Package 'zyp'

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Title Zhang + Yue-Pilon Trends Package

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Depends R (>= 2.4.0), Kendall

Suggests

Description Contains an efficient implementation of Sen's slope method (Sen, 1968) plus implementation of Xuebin Zhang's (Zhang, 1999) and Yue-Pilon's (Yue, 2002) prewhitening approaches to determining trends in climate data.

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R topics documented:

confint.zyp *confint.zyp*

Description

Computes a confidence interval on a result from zyp.sen.

Usage

```
## S3 method for class 'zyp'
confint(object, parm, level = 0.95, ...)
```

Arguments

object	an object of class zyp, returned by zyp.sen.
parm	unused; for compatibility with confint.
level	the confidence level to compute a confidence interval at.
...	additional unused arguments.

Details

This routine computes a confidence interval on the slope and intercept of the result returned by zyp.sen. The confidence interval on the slope is calculated using the method defined in (Sen, 1968).

The confidence interval on the intercept is computed by taking the standard deviation of the intercepts (sd.i), the z statistic for the given confidence level (z), and the mean (m). The confidence level is then:

`c(m - z * sd.i, m + z * sd.i)`

Value

A matrix containing the upper and lower bounds of the intersect and slope, respectively.

See Also

zyp.trend.vector, zyp-package.

Examples

```
x <- c(0, 1, 2, 4, 5)
y <- c(6, 4, 1, 8, 7)
slope <- zyp.sen(y~x)
ci <- confint.zyp(slope)
```

zyp *ZYP Prewhitened Nonlinear Trend Analysis Package*

Description

This function includes two approaches to analyze for trend, the Zhang method and Yue and Pilon method. These differ in their approach to pre-whitening to removing lag-1 autocorrelation. The magnitude of the trend is computed using the Theil-Sen approach (TSA).

In the Zhang method, trend is removed from the series if it is significant and the autocorrelation is computed. This process is continued until the dfferences in the estimates of the slope and the AR(1) in two consecutive iterations are smaller than 1 percent. The Mann-Kendall test for trend is then run on the resulting time series and TSA is used to compute the slope of the trend.

In the Yue and Pilon method, the slopes is estimated with the TSA, if almost equal to zero, then its is not necessary to conduct the trend analysis. If it differs from zero, then it is assumed to be linear and the data is detrended by the slope and the AR(1) is computed for the detrended series. This is referred to as the Trend Free Pre-whitening (TFPW) procedure. The residuals should be an independent series. The trend and residuals are then blended together. The Mann-Kendall test is the applied to the blended series to assess the significance of the trend.

One variance of this package, at least from the Yue and Pilon method, is that by default the values used to compute significance are reinflated by dividing by (1 - AR(1)). Empirically this provides better results. However, if you do not desire this behaviour, it can be controlled using the parameter 'preserve.range.for.sig.test'; setting this to 'FALSE' should give results which follow the Yue and Pilon paper exactly.

References

Wang, X.L. and Swail, V.R., 2001. Changes in extreme wave heights in northern hemisphere oceans and related atmospheric circulation regimes. Journal of Climate, 14: 2204-2221.

Yue, S., P. Pilon, B. Phinney and G. Cavadias, 2002. The influence of autocorrelation on the ability to detect trend in hydrological series. Hydrological Processes, 16: 1807-1829.

Zhang, X., Vincent, L.A., Hogg, W.D. and Niitsoo, A., 2000. Temperature and Precipitation Trends in Canada during the 20th Century. Atmosphere-Ocean 38(3): 395-429.

Sen, P.K., 1968. Estimates of the Regression Coefficient Based on Kendall's Tau. Journal of the American Statistical Association Vol. 63, No. 324: 1379-1389.

See Also

`zyp.trend.csv`, `zyp.trend.vector`.

zyp.sen *zyp.sen*

Description

Computes a Thiel-Sen estimate of slope for a vector of data.

Usage

```
zyp.sen(formula, dataframe)
```

Arguments

formula	a formula of the form y~x.
dataframe	an optional data frame to use with the formula.

Details

This routine computes Sen's estimate of slope for a vector of data.

The formula specified is of the form y~x, where y is the data and x is the accompanying dates of observation.

If a data frame is specified, the formula selects columns within that data frame; otherwise, the formula uses the specified variables.

Value

A vector containing the coefficients and associated data.

coefficients	the estimated intercept and slope.
slopes	the list of slopes (used for confidence intervals).
intercepts	the list of intercepts (used for confidence intervals.
rank	the rank of the relation (2).
residuals	the residuals of the fitted slope.
x	the original x axis data.
y	the original y axis data.

See Also

zyp.trend.vector, zyp-package, confint.zyp.

Examples

```
x <- c(0, 1, 2, 4, 5)
y <- c(6, 4, 1, 8, 7)
slope <- zyp.sen(y~x)
```

zyp.trend.csv *zyp.trend.csv*

Description

Computes prewhitened nonlinear trends on CSV files or data frames with 0 to n columns of metadata, with 1 row per location and each column containing data for a particular time (day, month, year). The zyp package allows you to use either Zhang's method, or the Yue Pilon method of computing nonlinear prewhitened trends.

Usage

```
zyp.trend.dataframe(indat, metadata.cols, method=c("yuepilon", "zhang"),
                    conf.intervals=TRUE, preserve.range.for.sig.test=TRUE)
zyp.trend.csv(filename, output.filename, metadata.cols,
              method=c("yuepilon", "zhang"), conf.intervals=TRUE,
              csv.header=TRUE, preserve.range.for.sig.test=TRUE)
```

Arguments

`indat`	the input data frame.
`filename`	the filename of the input CSV file.
`output.filename`	the filename to write output to.
`metadata.cols`	the number of columns of metadata.
`method`	the prewhitened trend method to use.
`conf.intervals`	whether to compute a 95 percent confidence interval based on all possible slopes.
`preserve.range.for.sig.test`	whether to re-inflate values by dividing by (1 - ac) following removal of autocorrelation prior to computation of significance.
`csv.header`	whether the input CSV file has a header.

Details

These routines compute prewhitened nonlinear trends on either CSV files with or without a header or data frames with 0 to n columns of metadata (which is preserved in the output). Each row is expected to contain metadata followed by a timeseries, and all rows are expected to have the same length of timeseries. NA values are handled correctly, so if you have several timeseries of unequal length you can pad them with NA values to provide valid input.

The prewhitened trend computation methods used are either Zhang's method (described in Wang and Swail, 2001) or Yue and Pilon's method (described in Yue and Pilon, 2002).

Value

A data frame containing the trends, in the case of zyp.trend.dataframe. Columns of the output are as follows.

lbound	the lower bound of the trend's confidence interval.
trend	the Sen's slope (trend) per unit time.
trendp	the Sen's slope (trend) over the time period.
ubound	the upper bound of the trend's confidence interval.
tau	Kendall's tau statistic computed on the final detrended timeseries.
sig	Kendall's P-value computed for the final detrended timeseries.
nruns	the number of runs required to converge upon a trend.
autocor	the autocorrelation of the final detrended timeseries.
valid_frac	the fraction of the data which is valid (not NA) once autocorrelation is removed.
linear	the least squares fit trend on the same dat.
intercept	the intercept of the Sen's slope (trend).

See Also

zyp.trend.vector, zyp-package.

Examples

```
#zyp.trend.csv("in.csv", "out.csv", 2, "yuepilon", F)
#trends <- zyp.trend.dataframe(indat, 2, "yuepilon")
```

---

zyp.trend.vector *zyp.trend.vector*

Description

Computes a prewhitened linear trend on a vector of data. The zyp package allows you to use either Zhang's method, or the Yue Pilon method of computing nonlinear prewhitened trends.

Usage

```
zyp.trend.vector(y, x=1:length(y), method=c("yuepilon", "zhang"),
conf.intervals=TRUE, preserve.range.for.sig.test=TRUE)
zyp.zhang(y, x=1:length(y), conf.intervals=TRUE, preserve.range.for.sig.test=TRUE)
zyp.yuepilon(y, x=1:length(y), conf.intervals=TRUE, preserve.range.for.sig.test=TRUE)
```

Arguments

y	vector of input data.
x	vector of time data (optional).
method	the prewhitened trend method to use.
conf.intervals	whether to compute a 95 percent confidence interval based on all possible slopes.
preserve.range.for.sig.test	whether to re-inflate values by dividing by (1 - ac) following removal of autocorrelation prior to computation of significance.

Details

This routine computes a prewhitened nonlinear trend on a vector of data, using either Zhang's (described in Wang and Swail, 2001) or Yue Pilon's (describe in Yue Pilon, 2002) method of prewhitening and Sen's slope, and use a Kendall test for significance.

Value

A vector containing the trend and associated data.

lbound	the lower bound of the trend's confidence interval.
trend	the Sen's slope (trend) per unit time.
trendp	the Sen's slope (trend) over the time period.
ubound	the upper bound of the trend's confidence interval.
tau	Kendall's tau statistic computed on the final detrended timeseries.
sig	Kendall's P-value computed for the final detrended timeseries.
nruns	the number of runs required to converge upon a trend.
autocor	the autocorrelation of the final detrended timeseries.
valid_frac	the fraction of the data which is valid (not NA) once autocorrelation is removed.
linear	the least squares fit trend on the same dat.
intercept	the intercept of the Sen's slope (trend).

See Also

zyp.trend.csv, zyp-package, confint.zyp, zyp.sen.

Examples

```
# Without confidence intervals, using the wrapper routine
d <- zyp.trend.vector(c(0, 1, 3, 4, 2, 5), method="yuepilon", conf.intervals=FALSE)

# With confidence intervals, using the wrapper routine
d <- zyp.trend.vector(c(0, 1, 3, 4, 2, 5), method="yuepilon")

# With confidence intervals, not using the wrapper routine
d.zhang <- zyp.zhang(c(0, 1, 3, 4, 2, 5))
d.yuepilon <- zyp.yuepilon(c(0, 1, 3, 4, 2, 5))
```

```
# With confidence intervals, with time data.
t.dat <- c(0, 0.3, 1, 3, 3.4, 6)
d <- zyp.trend.vector(c(0, 1, 3, 4, 2, 5), t.dat, method="yuepilon")
d.zhang <- zyp.zhang(c(0, 1, 3, 4, 2, 5), t.dat)
d.yuepilon <- zyp.yuepilon(c(0, 1, 3, 4, 2, 5), t.dat)
```

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