Package ‘pear’

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Title Package for Periodic Autoregression Analysis

Author A. I. McLeod <aim@uwo.ca> and Mehmet Balcilar <mehmet@mbalcilar.net>.

Maintainer Mehmet Balcilar <mehmet@mbalcilar.net>

Depends R (>= 2.0.0)

Description Package for estimating periodic autoregressive models. Package also includes methods for plotting periodic time series data.

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R topics documented:

`fraser` *Fraser River at Hope, mean monthly flow (cms), 1912.3-1991.12*

Description

Mean monthly flow data.

Usage

```
data(fraser)
```

Format

A ts object containing monthly data for 1912.3-1991.12

Source

Environment Canada CDROM

`ozone` *Ozone concentration, downtown L.A., 1955.1-1972.12*

Description

Ozone concentration, downtown L.A., 1955.1-1972.12 in parts per hundred million

Usage

```
data(ozone)
```

Format

A ts object containing monthly data for 1955.1-1972.12.

peacf *Periodic Autocorrelation Function*

Description

The periodic autocorrelation for a time series with period p may be defined as for period (m=1,. . . ,p) and lag, l=1,2,. . . by r(m, l) = c(m, l)/sqrt(c(m, 0)*c(m-l, 0)) where c(m, l) is the periodic autocovariance defined by c(m, l) = sum(z[t] * z[t-l]) where the sum is over all data in period m. When p=1, peacf produces output which is equivalent to that produced by Splus function acf.

Usage

```
peacf(z, lag.max, plot=TRUE)
```

Arguments

`z` a univariate time series object. Note that the period of z is given by attr(z, "tsp")[3]. Additional information about the time series can be provided in a title string by setting attr(z, "title") to the desired string. This title will then be displayed on the plot. Abbreviations for the periods may be provided in attr(z, "abb"). For example, to use the standard monthly abbreviations: attr(z, "abb")<-month.abb. These abbreviations will be used to aid one in interpreting the output.

`lag.max` maximum lag, if missing default is 0.25*length(z)/p, where p = attr(z, "tsp")[3]

`plot` if plot=TRUE, a plot of the periodic autocorrelations is produced.

Details

The use of the periodic autocorrelation and its plot are discussed in McLeod (1994) and a portmanteau model adequacy test is developed therein. The periodicity test is discussed in McLeod (1993). For more details, see the references below.

Value

a list is returned with the following components: means periodic means standard.deviations periodic standard deviations acf matrix of periodic autocorrelations benchmark.sd 1/sqrt(nyrs), nyrs=ceiling(length(z)/p) sub.lengths number of observations in each period period p = attr(z, "tsp")[3] title title = attr(z, "title") periodicity.test list: test for periodic correlation at lag 1 The components of this list are: Q1 = scalar value, the test statistic Q1.sl = signifiance level (upper tail) portmanteau.test list: portmanteau test at various lags The components of this list are: QM = matrix of portmanteau statistics for each period and lag QM.df = corresponding df of QM

Side Effects

a plot may be produced if plot=TRUE

References

Hipel, K.W. and McLeod, A.I. (1994) "Time Series Modelling of Water Resources and Environmental Systems" Elsevier, Amsterdam ISBN 0–444–89270–2. (1013 pages). McLeod, A.I. (1993), "Parsimony, Model Adequacy and Periodic Correlation in Time Series Forecasting", International Statistical Review, Vol. 61, No. 3, pp.387–393. McLeod, A.I. (1994), "Diagnostic Checking of Periodic Autoregression" Journal of Time Series Analysis, Vol. 15, No. 2, pp.221–233.

See Also

peacf.plot, pepacf, peplot, peboxplot, pear, acf, acf.plot

Examples

```
data(fraser)
peacf(log(fraser))
```

`peacf.plot` *periodic correlation plot*

Description

Produces auto and partial periodic correlation plots using the output from peacf and pepacf. If plot=TRUE in the argument to peacf or pepacf then these functions call peacf.plot.

Usage

```
peacf.plot(r)
```

Arguments

`r`	list returned from peacf or pepacf

Details

The plot shows the periodic correlations at various lags along with benchmark 95% limits for no correlation effect.

Value

NULL

Side Effects

plot produced

References

McLeod, A.I. (1994), "Diagnostic Checking of Periodic Autoregression" Journal of Time Series Analysis, Vol. 15, No. 2, pp.221–233.

See Also

peacf, pepacf

Examples

```
data(fraser)
acf.out <- peacf(log(fraser), plot=FALSE)
peacf.plot(acf.out)
```

---

pear — *fit a periodic autoregression model*

Description

Periodic time series models of any order, say m[j], for the j-th period, j=1,...,p can be fit to a periodic time series of period p. A generalization of the Yule-Walker method is used so that when p=1 the results from this function will be equivalent to the Splus function ar.yw(). If desired the aic or bic criterion can be used to select the model orders. Otherwise the user can select based on the partial autocorrelation function as suggested in Box and Jenkins (1976) and McLeod (1994).

Usage

```
pear(z, m, ic="none")
```

Arguments

`z`	a univariate time series object. Note that the period of z is given by attr(z, "tsp")[3]. Additional information about the time series can be provided in a title string by setting attr(z, "title") to the desired string. This title will then be displayed on the plot. Abbreviations for the periods may be provided in attr(z, "abb"). For example, to use the standard monthly abbreviations: attr(z, "abb")<-month.abb. These abbreviations will be used to aid one in interpreting the output.
`m`	If ic="none" then m is a required argument. In this case m specifies the order of the periodic autoregression to be fitted. Typically m is specified as a vector of length p where p is the period and m[k], k=1,...,p indicates the order for the k-th period. For convenience, if all periods are the same order then m can just be that scalar value. When ic="aic" or ic="bic" then the argument m is ignored.
`ic`	The default ic="none" means the model orders are supplied. Otherwise if ic="aic" or ic="bic" the automatic criteria aic or bic are used.

Details

Let z[t] be a period time series with period p and let m[j] denote the order of the autoregressive model for the j-th period, j=1,...,p. The parameters of this model can be estimated using the Yule-Walker type equations given in McLeod eq (3.1) and (3.2). The covariance matrix of the autoregressive parameters is obtained by replacing the theoretical autocovariances in eq (3.3, note addendum correction) with their sample values.

Value

a list with the following named components: model.orders vector of length p, indicating the fitted ar order for each period k, k=1,. . . ,p phi matrix of dimension p by m where m = max(model.orders). The (i,j) entry is phi[i,j] which is the autoregression coefficient for period i and lag j. se.phi matrix of standard deviations for the estimated phi's. For those phi's set to 0, the corresponding se.phi's are also set to 0. resvar vector of length p residuals time series object of length(z) portmanteau.test list: portmanteau test at various lags The named components of this list are: QM = matrix of portmanteau statistics for each period and lag QM.df = corresponding df of QM QM.sl = corresponding sl of QM residual.acf residual autocorrelation matrix residual.acf.sd estimated standard errors of the residual autocorrelations cov list with p components: cov[[i]] is the estimated covariance matrix for the parameters of period i

Side Effects

none

References

Box, G.E.P. and Jenkins, G.M. (1976), "Time Series Analysis: Forecasting and Control", Holden-Day: San Franciso. Hipel, K.W. and McLeod, A.I. (1994) "Time Series Modelling of Water Resources and Environmental Systems" Elsevier, Amsterdam ISBN 0-444-89270-2. (1013 pages). McLeod, A.I. (1994), "Diagnostic Checking of Periodic Autoregression" Journal of Time Series Analysis, Vol. 15, No. 2, pp.221–233. McLeod, A.I. (1995), Errata (see file errata.tex included with these files)

See Also

peacf, pepacf, ar.yw

Examples

```
data(fraser)
pear(log(fraser), ic="bic")
```

`peboxplot` *boxplots of a periodic time series*

Description

Side-by-side boxplots are produced for each period in a periodic time series. These plots can reveal many important features in a periodic time series such as the need for a variance stablizing transformation, outliers, heteroscedasticity not removable by a power transformation, etc. The peboxplot is a useful adjunct to the Splus functions tsplot and monthplot.

Usage

```
peboxplot(z, ...)
```

Arguments

`z`	a univariate time series object. Note that the period of z is given by attr(z, "tsp")[3]. Additional information about the time series can be provided in a title string by setting attr(z, "title") to the desired string. This title will then be displayed on the plot. Abbreviations for the periods may be provided in attr(z, "abb"). For example, to use the standard monthly abbreviations: attr(z, "abb")<-month.abb. These abbreviations will be used to aid one in interpreting the output.
`...`	optional arguments which are passed to the Splus boxplot function

Details

Boxplots of seasonal data are vary useful in many applications. See Hipel and McLeod (1994) for examples.

Value

NULL

Side Effects

plot produced

References

Hipel, K.W. and McLeod, A.I. (1994) "Time Series Modelling of Water Resources and Environmental Systems" Elsevier, Amsterdam ISBN 0–444–89270–2. (1013 pages).

See Also

peplot, monthplot, tsplot

Examples

```
data(fraser)
peboxplot(log(fraser))
```

`pepacf` *periodic partial autocorrelation function*

Description

The periodic partial autocorrelation function of a periodic time series is calculated and plotted if the argument plot=TRUE. When the period, p=1, this reduces to the usual partial autocorrelation function as defined in Box and Jenkins (1976) and is equivalent then to the Splus function acf(type="partial"). As discussed in Box and Jenkins (1976), McLeod (1994) and Hipel and McLeod (1994) the partial autocorrelation is a valuable tool in selecting the model order.

Usage

```
pepacf(z, lag.max, plot=TRUE, acf.out)
```

Arguments

`z`	a univariate time series object. Note that the period of z is given by attr(z, "tsp")[3]. Additional information about the time series can be provided in a title string by setting attr(z, "title") to the desired string. This title will then be displayed on the plot. Abbreviations for the periods may be provided in attr(z, "abb"). For example, to use the standard monthly abbreviations: attr(z, "abb")<-month.abb. These abbreviations will be used to aid one in interpreting the output.
`lag.max`	maximum lag, if missing default is 0.25*length(z)/p, where p = attr(z, "tsp")[3]
`plot`	if plot=TRUE, a plot of the periodic autocorrelations is produced.
`acf.out`	output from peacf function. If this is provided, execution will proceed faster, otherwise it is calculated from scratch.

Details

For the detailed derivation of the algorithm see Sakai (1982). Note that our partial autocorrelation is the negative of that given in Sakai's paper.

Value

a list containing the following components: acf.out output list from peacf pacf matrix of partial autocorrelations residual.sd matrix of residual standard deviations of the fitted models of order m, m=1,2,. . . ,lag.max phi matrix of autoregressive coefficients in the final model of order lag.max for each period aic matrix of aic values for each period and lag bic matrix of bic values for each period and lag maice vector of length p of the minimum aic models mbice vector of length p of the minimum bic models

Side Effects

a plot is produced if plot=TRUE

References

Box, G.E.P. and Jenkins, G.M. (1976), "Time Series Analysis: Forecasting and Control", Holden-Day: San Franciso. Hipel, K.W. and McLeod, A.I. (1994) "Time Series Modelling of Water Resources and Environmental Systems" Elsevier, Amsterdam ISBN 0–444–89270–2. (1013 pages). McLeod, A.I. (1994), "Diagnostic Checking of Periodic Autoregression" Journal of Time Series Analysis, Vol. 15, No. 2, pp.221–233. Sakai, H. (1982), "Circular lattice filtering using Pagano's Method", IEEE Transactions, Acoust. Speech, Signal Processing, Vol. 30, pp.279–287.

See Also

peacf, peacf.plot, peplot, acf, acf.plot

Examples

```
data(fraser)
pepacf(log(fraser))
```

`peplot` *Periodic Correlation Visualization Plot*

Description

In order to visualize dependence at lag k in a periodic series it is useful to plot z[t] vs z[t-k] for each period, m=1,2,. . . ,p. For example in a monthly series we look at scatter plots of Jan vs Dec (previous year), Feb vs Jan, Mar vs Feb, etc. for the lag 1 plots.

Usage

```
peplot(z, lag=1, label=FALSE, mfrow=c(2, 2))
```

Arguments

`z`	a univariate time series object. Note that the period of z is given by attr(z, "tsp")[3]. Additional information about the time series can be provided in a title string by setting attr(z, "title") to the desired string. This title will then be displayed on the plot. Abbreviations for the periods may be provided in attr(z, "abb"). For example, to use the standard monthly abbreviations: attr(z, "abb")<-month.abb. These abbreviations will be used to aid one in interpreting the output.
`lag`	lag separation
`label`	if label = TRUE, the Splus identify() function will be called allowing one to identify and label particular data points on the plots.
`mfrow`	Since many plots may be produced, the default is to produced 4 plots per page.

Details

The importance of looking at these plots was noted by Cox (1981)

Value

NULL

Side Effects

plot produced

References

Cox, D.R. (1981), "Statistical Analysis of Time Series: Some Recent Developments", Scandinavian Journal of Statistics, Vol. 8, pp.93–115.

Examples

```
data(fraser)
peplot(log(fraser))
```

---

pepsi *moving average expansion of a periodic autoregression*

Description

A periodic autoregression can be represented as an infinite periodic moving average process. This function calculates the coefficients in this expansion. These coefficients are needed in various time series computations such as in computing the variances of forecasts, variances of residual autocorrelations and theoretical autocovariances of a periodic autoregression. The function pepsi is used by pear to calculate the estimated standard deviations of the residual autocorrelations in a fitted periodic autoregression.

Usage

```
pepsi(phi, lag.max)
```

Arguments

`phi`	matrix with (i,j)-entry phi[i, j] where phi[i,j] is the autoregressive coefficient for period i at lag j. Here i=1,. . . ,p and j=1,. . . ,m where m is highest ar order specified.
`lag.max`	maximum number of lags to calculate in the moving average expansion.

Details

The moving average expansion for a periodic autoregressive is defined in equation (1.4) of McLeod (1994) and the algorithm implements the recursion given in equation (1.5).

Value

matrix with (i,j)-entry psi[i, j] where psi[i,j] is the autoregressive coefficient for period i at lag j. Here i=1,. . . ,p and j=1,. . . ,lag.max.

Side Effects

none

References

McLeod, A.I. (1994), "Diagnostic Checking of Periodic Autoregression" Journal of Time Series Analysis, Vol. 15, No. 2, pp.221–233.

See Also

pear

Examples

```
data(fraser)
pear.out <- pear(log(fraser), ic="bic")
pepsi(pear.out$phi,lag.max=20)
```

Index