Package 'UComp'

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Type Package

Title Automatic Unobserved Components and Other Time Series Models

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Description Comprehensive analysis and forecasting
of univariate time series using automatic
unobserved components models and algorithms.
Harvey, AC (1989) <doi:10.1017/CBO9781107049994>.
Pedregal DJ and Young PC (2002) <doi:10.1002/9780470996430>.
Durbin J and Koopman SJ (2012) <doi:10.1093/acprof:oso/9780199641178.001.0001>.
Hyndman RJ, Koehler AB, Ord JK, and Snyder RD (2008) <doi:10.1007/978-3-540-71918-2>.

License GPL-3

Encoding UTF-8

Imports ggplot2, gridExtra, tsibble, tsoutliers, stats, ggforce,
utils, parallel

LinkingTo Rcpp, RcppArmadillo

Depends Rcpp (>= 1.0.3), R (>= 3.5.0)

LazyData true

Suggests knitr, rmarkdown

RoxygenNote 7.2.3

NeedsCompilation yes

Repository CRAN

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R topics documented:

`Accuracy` *Accuracy*

Description

Accuracy for 1 time series y and several forecasting methods py and h steps ahead py is h x nMethods x nSeries

Usage

```
Accuracy(py, y, s = frequency(y), collectFun = mean)
```

Arguments

`py`	matrix of forecasts (h x nMethods x nForecasts)
`y`	a matrix of actual values (n x nForecasts)
`s`	seasonal period, number of observations per year
`collectFun`	aggregation function (mean, median, etc.)

Value

Table of results

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, gaussTest, ident, cusum, varTest, conv, armaFilter, dif, roots, zplane, acft, slide, plotSlide, tsDisplay, size

Examples

```
## Not run: Accuracy(py, y, 12)
```

---

acft *acft*

Description

Theoretical autocorrelation functions of ARMA models

Usage

```
acft(MApoly = 1, ARpoly = 1, ncoef = 38, s = 1)
```

Arguments

MApoly	coefficients of numerator polynomial in descending order
ARpoly	coefficients of denominator polynomial in descending order
ncoef	number of coefficients
s	seasonal period, number of observations per year

Value

Theoretical autocorrelation functions

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, gaussTest, ident, cusum, varTest, conv, armaFilter, dif, roots, zplane, slide, plotSlide, Accuracy, tsDisplay, size

Examples

```
acft(c(1, -0.8), c(1, 0.8))
```

AIC.UComp *AIC.UComp*

Description

Extract AIC value of UComp object

Usage

```
## S3 method for class 'UComp'
AIC(object, ..., k = 2)
```

Arguments

object	Object of class "UComp".
...	Additional inputs to function.
k	The penalty per parameter to be used.

Details

Selection criteria for models with different number of parameters, the smaller AIC the better. The formula used here is $AIC = -2(ln(L) - k)/n$, where $ln(L)$ is the log-likelihood at the optimum, k is the number of parameters plus non-stationary states and n is the number of observations. Mind that this formulation differs from the usual definition that does not divide by n. This makes that AIC(m) and AIC(logLik(m)) give different results, being m an UComp object.

Author(s)

Diego J. Pedregal

See Also

UC, UCmodel, UCvalidate, UCfilter, UCsmooth, UCdisturb, UCcomponents

Examples

```
## Not run:
y <- log(AirPassengers)
m1 <- UCmodel(y, model = "llt/equal/arma(0,0)")
AIC(m1)

## End(Not run)
```

airpas *Airpassengers in Spain*

Description

Foreign arrivals by air in Spain in thousands of passengers (airpas).

Usage

```
airpas
```

Format

Time series objects.
Monthly data from 1969

Source

airpas

Examples

```
## Not run:
 airpas

## End(Not run)
```

arma2tsi *arma2tsi*

Description

AR polynomial coefficients of ARMA model

Usage

```
arma2tsi(MApoly, ARpoly, n = 100)
```

Arguments

MApoly	coefficients of numerator polynomial in descending order
ARpoly	coefficients of denominator polynomial in descending order
n	number of coefficients

Author(s)

Diego J. Pedregal

armaFilter *armaFilter*

Description

Filter of time series

Usage

```
armaFilter(MA = 1, AR = 1, y)
```

Arguments

MA	numerator polynomial
AR	denominator polynomial
y	a vector, ts or tsibble object

Value

Filtered time series

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, gaussTest, ident, cusum, varTest, conv, dif, roots, zplane, acft, slide, plotSlide, Accuracy, tsDisplay, size

Examples

```
y <- armaFilter(1, c(1 , -0.8), rnorm(200))
```

---

auxInvBoxCox *auxInvBoxCox*

Description

Inverse of Box-Cox transformation

Usage

```
auxInvBoxCox(y, lambda)
```

Arguments

y	matrix, array or vector
lambda	lambda parameter of Box-Cox transformation

Author(s)

Diego J. Pedregal

BIC.UComp *BIC.UComp*

Description

Extract BIC (or SBC) value of UComp object

Usage

```
## S3 method for class 'UComp'
BIC(object, ...)
```

Arguments

object	Object of class "UComp".
...	Additional inputs to function.

Details

Selection criteria for models with different number of parameters, the smaller BIC the better. The formula used here is $BIC = (-2ln(L) + kln(n))/n$, where $ln(L)$ is the log-likelihood at the optimum, k is the number of parameters plus non-stationary states and n is the number of observations. Mind that this formulation differs from the usual definition that does not divide by n. This makes that BIC(m) and BIC(logLik(m)) give different results, being m an UComp object.

Author(s)

Diego J. Pedregal

See Also

UC, UCmodel, UCvalidate, UCfilter, UCsmooth, UCdisturb, UCcomponents

Examples

```
## Not run:
y <- log(AirPassengers)
m1 <- UCmodel(y, model = "llt/equal/arma(0,0)")
BIC(m1)

## End(Not run)
```

ch4 *Methane concentration at Cape Grim in Australia*

Description

Methane concentration at Cape Grim in Australia (ch4).

Usage

```
ch4
```

Format

Time series objects.

Monthly data from January 1992 to December 2019

Source

CH4 data

Examples

```
## Not run:
 ch4

## End(Not run)
```

colMedians *colMedians*

Description

Medians of matrix by columns

Usage

```
colMedians(x, na.rm = TRUE, ...)
```

Arguments

x	a matrix
na.rm	boolean indicating whether to remove nans
...	rest of inputs

Value

A vector with all the medians

Author(s)

Diego J. Pedregal

See Also

rowMedians, tests, sumStats, gaussTest, ident, cusum, varTest, conv, armaFilter, dif, roots, zplane, acft, slide, plotSlide, Accuracy, tsDisplay, size

Examples

```
s <- colMedians(matrix(4, 3, 2))
```

---

conv *conv*

Description

1D convolution: filtering or polynomial multiplication

Usage

```
conv(...)
```

Arguments

...	list of vectors to convolute

Value

Convolution of all input vectors

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, gaussTest, ident, cusum, varTest, armaFilter, dif, roots, zplane, acft, slide, plotSlide, Accuracy, tsDisplay, size

Examples

```
conv(c(1, -1), c(1, -2, 1))
conv(c(1, -1), c(1, 0.8))
```

cusum *cusum*

Description

Cusum and cusumsq tests

Usage

```
cusum(y, runFromTest = FALSE)
```

Arguments

y	a vector, ts or tsibble object
runFromTest	internal check variable

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, gaussTest, ident, varTest, conv, armaFilter, dif, roots, zplane, acft, slide, plotSlide, Accuracy, tsDisplay, size

Examples

```
cusum(AirPassengers)
```

dif *dif*

Description

Discrete differencing of time series

Usage

```
dif(y, difs = 1, seas = 1)
```

Arguments

y	a vector, ts or tsibble object
difs	vector with differencing orders
seas	vector of seasonal periods

Value

Differenced time series

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, gaussTest, ident, cusum, varTest, conv, armaFilter, roots, zplane, acft, slide, plotSlide, Accuracy, tsDisplay, size

Examples

```
dif(AirPassengers)
dif(AirPassengers, 2)
dif(AirPassengers, c(1, 1), c(1, 12))
```

ETS *ETS*

Description

Runs all relevant functions for ETS modelling

Usage

```
ETS(
  y,
  u = NULL,
  model = "???",
  s = frequency(y),
  h = 2 * s,
  criterion = "aicc",
  lambda = 1,
  armaIdent = FALSE,
  identAll = FALSE,
  forIntervals = FALSE,
  bootstrap = FALSE,
  nSimul = 5000,
  verbose = FALSE,
  alphaL = c(1e-08, 1 - 1e-08),
  betaL = alphaL,
  gammaL = alphaL,
  phiL = c(0.8, 0.98),
  p0 = -99999
)
```

Arguments

y	a time series to forecast (it may be either a numerical vector or a time series object). This is the only input required. If a vector, the additional input s should be supplied compulsorily (see below).
u	a matrix of input time series. If the output wanted to be forecast, matrix u should contain future values for inputs.
model	the model to estimate. It is a single string indicating the type of model for each component with one or two letters: • Error: ? / A / M • Trend: ? / N / A / Ad / M / Md • Seasonal: ? / N / A / M
s	seasonal period of time series (1 for annual, 4 for quarterly, ...)
h	forecast horizon. If the model includes inputs h is not used, the lenght of u is used instead.
criterion	information criterion for identification ("aic", "bic" or "aicc").
lambda	Box-Cox lambda parameter (NULL: estimate)
armaIdent	check for arma models for error component (TRUE / FALSE).
identAll	run all models to identify the best one (TRUE / FALSE)
forIntervals	estimate forecasting intervals (TRUE / FALSE)
bootstrap	use bootstrap simulation for predictive distributions
nSimul	number of simulation runs for bootstrap simulation of predictive distributions
verbose	intermediate estimation output (TRUE / FALSE)
alphaL	constraints limits for alpha parameter
betaL	constraints limits for beta parameter
gammaL	constraints limits for gamma parameter
phiL	constraints limits for phi parameter
p0	initial values for parameter search (alpha, beta, phi, gamma) with consraints: • 0 < alpha < 1 • 0 < beta < alpha • 0 < phi < 1 • 0 < gamma < 1 - alpha

Details

See help of ETSmodel.

Value

An object of class ETS. See ETSmodel.

Author(s)

Diego J. Pedregal

See Also

ETSmodel, ETSvalidate, ETScomponents, ETSestim

Examples

```
## Not run:
y <- log(AirPAssengers)
m1 <- ETS(y)
m1 <- ETS(y, model = "MAM")

## End(Not run)
```

ETScomponents *ETScomponents*

Description

Estimates components of ETS models

Usage

```
ETScomponents(m)
```

Arguments

m	an object of type ETS created with ETSmodel

Value

The same input object with the appropriate fields filled in, in particular:

comp	Estimated components in matrix form

Author(s)

Diego J. Pedregal

See Also

ETS, ETSmodel, ETSvalidate, ETSestim

Examples

```
## Not run:
m1 <- ETS(log(gdp))
m1 <- ETScomponents(m1)

## End(Not run)
```

ETSestim *ETSestim*

Description

Estimates and forecasts ETS models

Usage

```
ETSestim(m)
```

Arguments

m	an object of type ETS created with ETSmodel

Details

ETSestim estimates and forecasts a time series using an an ETS model

Value

The same input object with the appropriate fields filled in, in particular:

p	Estimated parameters
yFor	Forecasted values of output
yForV	Variance of forecasted values of output
ySimul	Bootstrap simulations for forecasting distribution evaluation

Author(s)

Diego J. Pedregal

See Also

ETS, ETSmodel, ETSvalidate, ETScomponents

Examples

```
## Not run:
m1 <- ETSsetup(log(gdp))
m1 <- ETSestim(m1)

## End(Not run)
```

ETSmodel *ETSmodel*

Description

Estimates and forecasts ETS general univariate models

Usage

```
ETSmodel(
  y,
  u = NULL,
  model = "???",
  s = frequency(y),
  h = max(2 * s, 6),
  criterion = "aicc",
  lambda = 1,
  armaIdent = FALSE,
  identAll = FALSE,
  forIntervals = FALSE,
  bootstrap = FALSE,
  nSimul = 5000,
  verbose = FALSE,
  alphaL = c(1e-08, 1 - 1e-08),
  betaL = alphaL,
  gammaL = alphaL,
  phiL = c(0.8, 0.98),
  p0 = -99999
)
```

Arguments

y	a time series to forecast (it may be either a numerical vector or a time series object). This is the only input required. If a vector, the additional input s should be supplied compulsorily (see below).
u	a matrix of input time series. If the output wanted to be forecast, matrix u should contain future values for inputs.
model	the model to estimate. It is a single string indicating the type of model for each component with one or two letters: • Error: ? / A / M • Trend: ? / N / A / Ad / M / Md • Seasonal: ? / N / A / M
s	seasonal period of time series (1 for annual, 4 for quarterly, ...)
h	forecast horizon. If the model includes inputs h is not used, the lenght of u is used instead.

criterion	information criterion for identification ("aic", "bic" or "aicc").
lambda	Box-Cox lambda parameter (NULL: estimate)
armaIdent	check for arma models for error component (TRUE / FALSE).
identAll	run all models to identify the best one (TRUE / FALSE)
forIntervals	estimate forecasting intervals (TRUE / FALSE)
bootstrap	use bootstrap simulation for predictive distributions
nSimul	number of simulation runs for bootstrap simulation of predictive distributions
verbose	intermediate estimation output (TRUE / FALSE)
alphaL	constraints limits for alpha parameter
betaL	constraints limits for beta parameter
gammaL	constraints limits for gamma parameter
phiL	constraints limits for phi parameter
p0	initial values for parameter search (alpha, beta, phi, gamma) with consraints: • 0 < alpha < 1 • 0 < beta < alpha • 0 < phi < 1 • 0 < gamma < 1 - alpha

Details

ETSmodel is a function for modelling and forecasting univariate time series with ExponenTial Smoothing (ETS) time series models. It sets up the model with a number of control variables that govern the way the rest of functions in the package will work. It also estimates the model parameters by Maximum Likelihood and forecasts the data.

Value

An object of class ETS. It is a list with fields including all the inputs and the fields listed below as outputs. All the functions in this package fill in part of the fields of any ETS object as specified in what follows (function ETS fills in all of them at once):

After running ETSmodel or ETSestim:

p	Estimated parameters
criteria	Values for estimation criteria (LogLik, AIC, BIC, AICc)
yFor	Forecasted values of output
yForV	Variance of forecasted values of output
ySimul	Bootstrap simulations for forecasting distribution evaluation

After running ETSvalidate:

table	Estimation and validation table
comp	Estimated components in matrix form

After running ETScomponents:

comp	Estimated components in matrix form

Author(s)

Diego J. Pedregal

See Also

ETS, ETSvalidate, ETScomponents, ETSestim

Examples

```
## Not run:
y <- log(AirPAssengers)
m1 <- ETSmodel(y)
m1 <- ETSmodel(y, model = "A?A")

## End(Not run)
```

ETSsetup *ETSsetup*

Description

Sets up ETS general univariate models

Usage

```
ETSsetup(
  y,
  u = NULL,
  model = "???",
  s = frequency(y),
  h = 2 * s,
  criterion = "aicc",
  lambda = 1,
  armaIdent = FALSE,
  identAll = FALSE,
  forIntervals = FALSE,
  bootstrap = FALSE,
  nSimul = 5000,
  verbose = FALSE,
  alphaL = c(1e-08, 1 - 1e-08),
  betaL = alphaL,
  gammaL = alphaL,
  phiL = c(0.8, 0.98),
  p0 = -99999
)
```

Arguments

y	a time series to forecast (it may be either a numerical vector or a time series object). This is the only input required. If a vector, the additional input s should be supplied compulsorily (see below).
u	a matrix of input time series. If the output wanted to be forecast, matrix u should contain future values for inputs.
model	the model to estimate. It is a single string indicating the type of model for each component with one or two letters: • Error: ? / A / M • Trend: ? / N / A / Ad / M / Md • Seasonal: ? / N / A / M
s	seasonal period of time series (1 for annual, 4 for quarterly, ...)
h	forecast horizon. If the model includes inputs h is not used, the lenght of u is used instead.
criterion	information criterion for identification ("aic", "bic" or "aicc").
lambda	Box-Cox lambda parameter (NULL: estimate)
armaIdent	check for arma models for error component (TRUE / FALSE).
identAll	run all models to identify the best one (TRUE / FALSE)
forIntervals	estimate forecasting intervals (TRUE / FALSE)
bootstrap	use bootstrap simulation for predictive distributions
nSimul	number of simulation runs for bootstrap simulation of predictive distributions
verbose	intermediate estimation output (TRUE / FALSE)
alphaL	constraints limits for alpha parameter
betaL	constraints limits for beta parameter
gammaL	constraints limits for gamma parameter
phiL	constraints limits for phi parameter
p0	initial values for parameter search (alpha, beta, phi, gamma) with consraints: • 0 < alpha < 1 • 0 < beta < alpha • 0 < phi < 1 • 0 < gamma < 1 - alpha

Details

See help of ETSmodel.

Value

An object of class ETS. See ETSmodel.

Author(s)

Diego J. Pedregal

See Also

ETS, ETSmodel, ETSvalidate, ETScomponents, ETSestim

Examples

```
## Not run:
y <- log(AirPAssengers)
m1 <- ETSsetup(y)
m1 <- ETSsetup(y,  model = "???")
m1 <- ETSsetup(y,  model = "?AA")

## End(Not run)
```

ETSvalidate *ETSvalidate*

Description

Shows a table of estimation and diagnostics results for UC models

Usage

```
ETSvalidate(m)
```

Arguments

m	an object of type UComp created with UCmodel

Value

The same input object with the appropriate fields filled in, in particular:

table	Estimation and validation table

Author(s)

Diego J. Pedregal

See Also

ETS, ETSmodel, ETSvalidate, ETScomponents

Examples

```
## Not run:
m1 <- ETSmodel(log(gdp))
m1 <- ETSvalidate(m1)

## End(Not run)
```

extract *extract*

Description

Reorder data frame returning column col reordered according to the values in column accordingTo

Usage

```
extract(x, col, accordingTo = 1)
```

Arguments

x	a data frame
col	column to be ordered
accordingTo	column to take as the pattern

Value

data frame reordered

Author(s)

Diego J. Pedregal

fitted.ETS *fitted.ETS*

Description

Fitted output values of ETS object

Fitted output values of PTS object

Usage

```
## S3 method for class 'ETS'
fitted(object, ...)

## S3 method for class 'PTS'
fitted(object, ...)
```

Arguments

object	Object of class "PTS".
...	Additional inputs to function.

Details

See help of ETS.

See help of PTS.

Author(s)

Diego J. Pedregal

See Also

ETS, ETSmodel, ETSvalidate, ETScomponents, ETSestim

PTS, PTSmodel, PTSvalidate, PTScomponents, PTSestim

Examples

```
## Not run:
m1 <- ETSmodel(log(gdp))
fitted(m1)

## End(Not run)
## Not run:
m1 <- PTSmodel(log(AirPassengers))
fitted(m1)

## End(Not run)
```

---

gaussTest *gaussTest*

Description

Gaussianity tests

Usage

```
gaussTest(y, runFromTests = FALSE)
```

Arguments

y	a vector, ts or tsibble object
runFromTests	internal check

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, ident, cusum, varTest, conv, armaFilter, dif, roots, zplane, acft, slide, plotSlide, Accuracy, tsDisplay, size

Examples

```
gaussTest(AirPassengers)
```

---

gdp *Spanish GDP*

Description

Quarterly real Spanish Gross Domestic Product (gdp)

Usage

```
gdp
```

Format

Time series objects.

Quarterly since 1995

Source

gdp

Examples

```
## Not run:
 gdp

## End(Not run)
```

getp0 *getp0*

Description

Get initial conditions for parameters of UComp object

Usage

```
getp0(y, model = "llt/equal/arma(0,0)", periods = NA)
```

Arguments

y	a time series to forecast.
model	any valid UComp model without any ?.
periods	vector of fundamental period and harmonics required.

Details

Provides initial parameters of a given model for the time series. They may be changed arbitrarily by the user to include as an input p0 to UC or UCmodel functions (see example below). There is no guarantee that the model will converge and selecting initial conditions should be used with care.

Value

A set of parameters p0 of an object of class UComp to use as input to UC, UCmodel or UCsetup.

Author(s)

Diego J. Pedregal

See Also

UC, UCvalidate, UCfilter, UCsmooth, UCdisturb, UCcomponents, UChp

Examples

```
## Not run:
p0 <- getp0(log(AirPassengers), model = "llt/equal/arma(0,0)")
p0[1] <- 0  # p0[1] <- NA
m <- UCmodel(log(AirPassengers), model = "llt/equal/arma(0,0)", p0 = p0)

## End(Not run)
```

ident *ident*

Description

Autocorrelation functions of a time series

Usage

```
ident(y, nCoef = min(37, floor(length(y)/4)), nPar = 0, runFromTests = FALSE)
```

Arguments

y	a vector, ts or tsibble object
nCoef	number of autocorrelation coefficients to estimate
nPar	number of parameters in a model if y is a residual
runFromTests	internal check

Value

A vector with all the dimensions

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, gaussTest, cusum, varTest, conv, armaFilter, dif, roots, zplane, acft, slide, plotSlide, Accuracy, tsDisplay, size

Examples

```
ident(AirPassengers)
```

invBoxCox *invBoxCox*

Description

Calculates inverse of Box-Cox transformation with confidence bands, calculated as const time the standard error

Usage

```
invBoxCox(y, yVar, lambda, const = 2)
```

Arguments

y	matrix, array or vector
yVar	matrix, array or vector of variances of y
lambda	lambda parameter of Box-Cox transformation
const	number of standard error for confidence band

Author(s)

Diego J. Pedregal

ipi *Spanish Industrial Production Index*

Description

Spanish Industrial Production Index (ipi).

Usage

```
ipi
```

Format

Objeto time series.

Monthly since 1975

Source

ipi

Examples

```
## Not run:
 ipi

## End(Not run)
```

`modelUC2arma` *modelUC2arma*

Description

Extracts arma part of modelUC model

Usage

```
modelUC2arma(model)
```

Arguments

`model`	a UC model

Value

arma orders

Author(s)

Diego J. Pedregal

`modelUC2PTS` *modelUC2PTS*

Description

Translates modelUC to model PTS

Usage

```
modelUC2PTS(modelUC)
```

Arguments

`modelUC`	a UC model

Value

a PTS model

Author(s)

Diego J. Pedregal

`OECDgdp` *OECD GDP*

Description

Seasonally adjusted quarterly OECD real gross domestic product (OECDgdp).

Usage

```
OECDgdp
```

Format

Time series objects.

Quarterly data from 1962 to 2019

Source

OECDgdp

Examples

```
## Not run:
 OECDgdp

## End(Not run)
```

`plot.ETS` *plot.ETS*

Description

Plot components of ETS object

Plot components of PTS object

Usage

```
## S3 method for class 'ETS'
plot(x, ...)

## S3 method for class 'PTS'
plot(x, ...)
```

Arguments

x	Object of class "PTS".
...	Additional inputs to function.

Details

See help of ETS.

See help of PTS.

Author(s)

Diego J. Pedregal

See Also

ETS, ETSmodel, ETSvalidate, ETScomponents, ETSestim

PTS, PTSmodel, PTSvalidate, PTScomponents, PTSestim

Examples

```
## Not run:
m1 <- ETSmodel(log(gdp))
plot(m1)

## End(Not run)
## Not run:
m1 <- PTS(log(AirPassengers))
plot(m1)

## End(Not run)
```

---

plotAcfPacf *plotAcfPacf*

Description

Plot of ACF and PACF

Usage

```
plotAcfPacf(ACF, PACF, s = 1, n = NA, runFromTest = FALSE)
```

Arguments

ACF	variable to plot
PACF	second variable to plot
s	seasonal period
n	number of coefficients
runFromTest	internal check variable

Author(s)

Diego J. Pedregal

`plotBar` *plotBar*

Description

Plot variable in bars

Usage

```
plotBar(ACF, s = 1, n = NA, label = "ACF")
```

Arguments

`ACF`	variable to plot
`s`	seasonal period
`n`	number of coefficients
`label`	label for plot

Value

Handle of plot

Author(s)

Diego J. Pedregal

`plotSlide` *plotSlide*

Description

Plot summarised results from slide

Usage

```
plotSlide(py1, y, orig, step = 1, errorFun, collectFun = mean)
```

Arguments

py1	output from slide function
y	a vector or matrix of time series (the same used in slide call)
orig	starting forecasting origin (the same used in slide call)
step	observations ahead to move the forecasting origin (the same used in slide call)
errorFun	user function to calculate error measures
collectFun	aggregation function (mean, median, etc.)

Value

Results

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, gaussTest, ident, cusum, varTest, conv, armaFilter, dif, roots, zplane, acft, slide, Accuracy, tsDisplay, size

Examples

```
## Not run: plotSlide(py1, AirPassengers, 100, 1, errorFun)
```

---

plus_one *plus_one*

Description

Returns date of next to end time series y

Usage

```
plus_one(y)
```

Arguments

y	a ts object

Value

Next time stamp

Author(s)

Diego J. Pedregal

predict.UComp *predict.UComp*

Description

Forecasting using structural Unobseved Components models with prediction intervals

Usage

```
## S3 method for class 'UComp'
predict(object, newdata = NULL, n.ahead = NULL, level = 0.95, ...)
```

Arguments

object	Object of class "UComp".
newdata	New output data to apply "UComp" object to.
n.ahead	Number of steps ahead to forecast or new inputs variables including their predictions.
level	Confidence level for prediction intervals.
...	Ignored.

Details

See help of UC.

Value

A matrix with the mean forecasts and lower and upper prediction intervals

Author(s)

Diego J. Pedregal

See Also

UC, UCmodel, UCvalidate, UCfilter, UCsmooth, UCdisturb, UCcomponents

Examples

```
## Not run:
y <- log(AirPassengers)
m1 <- UCmodel(y, model = "llt/eq/arma(0,0)")
f1 <- predict(m1)

## End(Not run)
```

print.ETS *print.ETS*

Description

Prints an ETS object

Prints a PTS object

Usage

```
## S3 method for class 'ETS'
print(x, ...)

## S3 method for class 'PTS'
print(x, ...)
```

Arguments

x	Object of class "PTS".
...	Additional inputs to handle the way to print output.

Details

See help of ETS.

See help of PTS.

Author(s)

Diego J. Pedregal

See Also

ETS, ETSmodel, ETSvalidate, ETScomponents, ETSestim

PTS, PTSmodel, PTSvalidate, PTScomponents, PTSestim

Examples

```
## Not run:
m1 <- ETSmodel(log(gdp))
print(m1)

## End(Not run)
## Not run:
m1 <- PTSmodel(log(AirPassengers))
print(m1)

## End(Not run)
```

PTS *PTS*

Description

Estimates, forecasts and smooth PTS general univariate models

Usage

```
PTS(
  y,
  u = NULL,
  model = "???",
  s = frequency(y),
  h = 2 * s,
  criterion = "aicc",
  lambda = 1,
  armaIdent = FALSE,
  verbose = FALSE
)
```

Arguments

y	a time series to forecast (it may be either a numerical vector or a time series object). This is the only input required. If a vector, the additional input s should be supplied compulsorily (see below).
u	a matrix of input time series. If the output wanted to be forecast, matrix u should contain future values for inputs.
model	the model to estimate. It is a single string indicating the type of model for each component with one or two letters: • Error: ? / N / A • Trend: ? / N / A / Ad / L • Seasonal: ? / N / A / D (trigonometric with different variances)
s	seasonal period of time series (1 for annual, 4 for quarterly, ...)
h	forecast horizon. If the model includes inputs h is not used, the lenght of u is used instead.
criterion	information criterion for identification ("aic", "bic" or "aicc").
lambda	Box-Cox lambda parameter (NULL: estimate)
armaIdent	check for arma models for error component (TRUE / FALSE).
verbose	intermediate estimation output (TRUE / FALSE)

Details

PTS is a function for modelling and forecasting univariate time series according to Power-Trend-Seasonal (PTS). It sets up the model with a number of control variables that govern the way the rest of functions in the package work. It also estimates the model parameters by Maximum Likelihood and forecasts the data. Standard methods applicable to UComp objects are print, summary, plot, fitted, residuals, logLik, AIC, BIC, coef, predict, tsdiag.

Value

An object of class PTS. It is a list with fields including all the inputs and the fields listed below as outputs. All the functions in this package fill in part of the fields of any PTS object as specified in what follows (function PTS fills in all of them at once):

After running PTSmodel or PTSestim:

- p0: Initial values for parameter search
- p: Estimated parameters
- lambda: Estimated Box-Cox lambda parameter
- v: Estimated innovations (white noise in correctly specified models)
- yFor: Forecasted values of output
- yForV: Variance of forecasted values of output

After running PTSvalidate:

- table: Estimation and validation table

After running PTScomponents:

- comp: Estimated components in matrix form

Author(s)

Diego J. Pedregal

See Also

PTSmodel, PTSsetup, PTSvalidate, PTScomponents, PTSestim

Examples

```
## Not run:
m1 <- PTS(log(AirPassengers))

## End(Not run)
```

PTS2modelUC *PTS2modelUC*

Description

Translates PTS model to UC model

Usage

```
PTS2modelUC(model, armaOrders = c(0, 0))
```

Arguments

model	a PTS model
armaOrders	arma orders of noise model

Value

a UC model

Author(s)

Diego J. Pedregal

PTScomponents *PTScomponents*

Description

Estimates components of PTS models

Usage

```
PTScomponents(m)
```

Arguments

m	an object of type PTS created with PTSmodel

Value

The same input object with the appropriate fields filled in, in particular:

- comp: Estimated components in matrix form

Author(s)

Diego J. Pedregal

See Also

PTSmodel, PTSsetup, PTSestim, PTSvalidate, PTS

Examples

```
## Not run:
m1 <- PTS(log(AirPassengers))
m1 <- PTScomponents(m1)

## End(Not run)
```

PTSestim *PTSestim*

Description

Estimates and forecasts PTS models

Usage

```
PTSestim(m)
```

Arguments

m	an object of type PTS created with PTSmodel

Details

PTSestim estimates and forecasts a time series using an a PTS model

Value

The same input object with the appropriate fields filled in, in particular:

- p0: Initial values for parameter search
- p: Estimated parameters
- lambda: Estimated Box-Cox lambda parameter
- v: Estimated innovations (white noise in correctly specified models)
- yFor: Forecasted values of output
- yForV: Variance of forecasted values of output

Author(s)

Diego J. Pedregal

See Also

PTSmodel, PTSsetup, PTSvalidate, PTScomponents, PTS

Examples

```
## Not run:
m1 <- PTSsetup(log(AirPassengers))
m1 <- PTSestim(m1)

## End(Not run)
```

PTSmodel *PTSmodel*

Description

Estimates and forecasts PTS general univariate models

Usage

```
PTSmodel(
  y,
  u = NULL,
  model = "???",
  s = frequency(y),
  h = 2 * s,
  criterion = "aicc",
  lambda = 1,
  armaIdent = FALSE,
  verbose = FALSE
)
```

Arguments

y	a time series to forecast (it may be either a numerical vector or a time series object). This is the only input required. If a vector, the additional input s should be supplied compulsorily (see below).
u	a matrix of input time series. If the output wanted to be forecast, matrix u should contain future values for inputs.
model	the model to estimate. It is a single string indicating the type of model for each component with one or two letters: • Error: ? / N / A • Trend: ? / N / A / Ad / L • Seasonal: ? / N / A / D (trigonometric with different variances)
s	seasonal period of time series (1 for annual, 4 for quarterly, ...)

h	forecast horizon. If the model includes inputs h is not used, the lenght of u is used instead.
criterion	information criterion for identification ("aic", "bic" or "aicc").
lambda	Box-Cox lambda parameter (NULL: estimate)
armaIdent	check for arma models for error component (TRUE / FALSE).
verbose	intermediate estimation output (TRUE / FALSE)

Details

PTSmodel is a function for modelling and forecasting univariate time series according to Power-Trend-Seasonal (PTS). It sets up the model with a number of control variables that govern the way the rest of functions in the package work. It also estimates the model parameters by Maximum Likelihood and forecasts the data. Standard methods applicable to UComp objects are print, summary, plot, fitted, residuals, logLik, AIC, BIC, coef, predict, tsdiag.

Value

An object of class PTS. It is a list with fields including all the inputs and the fields listed below as outputs. All the functions in this package fill in part of the fields of any PTS object as specified in what follows (function PTS fills in all of them at once):

After running PTSmodel or PTSestim:

- p0: Initial values for parameter search
- p: Estimated parameters
- lambda: Estimated Box-Cox lambda parameter
- v: Estimated innovations (white noise in correctly specified models)
- yFor: Forecasted values of output
- yForV: Variance of forecasted values of output

After running PTSvalidate:

- table: Estimation and validation table

After running PTScomponents:

- comp: Estimated components in matrix form

Author(s)

Diego J. Pedregal

See Also

PTS, PTSsetup, PTSvalidate, PTScomponents, PTSestim

Examples

```
## Not run:
m1 <- PTSmodel(log(AirPassengers))

## End(Not run)
```

PTSsetup *PTSsetup*

Description

Run up PTS general univariate MSOE models

Usage

```
PTSsetup(
  y,
  u = NULL,
  model = "???",
  s = frequency(y),
  h = 2 * s,
  criterion = "aic",
  lambda = 1,
  armaIdent = FALSE,
  verbose = FALSE
)
```

Arguments

y	a time series to forecast (it may be either a numerical vector or a time series object). This is the only input required. If a vector, the additional input s should be supplied compulsorily (see below).
u	a matrix of input time series. If the output wanted to be forecast, matrix u should contain future values for inputs.
model	the model to estimate. It is a single string indicating the type of model for each component with one or two letters: • Error: ? / N / A • Trend: ? / N / A / Ad / L • Seasonal: ? / N / A / D (trigonometric with different variances)
s	seasonal period of time series (1 for annual, 4 for quarterly, ...)
h	forecast horizon. If the model includes inputs h is not used, the lenght of u is used instead.
criterion	information criterion for identification ("aic", "bic" or "aicc").
lambda	Box-Cox lambda parameter (NULL: estimate)
armaIdent	check for arma models for error component (TRUE / FALSE).
verbose	intermediate estimation output (TRUE / FALSE)

Details

See help of PTS.

Value

An object of class PTS. It is a list with fields including all the inputs and the fields listed below as outputs. All the functions in this package fill in part of the fields of any PTS object as specified in what follows (function PTS fills in all of them at once):

After running PTSmodel or PTSestim:

- p0: Initial values for parameter search
- p: Estimated parameters
- lambda: Estimated Box-Cox lambda parameter
- v: Estimated innovations (white noise in correctly specified models)
- yFor: Forecasted values of output
- yForV: Variance of forecasted values of output

After running PTSvalidate:

- table: Estimation and validation table

After running PTScomponents:

- comp: Estimated components in matrix form

Standard methods applicable to PTS objects are print, summary, plot, fitted, residuals, logLik, AIC, BIC, coef, predict, tsdiag.

Author(s)

Diego J. Pedregal

See Also

PTS, PTSmodel, PTSvalidate, PTScomponents, PTSestim

Examples

```
## Not run:
m1 <- PTSsetup(log(AirPassengers))

## End(Not run)
```

PTSvalidate *PTSvalidate*

Description

Shows a table of estimation and diagnostics results for PTS models

Usage

```
PTSvalidate(m, verbose = TRUE)
```

Arguments

m	an object of type PTS created with PTSmodel
verbose	verbose mode TRUE/FALSE

Value

The same input object with the appropriate fields filled in, in particular:

- table: Estimation and validation table

Author(s)

Diego J. Pedregal

See Also

PTSmodel, PTSsetup, PTSestim, PTScomponents, PTS

Examples

```
## Not run:
m1 <- PTSmodel(log(AirPassengers))
m1 <- PTSvalidate(m1)

## End(Not run)
```

`removeNaNs` *removeNaNs*

Description

Remove nans at beginning or end of vector

Usage

```
removeNaNs(x)
```

Arguments

`x`	a vector or a ts object

Value

vector with nans removed (only those at beginning or end)

Author(s)

Diego J. Pedregal

`residuals.ETS` *residuals.ETS*

Description

Residuals of ETS object

Residuals of PTS object

Usage

```
## S3 method for class 'ETS'
residuals(object, ...)

## S3 method for class 'PTS'
residuals(object, ...)
```

Arguments

`object`	Object of class "PTS".
`...`	Additional inputs to function.

Details

See help of ETS.

See help of PTS.

Author(s)

Diego J. Pedregal

See Also

ETS, ETSmodel, ETSvalidate, ETScomponents, ETSestim

PTS, PTSmodel, PTSvalidate, PTScomponents, PTSestim

Examples

```
## Not run:
m1 <- ETSmodel(log(gdp))
residuals(m1)

## End(Not run)
## Not run:
m1 <- PTSmodel(log(AirPassengers))
residuals(m1)

## End(Not run)
```

---

roots *roots*

Description

Roots of polynomial

Usage

```
roots(x)
```

Arguments

x	coefficients of polynomial in descending order

Value

Roots of polynomial

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, gaussTest, ident, cusum, varTest, conv, armaFilter, dif, zplane, acft, slide, plotSlide, Accuracy, tsDisplay, size

Examples

```
roots(c(1, -2 ,1))
roots(conv(c(1, -1), c(1, 0.8)))
```

---

rowMedians *rowMedians*

Description

Medians of matrix by rows

Usage

```
rowMedians(x, na.rm = TRUE, ...)
```

Arguments

x	a matrix
na.rm	boolean indicating whether to remove nans
...	rest of inputs

Value

A vector with all the medians

Author(s)

Diego J. Pedregal

See Also

colMedians, tests, sumStats, gaussTest, ident, cusum, varTest, conv, armaFilter, dif, roots, zplane, acft, slide, plotSlide, Accuracy, tsDisplay, size

Examples

```
s <- rowMedians(matrix(4, 3, 2))
```

sales *Sales index for large retailers in Spain*

Description

Sales index for food of large retailers in Spain

Usage

```
sales
```

Format

Time series objects.

Monthly data from January 1995 to December 2019

Source

sales

Examples

```
## Not run:
 sales

## End(Not run)
```

size *size*

Description

size of vectors or matrices

Size of vector, matrix or array

Usage

```
size(y)

size(y)
```

Arguments

y	a vector, matrix or array

Value

A vector with all the dimensions

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, gaussTest, ident, cusum, varTest, conv, armaFilter, dif, roots, zplane, acft, slide, plotSlide, Accuracy, tsDisplay

Examples

```
s <- size(matrix(4, 3, 2))
s <- size(rep(4, 3))
s <- size(array(4, c(3, 2, 2)))
```

---

slide *slide*

Description

Rolling forecasting of a matrix of time series

Usage

```
slide(
  y,
  orig,
  forecFun,
  ...,
  h = 12,
  step = 1,
  output = TRUE,
  window = NA,
  parallel = FALSE
)
```

Arguments

y	a vector or matrix of time series
orig	starting forecasting origin
forecFun	user function that implements forecasting methods
...	rest of inputs to forecFun function
h	forecasting horizon

step	observations ahead to move the forecasting origin
output	output TRUE/FALSE
window	fixed window width in number of observations (NA for non fixed)
parallel	run forecasts in parallel

Details

Takes a time series and run forecasting methods implemented in function forecFun h steps ahead along the time series y, starting at forecasting origin orig, and moving step observations ahead. Forecasts may be run in parallel by setting parallel to TRUE. A fixed window width may be specified with input window. The output is of dimensions (h, nOrigs, nModels, nSeries)

Value

A vector with all the dimensions

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, gaussTest, ident, cusum, varTest, conv, armaFilter, dif, roots, zplane, acft, plotSlide, Accuracy, tsDisplay, size

Examples

```
## Not run: slide(AirPassengers, 100, forecFun)
```

---

slideAux *slideAux*

Description

Auxiliary function run from slide

Usage

```
slideAux(
  y,
  orig,
  forecFun,
  h = 12,
  step = 1,
  output = TRUE,
  graph = TRUE,
  window = NA,
```

```
  parallel = FALSE,
  ...
)
```

Arguments

y	a vector or matrix of time series
orig	starting forecasting origin
forecFun	user function that implements forecasting methods
h	forecasting horizon
step	observations ahead to move the forecasting origin
output	output TRUE/FALSE
graph	fraphical output TRUE/FALSE
window	fixed window width in number of observations (NA for non fixed)
parallel	run forecasts in parallel
...	rest of inputs to forecFun function

Value

Next time stamp

Author(s)

Diego J. Pedregal

---

summary.ETS *summary.ETS*

Description

Prints an ETS object on screen

Usage

```
## S3 method for class 'ETS'
summary(object, ...)
```

Arguments

object	Object of class "ETS".
...	Additional inputs to function.

Details

See help of ETS.

Author(s)

Diego J. Pedregal

See Also

ETS, ETSmodel, ETSvalidate, ETScomponents, ETSestim

Examples

```
## Not run:
m1 <- ETSmodel(log(gdp))
summary(m1)

## End(Not run)
```

---

summary.PTS *summary.PTS*

Description

Prints an PTS object on screen

Usage

```
## S3 method for class 'PTS'
summary(object, ...)
```

Arguments

object	Object of class "PTS".
...	Additional inputs to function.

Details

See help of PTS.

Author(s)

Diego J. Pedregal

See Also

PTS, PTSmodel, PTSvalidate, PTScomponents, PTSestim

Examples

```
## Not run:
m1 <- PTSmodel(log(AirPassengers))
summary(m1)

## End(Not run)
```

---

sumStats *sumStats*

Description

Summary statistics of a matrix of variables

Usage

```
sumStats(y, decimals = 5)
```

Arguments

y	a vector, matrix of time series
decimals	number of decimals for table

Details

Position, dispersion, skewness, kurtosis, etc.

Value

Table of values

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, gaussTest, ident, cusum, varTest, conv, armaFilter, dif, roots, zplane, acft, slide, plotSlide, Accuracy, tsDisplay, size

Examples

```
s <- sumStats(AirPassengers)
```

tests *tests*

Description

Tests on a time series

Usage

```
tests(
  y,
  parts = 1/3,
  nCoef = min(25, length(x)/4),
  nPar = 0,
  s = frequency(y),
  avoid = 16
)
```

Arguments

y	a vector, ts or tsibble object
parts	proportion of sample to include in ratio of variances test
nCoef	number of autocorrelation coefficients to estimate
nPar	number of parameters in a model if y is a residual
s	seasonal period, number of observations per year
avoid	number of observations to avoid at beginning of sample to eliminate initial effects

Details

Multiple tests on a time series, including summary statistics, autocorrelation, Gaussianity and heteroskedasticity,

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, sumStats, gaussTest, ident, cusum, varTest, conv, armaFilter, dif, roots, zplane, acft, slide, plotSlide, Accuracy, tsDisplay, size

Examples

```
tests(AirPassengers)
```

tsDisplay *tsDisplay*

Description

Displays time series plot with autocorrelation functions

Usage

```
tsDisplay(y, nCoef = 25, nPar = 0, s = NA)
```

Arguments

y	a vector, ts or tsibble object
nCoef	number of autocorrelation coefficients to estimate
nPar	number of parameters in a model if y is a residual
s	seasonal period, number of observations per year

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, gaussTest, ident, cusum, varTest, conv, armaFilter, dif, roots, zplane, acft, slide, plotSlide, Accuracy, size

Examples

```
tsDisplay(AirPassengers)
```

UC *UC*

Description

Runs all relevant functions for UC modelling

Usage

```
UC(
  y,
  u = NULL,
  model = "?/none/?/?",
  h = 9999,
  lambda = 1,
  outlier = 9999,
  tTest = FALSE,
  criterion = "aic",
  periods = NA,
  verbose = FALSE,
  stepwise = FALSE,
  p0 = -9999.9,
  arma = TRUE,
  TVP = NULL,
  trendOptions = "none/rw/llt/dt",
  seasonalOptions = "none/equal/different",
  irregularOptions = "none/arma(0,0)"
)
```

Arguments

y	a time series to forecast (it may be either a numerical vector or a time series object). This is the only input required. If a vector, the additional input periods should be supplied compulsorily (see below).
u	a matrix of external regressors included only in the observation equation. (it may be either a numerical vector or a time series object). If the output wanted to be forecast, matrix u should contain future values for inputs.
model	the model to estimate. It is a single string indicating the type of model for each component. It allows two formats "trend/seasonal/irregular" or "trend/cycle/seasonal/irregular". The possibilities available for each component are: • Trend: ? / none / rw / irw / llt / dt / td; • Seasonal: ? / none / equal / different; • Irregular: ? / none / arma(0, 0) / arma(p, q) - with p and q integer positive orders; • Cycles: ? / none / combination of positive or negative numbers. Positive numbers fix the period of the cycle while negative values estimate the period taking as initial condition the absolute value of the period supplied. Several cycles with positive or negative values are possible and if a question mark is included, the model test for the existence of the cycles specified. The following are valid examples with different meanings: 48, 48?, -48, -48?, 48+60, -48+60, -48-60, 48-60, 48+60?, -48+60?, -48-60?, 48-60?.
h	forecast horizon. If the model includes inputs h is not used, the lenght of u is used instead.
lambda	Box-Cox transformation lambda, NULL for automatic estimation

outlier	critical level of outlier tests. If NA it does not carry out any outlier detection (default). A positive value indicates the critical minimum t test for outlier detection in any model during identification. Three types of outliers are identified, namely Additive Outliers (AO), Level Shifts (LS) and Slope Change (SC).
tTest	augmented Dickey Fuller test for unit roots used in stepwise algorithm (TRUE / FALSE). The number of models to search for is reduced, depending on the result of this test.
criterion	information criterion for identification ("aic", "bic" or "aicc").
periods	vector of fundamental period and harmonics required.
verbose	intermediate results shown about progress of estimation (TRUE / FALSE).
stepwise	stepwise identification procedure (TRUE / FALSE).
p0	initial parameter vector for optimisation search.
arma	check for arma models for irregular components (TRUE / FALSE).
TVP	vector of zeros and ones to indicate TVP parameters.
trendOptions	trend models to select amongst (e.g., "rw/llt").
seasonalOptions	seasonal models to select amongst (e.g., "none/differentt").
irregularOptions	irregular models to select amongst (e.g., "none/arma(0,1)").

Details

UC is a function for modelling and forecasting univariate time series according to Unobserved Components models (UC). It sets up the model with a number of control variables that govern the way the rest of functions in the package work. It also estimates the model parameters by Maximum Likelihood, forecasts the data, performs smoothing, estimates model disturbances, estimates components and shows statistical diagnostics. Standard methods applicable to UComp objects are print, summary, plot, fitted, residuals, logLik, AIC, BIC, coef, predict, tsdiag.

Value

An object of class UComp. It is a list with fields including all the inputs and the fields listed below as outputs. All the functions in this package fill in part of the fields of any UComp object as specified in what follows (function UC fills in all of them at once):

After running UCmodel or UCestim:

- p: Estimated parameters
- v: Estimated innovations (white noise in correctly specified models)
- yFor: Forecasted values of output
- yForV: Forecasted values +- one standard error
- criteria: Value of criteria for estimated model
- iter: Number of iterations in estimation
- grad: Gradient at estimated parameters
- covp: Covariance matrix of parameters

After running UCvalidate:

- table: Estimation and validation table

After running UCcomponents:

- comp: Estimated components in matrix form
- compV: Estimated components variance in matrix form

After running UCfilter, UCsmooth or UCdisturb:

- yFit: Fitted values of output
- yFitV: Variance of fitted values of output
- a: State estimates
- P: Variance of state estimates
- aFor: Forecasts of states
- PFor: Forecasts of states variances

After running UCdisturb:

- eta: State perturbations estimates
- eps: Observed perturbations estimates

Author(s)

Diego J. Pedregal

See Also

UC, UCvalidate, UCfilter, UCsmooth, UCdisturb, UCcomponents, UChp

Examples

```
## Not run:
y <- log(AirPassengers)
m1 <- UC(y)
m1 <- UC(y, model = "llt/different/arma(0,0)")

## End(Not run)
```

UCcomponents *UCcomponents*

Description

Estimates unobserved components of UC models Standard methods applicable to UComp objects are print, summary, plot, fitted, residuals, logLik, AIC, BIC, coef, predict, tsdiag.

Usage

```
UCcomponents(sys)
```

Arguments

sys	an object of type UComp created with UC or UCmodel

Value

The same input object with the appropriate fields filled in, in particular:

- comp: Estimated components in matrix form
- compV: Estimated components variance in matrix form

Author(s)

Diego J. Pedregal

See Also

UC, UCmodel, UCvalidate, UCfilter, UCsmooth, UCdisturb, UChp

Examples

```
## Not run:
m1 <- UC(log(AirPassengers))
m1 <- UCcomponents(m1)

## End(Not run)
```

UCdisturb *UCdisturb*

Description

Runs the Disturbance Smoother for UC models Standard methods applicable to UComp objects are print, summary, plot, fitted, residuals, logLik, AIC, BIC, coef, predict, tsdiag.

Usage

```
UCdisturb(sys)
```

Arguments

sys	an object of type UComp created with UC

Value

The same input object with the appropriate fields filled in, in particular:

- yFit: Fitted values of output
- yFitV: Variance of fitted values of output
- a: State estimates
- P: Variance of state estimates (diagonal of covariance matrices)
- eta: State perturbations estimates
- eps: Observed perturbations estimates

Author(s)

Diego J. Pedregal

See Also

UC, UCmodel, UCvalidate, UCfilter, UCsmooth, UCcomponents, UChp

Examples

```
## Not run:
m1 <- UC(log(AirPassengers))
m1 <- UCdisturb(m1)

## End(Not run)
```

UCestim *UCestim*

Description

Estimates and forecasts UC models

Usage

```
UCestim(sys)
```

Arguments

sys	an object of type UComp created with UC

Details

UCestim estimates and forecasts a time series using an UC model. The optimization method is a BFGS quasi-Newton algorithm with a backtracking line search using Armijo conditions. Parameter names in output table are the following:

- Damping: Damping factor for DT trend.
- Level: Variance of level disturbance.
- Slope: Variance of slope disturbance.
- Rho(#): Damping factor of cycle #.
- Period(#): Estimated period of cycle #.
- Var(#): Variance of cycle #.
- Seas(#): Seasonal harmonic with period #.
- Irregular: Variance of irregular component.
- AR(#): AR parameter of lag #.
- MA(#): MA parameter of lag #.
- AO#: Additive outlier in observation #.
- LS#: Level shift outlier in observation #.
- SC#: Slope change outlier in observation #.
- Beta(#): Beta parameter of input #.
- Cnst: Constant.

Standard methods applicable to UComp objects are print, summary, plot, fitted, residuals, logLik, AIC, BIC, coef, predict, tsdiag.

Value

The same input object with the appropriate fields filled in, in particular:

- p: Estimated transformed parameters
- v: Estimated innovations (white noise in correctly specified models)
- yFor: Forecast values of output
- yForV: Forecasted values variance
- criteria: Value of criteria for estimated model
- covp: Covariance matrix of estimated transformed parameters
- grad: Gradient of log-likelihood at the optimum
- iter: Estimation iterations

Author(s)

Diego J. Pedregal

See Also

UC, UCmodel, UCvalidate, UCfilter, UCsmooth, UCdisturb, UCcomponents, UChp

Examples

```
## Not run:
m1 <- UCsetup(log(AirPassengers))
m1 <- UCestim(m1)

## End(Not run)
```

`UCfilter` *UCfilter*

Description

Runs the Kalman Filter for UC models Standard methods applicable to `UComp` objects are print, summary, plot, fitted, residuals, logLik, AIC, BIC, coef, predict, tsdiag.

Usage

```
UCfilter(sys)
```

Arguments

`sys`	an object of type `UComp` created with `UC`

Value

The same input object with the appropriate fields filled in, in particular:

- yFit: Fitted values of output
- yFitV: Variance of fitted values of output
- a: State estimates
- P: Variance of state estimates (diagonal of covariance matrices)

Author(s)

Diego J. Pedregal

See Also

UC, UCmodel, UCvalidate, UCsmooth, UCdisturb, UCcomponents, UChp

Examples

```
## Not run:
m1 <- UC(log(AirPassengers))
m1 <- UCfilter(m1)

## End(Not run)
```

UChp *UChp*

Description

Hodrick-Prescott filter estimation

Usage

```
UChp(y, lambda = 1600)
```

Arguments

y	A time series object
lambda	Smoothing constant (default: 1600)

Value

The cycle estimation

Author(s)

Diego J. Pedregal

See Also

UC, UCmodel, UCvalidate, UCfilter, UCsmooth, UCcomponents, UCdisturb

Examples

```
## Not run:
cycle <- UChp(USgdp)
plot(cycle)

## End(Not run)
```

UCmodel *UCmodel*

Description

Estimates and forecasts UC general univariate models

Usage

```
UCmodel(
  y,
  u = NULL,
  model = "?/none/?/?",
  h = 9999,
  lambda = 1,
  outlier = 9999,
  tTest = FALSE,
  criterion = "aic",
  periods = NA,
  verbose = FALSE,
  stepwise = FALSE,
  p0 = -9999.9,
  arma = TRUE,
  TVP = NULL,
  trendOptions = "none/rw/llt/dt",
  seasonalOptions = "none/equal/different",
  irregularOptions = "none/arma(0,0)"
)
```

Arguments

y	a time series to forecast (it may be either a numerical vector or a time series object). This is the only input required. If a vector, the additional input periods should be supplied compulsorily (see below).
u	a matrix of external regressors included only in the observation equation. (it may be either a numerical vector or a time series object). If the output wanted to be forecast, matrix u should contain future values for inputs.

`model` the model to estimate. It is a single string indicating the type of model for each component. It allows two formats "trend/seasonal/irregular" or "trend/cycle/seasonal/irregular". The possibilities available for each component are:

- Trend: ? / none / rw / irw / llt / dt / td;
- Seasonal: ? / none / equal / different;
- Irregular: ? / none / arma(0, 0) / arma(p, q) - with p and q integer positive orders;
- Cycles: ? / none / combination of positive or negative numbers. Positive numbers fix the period of the cycle while negative values estimate the period taking as initial condition the absolute value of the period supplied. Several cycles with positive or negative values are possible and if a question mark is included, the model test for the existence of the cycles specified. The following are valid examples with different meanings: 48, 48?, -48, -48?, 48+60, -48+60, -48-60, 48-60, 48+60?, -48+60?, -48-60?, 48-60?.

`h` forecast horizon. If the model includes inputs h is not used, the lenght of u is used instead.

`lambda` Box-Cox transformation lambda, NULL for automatic estimation

`outlier` critical level of outlier tests. If NA it does not carry out any outlier detection (default). A positive value indicates the critical minimum t test for outlier detection in any model during identification. Three types of outliers are identified, namely Additive Outliers (AO), Level Shifts (LS) and Slope Change (SC).

`tTest` augmented Dickey Fuller test for unit roots used in stepwise algorithm (TRUE / FALSE). The number of models to search for is reduced, depending on the result of this test.

`criterion` information criterion for identification ("aic", "bic" or "aicc").

`periods` vector of fundamental period and harmonics required.

`verbose` intermediate results shown about progress of estimation (TRUE / FALSE).

`stepwise` stepwise identification procedure (TRUE / FALSE).

`p0` initial parameter vector for optimisation search.

`arma` check for arma models for irregular components (TRUE / FALSE).

`TVP` vector of zeros and ones to indicate TVP parameters.

`trendOptions` trend models to select amongst (e.g., "rw/llt").

`seasonalOptions` seasonal models to select amongst (e.g., "none/differentt").

`irregularOptions` irregular models to select amongst (e.g., "none/arma(0,1)").

Details

`UCmodel` is a function for modelling and forecasting univariate time series according to Unobserved Components models (UC). It sets up the model with a number of control variables that govern the way the rest of functions in the package work. It also estimates the model parameters by Maximum Likelihood and forecasts the data. Standard methods applicable to UComp objects are print, summary, plot, fitted, residuals, logLik, AIC, BIC, coef, predict, tsdiag.

Value

An object of class UComp. It is a list with fields including all the inputs and the fields listed below as outputs. All the functions in this package fill in part of the fields of any UComp object as specified in what follows (function UC fills in all of them at once):

After running UCmodel or UCestim:

- p: Estimated parameters
- v: Estimated innovations (white noise in correctly specified models)
- yFor: Forecasted values of output
- yForV: Forecasted values +- one standard error
- criteria: Value of criteria for estimated model
- iter: Number of iterations in estimation
- grad: Gradient at estimated parameters
- covp: Covariance matrix of parameters

After running UCvalidate:

- table: Estimation and validation table

After running UCcomponents:

- comp: Estimated components in matrix form
- compV: Estimated components variance in matrix form

After running UCfilter, UCsmooth or UCdisturb:

- yFit: Fitted values of output
- yFitV: Variance of fitted values of output
- a: State estimates
- P: Variance of state estimates
- aFor: Forecasts of states
- PFor: Forecasts of states variances

After running UCdisturb:

- eta: State perturbations estimates
- eps: Observed perturbations estimates

Author(s)

Diego J. Pedregal

See Also

UC, UCvalidate, UCfilter, UCsmooth, UCdisturb, UCcomponents, UChp

Examples

```
## Not run:
y <- log(AirPassengers)
m1 <- UCmodel(y)
m1 <- UCmodel(y, model = "llt/equal/arma(0,0)")

## End(Not run)
```

UComp *UComp*

Description

A package for fast automatic identification of Time series models of several kinds

Details

UComp is a package for time series modelling and forecasting of times series models inspired on different sources: 1. the structural Unobserved Components models due to A.C. Harvey (Basic Structural Model: BSM), enhanced with automatic identification tools by Diego J. Pedregal. 2. ExponenTial Smoothing by R.J. Hyndman and colaborators. The package is designed for automatic identification among a wide range of possible models for trends, cycles, seasonal and irregular components. The models may include exogenous variables. ARMA irregular components and automatic detection of outliers are also possible.

References

Harvey AC (1989). Forecasting, Structural Time Series Models and the Kalman Filter. Cam- bridge University Press.

de Jong, P & Penzer, J (1998). Diagnosing Shocks in Time Series, Journal of the American Statistical Association, 93, 442, 796-806.

Pedregal, DJ, & Young, PC (2002). Statistical approaches to modelling and forecasting time series. In M. Clements, & D. Hendry (Eds.), Companion to economic forecasting (pp. 69–104). Oxford: Blackwell Publishers.

Durbin J, Koopman SJ (2012). Time Series Analysis by State Space Methods. 38. Oxford University Press.

Proietti T and Luati A (2013). Maximum likelihood estimation of time series models: the Kalman filter and beyond, in Handbook of research methods and applications in empirical macroeconomics, ed. Nigar Hashimzade and Michael Thornton, E. Elgar, UK.

Hyndman RJ, Koehler AB, Ord JK and Snyder RD (2008), Forecasting with exponential smoothing, The State Sapce approach, Berlin, Springer-Verlag.

Maintainer

Diego J. Pedregal

Author(s)

Diego J. Pedregal

`UCsetup` *UCsetup*

Description

Sets up UC general univariate models

Usage

```
UCsetup(
  y,
  u = NULL,
  model = "?/none/?/?",
  h = 9999,
  lambda = 1,
  outlier = 9999,
  tTest = FALSE,
  criterion = "aic",
  periods = NA,
  verbose = FALSE,
  stepwise = FALSE,
  p0 = -9999.9,
  arma = FALSE,
  TVP = NULL,
  trendOptions = "none/rw/llt/dt",
  seasonalOptions = "none/equal/different",
  irregularOptions = "none/arma(0,0)"
)
```

Arguments

`y`	a time series to forecast (it may be either a numerical vector or a time series object). This is the only input required. If a vector, the additional input `periods` should be supplied compulsorily (see below).
`u`	a matrix of external regressors included only in the observation equation. (it may be either a numerical vector or a time series object). If the output wanted to be forecast, matrix `u` should contain future values for inputs.
`model`	the model to estimate. It is a single string indicating the type of model for each component. It allows two formats "trend/seasonal/irregular" or "trend/cycle/seasonal/irregular". The possibilities available for each component are: • Trend: ? / none / rw / irw / llt / dt / td; • Seasonal: ? / none / equal / different;

- Irregular: ? / none / arma(0, 0) / arma(p, q) - with p and q integer positive orders;
- Cycles: ? / none / combination of positive or negative numbers. Positive numbers fix the period of the cycle while negative values estimate the period taking as initial condition the absolute value of the period supplied. Several cycles with positive or negative values are possible and if a question mark is included, the model test for the existence of the cycles specified. The following are valid examples with different meanings: 48, 48?, -48, -48?, 48+60, -48+60, -48-60, 48-60, 48+60?, -48+60?, -48-60?, 48-60?.

`h` forecast horizon. If the model includes inputs h is not used, the lenght of u is used instead.

`lambda` Box-Cox transformation lambda, NULL for automatic estimation

`outlier` critical level of outlier tests. If NA it does not carry out any outlier detection (default). A positive value indicates the critical minimum t test for outlier detection in any model during identification. Three types of outliers are identified, namely Additive Outliers (AO), Level Shifts (LS) and Slope Change (SC).

`tTest` augmented Dickey Fuller test for unit roots used in stepwise algorithm (TRUE / FALSE). The number of models to search for is reduced, depending on the result of this test.

`criterion` information criterion for identification ("aic", "bic" or "aicc").

`periods` vector of fundamental period and harmonics required.

`verbose` intermediate results shown about progress of estimation (TRUE / FALSE).

`stepwise` stepwise identification procedure (TRUE / FALSE).

`p0` initial parameter vector for optimisation search.

`arma` check for arma models for irregular components (TRUE / FALSE).

`TVP` vector of zeros and ones to indicate TVP parameters.

`trendOptions` trend models to select amongst (e.g., "rw/llt").

`seasonalOptions`
seasonal models to select amongst (e.g., "none/differentt").

`irregularOptions`
irregular models to select amongst (e.g., "none/arma(0,1)").

Details

See help of `UC`.

Value

An object of class `UComp`. It is a list with fields including all the inputs and the fields listed below as outputs. All the functions in this package fill in part of the fields of any `UComp` object as specified in what follows (function `UC` fills in all of them at once):

After running `UCmodel` or `UCestim`:

- p: Estimated parameters

- v: Estimated innovations (white noise in correctly specified models)
- yFor: Forecasted values of output
- yForV: Variance of forecasts
- criteria: Value of criteria for estimated model
- iter: Number of iterations in estimation
- grad: Gradient at estimated parameters
- covp: Covariance matrix of parameters

After running `UCvalidate`:

- table: Estimation and validation table

After running `UCcomponents`:

- comp: Estimated components in matrix form
- compV: Estimated components variance in matrix form

After running `UCfilter`, `UCsmooth` or `UCdisturb`:

- yFit: Fitted values of output
- yFitV: Estimated fitted values variance
- a: State estimates
- P: Variance of state estimates
- aFor: Forecasts of states
- PFor: Forecasts of states variances

After running `UCdisturb`:

- eta: State perturbations estimates
- eps: Observed perturbations estimates

Standard methods applicable to UComp objects are print, summary, plot, fitted, residuals, logLik, AIC, BIC, coef, predict, tsdiag.

Author(s)

Diego J. Pedregal

See Also

`UC`, `UCmodel`, `UCvalidate`, `UCfilter`, `UCsmooth`, `UCdisturb`, `UCcomponents`, `UChp`

Examples

```
## Not run:
y <- log(AirPassengers)
m1 <- UCsetup(y)
m1 <- UCsetup(y, outlier = 4)
m1 <- UCsetup(y, model = "llt/equal/arma(0,0)")
m1 <- UCsetup(y, model = "?/?/?/?")
m1 <- UCsetup(y, model = "llt/?/equal/?", outlier = 4)

## End(Not run)
```

UCsmooth *UCsmooth*

Description

Runs the Fixed Interval Smoother for UC models Standard methods applicable to UComp objects are print, summary, plot, fitted, residuals, logLik, AIC, BIC, coef, predict, tsdiag.

Usage

```
UCsmooth(sys)
```

Arguments

sys	an object of type UComp created with UC

Value

The same input object with the appropriate fields filled in, in particular:

- yFit: Fitted values of output
- yFitV: Variance of fitted values of output
- a: State estimates
- P: Variance of state estimates (diagonal of covariance matrices)

Author(s)

Diego J. Pedregal

See Also

UC, UCmodel, UCvalidate, UCfilter, UCdisturb, UCcomponents, UChp

Examples

```
## Not run:
m1 <- UC(log(AirPassengers))
m1 <- UCsmooth(m1)

## End(Not run)
```

`UCvalidate` *UCvalidate*

Description

Shows a table of estimation and diagnostics results for UC models. Equivalent to print or summary. The table shows information in four sections: Firstly, information about the model estimated, the relevant periods of the seasonal component included, and further information about convergence. Secondly, parameters with their names are provided, the asymptotic standard errors, the ratio of the two, and the gradient at the optimum. One asterisk indicates concentrated-out parameters and two asterisks signals parameters constrained during estimation. Thirdly, information criteria and the value of the log-likelihood. Finally, diagnostic statistics about innovations, namely, the Ljung-Box Q test of absense of autocorrelation statistic for several lags, the Jarque-Bera gaussianity test, and a standard ratio of variances test.

Usage

```
UCvalidate(sys, printScreen = TRUE)
```

Arguments

`sys`	an object of type `UComp` created with `UC`
`printScreen`	print to screen or just return output table

Value

The same input object with the appropriate fields filled in, in particular:

- table: Estimation and validation table

Author(s)

Diego J. Pedregal

See Also

`UC`, `UCmodel`, `UCfilter`, `UCsmooth`, `UCdisturb`, `UCcomponents`, `UChp`

Examples

```
## Not run:
m1 <- UC(log(gdp))
m1 <- UCvalidate(m1)

## End(Not run)
```

USgdp *US GDP*

Description

Seasonally adjusted quarterly US real gross domestic product (USgdp).

Usage

```
USgdp
```

Format

Time series objects.

Quarterly data from 1962 to 2019

Source

USgdp

Examples

```
## Not run:
 USgdp

## End(Not run)
```

---

varTest *varTest*

Description

Ratio of variances test

Usage

```
varTest(y, parts = 1/3)
```

Arguments

y	a vector, ts or tsibble object
parts	portion of sample to estimate variances

Value

Table with test results

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, gaussTest, ident, cusum, conv, armaFilter, dif, roots, zplane, acft, slide, plotSlide, Accuracy, tsDisplay, size

Examples

```
varTest(AirPassengers)
```

---

zplane *zplane*

Description

Real-imaginary plane to show roots of digital filters (ARMA)

Usage

```
zplane(MApoly = 1, ARpoly = 1)
```

Arguments

MApoly	coefficients of numerator polynomial in descending order
ARpoly	coefficients of denominator polynomial in descending order

Details

Shows the real-imaginary plane to show zeros (roots of numerator or MA polynomial) and poles (roots of denominator of AR polynomial). Unit roots and real vs imaginary roots can be seen by eye

Author(s)

Diego J. Pedregal

See Also

colMedians, rowMedians, tests, sumStats, gaussTest, ident, cusum, varTest, conv, armaFilter, dif, roots, acft, slide, plotSlide, Accuracy, tsDisplay, size

Examples

```
zplane(c(1, -2, 1), c(1, -0.8))
```

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