 2 * dt, 
  J1 = NULL, 
  max.scale = NULL, 
  mother = "morlet", 
  param = -1, 
  lag1 = NULL, 
  sig.level = 0.95, 
  sig.test = 0, 
  nrands = 300, 
  quiet = FALSE
)

Arguments

y  time series 1 in matrix format (m rows x 2 columns). The first column should contain the time steps and the second column should contain the values.

x1  time series 2 in matrix format (m rows x 2 columns). The first column should contain the time steps and the second column should contain the values.

x2  time series 3 in matrix format (m rows x 2 columns). The first column should contain the time steps and the second column should contain the values.

x3  time series 4 in matrix format (m rows x 2 columns). The first column should contain the time steps and the second column should contain the values.

pad  pad the values will with zeros to increase the speed of the transform. Default is TRUE.

dj  spacing between successive scales. Default is 1/12.

s0  smallest scale of the wavelet. Default is 2*dt.

J1  number of scales - 1.

max.scale  maximum scale. Computed automatically if left unspecified.
mother

type of mother wavelet function to use. Can be set to morlet, dog, or paul. Default is morlet. Significance testing is only available for morlet wavelet.

param

nondimensional parameter specific to the wavelet function.

lag1

vector containing the AR(1) coefficient of each time series.

sig.level

significance level. Default is 0.95.

sig.test

type of significance test. If set to 0, use a regular $\chi^2$ test. If set to 1, then perform a time-average test. If set to 2, then do a scale-average test.

nrands

number of Monte Carlo randomizations. Default is 300.

quiet

Do not display progress bar. Default is FALSE

**Value**

Return a vectorwavelet object containing:

- coi: matrix containing cone of influence
- rsq: matrix of wavelet coherence
- phase: matrix of phases
- period: vector of periods
- scale: vector of scales
- dt: length of a time step
- t: vector of times
- xaxis: vector of values used to plot xaxis
- s0: smallest scale of the wavelet
- dj: spacing between successive scales
- mother: mother wavelet used
- type: type of vectorwavelet object created (qmwc)
- signif: matrix containing sig.level percentiles of wavelet coherence based on the Monte Carlo AR(1) time series

**Author(s)**

Tunc Oygur (info@tuncoygur.com.tr)

**References**


Examples

```r
old.par <- par(no.readonly=TRUE)

t <- (-100:100)

y <- sin(t*2*pi)+sin(t*2*pi/4)+sin(t*2*pi/8)+sin(t*2*pi/16)+sin(t*2*pi/32)+sin(t*2*pi/64)
x1 <- sin(t*2*pi/16)
x2 <- sin(t*2*pi/32)
x3 <- sin(t*2*pi/64)

y <- cbind(t,y)
x1 <- cbind(t,x1)
x2 <- cbind(t,x2)
x3 <- cbind(t,x3)

## Quadruple wavelet coherence
result <- qmwc(y, x1, x2, x3, nrands = 10)

result <- qmwc(y, x1, x2, x3)
```

```r
## Plot wavelet coherence and make room to the right for the color bar
## Note: plot function can be used instead of plot.vectorwavelet
par(oma = c(0, 0, 0, 1), mar = c(5, 4, 4, 5) + 0.1, pin = c(3,3))
plot.vectorwavelet(result, plot.cb = TRUE, main = "Plot quadruple wavelet coherence")

par(old.par)
```

---

**vwc**

*Compute n-dimensional vector wavelet coherence*

**Description**

Compute n-dimensional vector wavelet coherence

**Usage**

```r
vwc(
  y,
  x,
  pad = TRUE,
  dj = 1/12,
  s0 = 2 * dt,
  J1 = NULL,
  max.scale = NULL,
  mother = "morlet",
  param = -1,
  lag1 = NULL,
```
Arguments

- **y**: time series y in matrix format (m rows x 2 columns). The first column should contain the time steps and the second column should contain the values.
- **x**: multivariate time series x in matrix format (m rows x n columns). The first column should contain the time steps and the other columns should contain the values.
- **pad**: pad the values will with zeros to increase the speed of the transform. Default is TRUE.
- **dj**: spacing between successive scales. Default is 1/12.
- **s0**: smallest scale of the wavelet. Default is 2*dt.
- **J1**: number of scales - 1.
- **max.scale**: maximum scale. Computed automatically if left unspecified.
- **mother**: type of mother wavelet function to use. Can be set to morlet, dog, or paul. Default is morlet. Significance testing is only available for morlet wavelet.
- **param**: nondimensional parameter specific to the wavelet function.
- **lag1**: vector containing the AR(1) coefficient of each time series.
- **sig.level**: significance level. Default is 0.95.
- **sig.test**: type of significance test. If set to 0, use a regular \( \chi^2 \) test. If set to 1, then perform a time-average test. If set to 2, then do a scale-average test.
- **nrands**: number of Monte Carlo randomizations. Default is 300.
- **quiet**: Do not display progress bar. Default is FALSE

Value

Return a vector wavelet object containing:

- **coi**: matrix containing cone of influence
- **rsq**: matrix of wavelet coherence
- **phase**: matrix of phases
- **period**: vector of periods
- **scale**: vector of scales
- **dt**: length of a time step
- **t**: vector of times
- **xaxis**: vector of values used to plot xaxis
- **s0**: smallest scale of the wavelet
dj spacing between successive scales
mother mother wavelet used
type type of vectorwavelet object created (vwc)
signif matrix containing sig.level percentiles of wavelet coherence based on the Monte Carlo AR(1) time series

Author(s)
Tunc Oygur (info@tuncoygur.com.tr)

References

Examples

do { par <- par(no.readonly=TRUE)
}
t <- (-100:100)
y <- sin(t*2*pi)+sin(t*2*pi/4)+sin(t*2*pi/8)+sin(t*2*pi/16)+sin(t*2*pi/32)+sin(t*2*pi/64)
x1 <- sin(t*2*pi/8)
x2 <- sin(t*2*pi/16)
x3 <- sin(t*2*pi/32)
x4 <- sin(t*2*pi/64)
y <- cbind(t,y)
x <- cbind(t,x1,x2,x3,x4)

# n-dimensional multiple wavelet coherence
result <- vwc(y, x, nrands = 10)
result <- vwc(y, x)

# Plot wavelet coherence and make room to the right for the color bar
# Note: plot function can be used instead of plot.vectorwavelet
par oma = c(0, 0, 0, 1), mar = c(5, 4, 4, 5) + 0.1, pin = c(3,3))
plot.vectorwavelet(result, plot.cb = TRUE, main = "Plot n-dimensional vwc (n=5)"
}
par(old.par)
Index

* coherence
  mwc, 3
  qmwc, 10
  vectorwavelet-package, 2
  vwc, 12
* continuous
  mwc, 3
  qmwc, 10
  vectorwavelet-package, 2
  vwc, 12
* multiple
  mwc, 3
  vectorwavelet-package, 2
* n-dimensional
  vwc, 12
* quadruple
  qmwc, 10
  vectorwavelet-package, 2
* transform
  mwc, 3
  qmwc, 10
  vectorwavelet-package, 2
  vwc, 12
* vector
  vectorwavelet-package, 2
* wavelet
  mwc, 3
  qmwc, 10
  vectorwavelet-package, 2
  vwc, 12

ar1nv, 3
mwc, 3
n.check.data, 6
n.check.datum, 7
plot.vectorwavelet, 7
qmwc, 10