Package ‘mar1s’

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Description Multiplicative AR(1) with Seasonal is a stochastic process model built on top of AR(1). The package provides the following procedures for MAR(1)S processes: fit, compose, decompose, advanced simulate and predict.
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compose.ar1

Compose and Decompose AR(1) Process

Description

compose.ar1 composes AR(1) process realization by given vector(s) of innovations.
decompose.ar1 extracts AR(1) process residuals from time series.

Usage

compose.ar1(arcoef, innov, init = 0, xregcoef = 0, xreg = NULL,
             init.xreg = rep(0, length(xregcoef)))
decompose.ar1(arcoef, data, init = NA, xregcoef = 0, xreg = NULL,
              init.xreg = rep(NA, length(xregcoef)))

Arguments

arcoef A number specifying autoregression coefficient.
innov A univariate or multivariate time series containing the innovations.
data A univariate or multivariate time series containing the process realization(s).
init A number specifying the value of the process just prior to the start value in
     innov/data.
xregcoef A vector specifying coefficients for the external regressors.
xreg A matrix-like object of the same row count as innov/data, specifying the values
      of external regressors. The default NULL means zeroes.
init.xreg A vector specifying the values of external regressors just prior to the start values
       in xreg. The default NULL means zeroes.

Details

Here AR(1) process with external regressors is a linear regression with AR(1) model for the error
term:

\[ y_t = b_1 x_{t,1} + \ldots + b_k x_{t,k} + z_t \]

\[ z_t = az_{t-1} + e_t \]

Use xreg = NULL for the regular AR(1) process.

Value

An object of the same type and dimensions as innov/data (typically time series).
See Also

arima for more general ARMA\((p, q)\) processes.

Examples

```r
## Simple
e <- ts(c(0, 1, 0, 1, 0), freq = 12)
compose.ar1(0.1, e)
compose.ar1(0.1, e, 1)

x <- ts(c(0, 1, 0, 1, 0), freq = 12)
decompose.ar1(0.1, x)
decompose.ar1(0.1, x, 1)

## Multiseries
compose.ar1(0.1, ts(cbind(0, 1)))
compose.ar1(0.1, ts(cbind(c(0, 1, 0), c(1, 0, 1))))

decompose.ar1(0.1, ts(cbind(0, 1)))
decompose.ar1(0.1, ts(cbind(c(0, 1, 0), c(1, 0, 1))))

## External regressors
xreg1 <- rep(2, 5)
xreg2 <- matrix(rep(c(2, 1), each = 5), 5, 2)
e <- ts(c(0, 1, 0, 1, 0), freq = 12)
compose.ar1(0.1, e, xregcoef = 0.5, xreg = xreg1)
compose.ar1(0.1, e, xregcoef = 0.5, init = 0, xreg = xreg1, init.xreg = -2)
compose.ar1(0.1, e, xregcoef = c(1,-1), xreg = xreg2)

x <- ts(c(0, 1, 0, 1, 0), freq = 12)
decompose.ar1(0.1, x, xregcoef = 0.5, xreg = xreg1)
decompose.ar1(0.1, x, xregcoef = 0.5, init = 0, xreg = xreg1, init.xreg = -2)
decompose.ar1(0.1, x, xregcoef = c(1,-1), xreg = xreg2)

## Back-test
a <- 0.5
innov <- ts(rnorm(10), frequency = 12)
init <- 1
xrcbrw <- seq(-0.1, 0.1, length.out = 3)
xreg <- matrix(1:30, 10, 3)
init.xreg <- 1:3
x <- compose.ar1(a, innov, init, xrcbrw, xreg, init.xreg)
r <- decompose.ar1(a, x, init, xrcbrw, xreg, init.xreg)
stopifnot(all.equal(innov, r))
```

---

**compose.mar1s**

Compose and Decompose MAR\((1)S\) Process
compose.mar1s composes MAR(1)S process realization by given vector of log-innovations. 
decompose.mar1s extracts MAR(1)S process components from time series.

Usage

compose.mar1s(object, loginnov, start.time = head(time(loginnov), 1), 
xreg.absdata = NULL, init.absdata = NULL)

decompose.mar1s(object, absdata, start.time = head(time(absdata), 1), 
init.absdata = rep(NA, NCOL(absdata)))

Arguments

object An object of class "mar1s" specifying the model parameters.
loginnov A univariate time series containing the log-innovations.
absdata A univariate or multivariate time series containing the process realization.
start.time The sampling time for the first simulation step.
xreg.absdata A matrix-like object with row count = n.ahead, specifying the values for the 
external regressors. If NULL, default values are used.
init.absdata A vector specifying the initial values of the process. If NULL, default values are 
used.

Details

Multiplicative AR(1) with Seasonal (MAR(1)S) process is defined as

\[ x_t = \exp(s_t + y_t) \]

\[ y_{t,1} = b_1 y_{t,2} + \ldots + b_k y_{t,k+1} + z_t \]

\[ z_t = a z_{t-1} + e_t \]

where

- \( s_t \) is the log-seasonal component,
- \( y_t \) is the AR(1) (log-stochastic) component,
- \( e_t \) is the log-residuals (random component).

Value

- absdata Realization of the process (a univariate or multivariate time series object).
- logdata Logarithm of absdata (a univariate or multivariate time series object).
- logstoch Log-stochastic component (a univariate or multivariate time series object).
- logresid Random component (a univariate time series object).
Note

decompose.mar1s and fit.mar1s compute the random component in different ways: decompose.mar1s uses filter while fit.mar1s saves the residuals returned by arima. The results may be different in:

the first value: decompose.mar1s uses specified init.absdata while arima always assumes zero initial values for the fitted process;

non-finite values: decompose.mar1s handles non-finite values more accurately.

See Also

compose.ar1 for the AR(1) with external regressors processes, fit.mar1s for fitting MAR(1)S process to data, sim.mar1s for MAR(1)S process simulation and prediction.

Examples

data(forest.fire, package = "mar1s")
data(nesterov.index, package = "mar1s")

## Simple
mar1s <- fit.mar1s(window(forest.fire, 1969, 1989))
x <- ts(rnorm(365, sd = mar1s$logresid.sd), start = c(1989, 1))
plot(compose.mar1s(mar1s, x)$absdata)

decomp <- decompose.mar1s(mar1s, mar1s$decomposed$absdata)
delta <- abs(nan2na(mar1s$decomposed$logresid) - nan2na(decomp$logresid))
stopifnot(all(na.exclude(tail(delta, -1)) < 1e-6))

## External regressors
mar1s <- fit.mar1s(window(forest.fire, 1969, 1989),
                   window(nesterov.index[, "mean"], 1969, 1989))
x <- rnorm(365, sd = mar1s$logresid.sd)
xreg <- window(nesterov.index[, "mean"], 1989.001, 1990)
plot(compose.mar1s(mar1s, x, c(1989, 1), xreg)$absdata)

decomp <- decompose.mar1s(mar1s, mar1s$decomposed$absdata)
delta <- abs(mar1s$decomposed$logstoch - decomp$logstoch)
stopifnot(all(na.exclude(delta) < 1e-6))
delta <- abs(nan2na(mar1s$decomposed$logresid) - nan2na(decomp$logresid))
stopifnot(all(na.exclude(tail(delta, -1)) < 1e-6))
Description

Fits Multiplicative AR(1) with Seasonal process model to time series.

Usage

fit.mar1s(x, xreg = NULL, seasonal.fun = seasonal.smooth, ...)

Arguments

x
A univariate time series.

xreg
A univariate or multivariate time series of external regressors, or NULL.

seasonal.fun
A function which takes a univariate time series as its first argument and returns the estimated seasonal component.

... Additional arguments passed to seasonal.fun.

Value

An object of class "mar1s" with the following components:

logseasonal Estimated log-seasonal figure (a univariate or multivariate time series object).

logstoch.ar1 AR(1) with external regressors model fitted for the log-stochastic component (an object of class "Arima").

logresid.sd Standard deviation of the residuals.

decomposed An object of class "mar1s.ts" containing decomposed time series (see compose.mar1s).

See Also

compose.mar1s for MAR(1)S process formal definition and composition/decomposition functions, seasonal.ave, seasonal.smooth for seasonal component extraction functions, sim.mar1s for MAR(1)S process simulation and prediction.

Examples

data(forest.fire, package = "mar1s")
data(nesterov.index, package = "mar1s")

## Simple
mar1s <- fit.mar1s(forest.fire)
plot(mar1s$logseasonal)
confint(mar1s$logstoch.ar1)
mar1s$logresid.sd
resid <- nan2na(mar1s$decomposed$logresid)
qqnorm(resid)
qqline(resid)

## External regressors
mar1s <- fit.mar1s(forest.fire, nesterov.index[, "mean"])
plot(cbind(mar1s$logseasonal, mar1s$logseasonal.r))
confint(mar1s$logstoch.ar1)
forest.fire

Description

Number of forest fire seats in Irkutsk region, USSR. Daily from April 01 to October 31, 1969–1991 (total 4708 observations).

Usage

data(forest.fire)

Format

A univariate time series.

Source


Examples

data(forest.fire)
colnames(forest.fire)
plot(forest.fire)

nesterov.index

Nesterov index in Irkutsk region, USSR: historical data

Description

Values of Nesterov index in 6 distincts of Irkutsk region, USSR + region averaged. Daily from April 01 to October 31, 1969–1991 (total 4708 observations).

Usage

data(nesterov.index)

Format

A multivariate time series.
Details
The Nesterov index is the official Russian fire-danger rating specified by standard GOST R 22.1.09–99. It is calculated using the ignition index, the temperature, the dew-point temperature and the number of days since last significant ($\geq 3\text{mm}$) precipitation.

Source
Russian Institute of Hydrometeorological Information–World Data Center (http://meteo.ru/english/).

Examples
data(nesterov.index)
colnames(nesterov.index)
plot(nesterov.index)

seasonal.ave Averaged Seasonal Component of Time Series

Description
Extracts seasonal component of time series by averaging observations on the same position in the cycle.

Usage
seasonal.ave(x, ave.FUN = mean, ...)

Arguments
x A univariate time series.
ave.FUN Averaging function.
... Additional arguments passed to ave.FUN.

Value
A time series object with times from 0 to 1 and the same frequency as x.

See Also
ave, seasonal.smooth for alternative seasonal extraction method.
seasonal.smooth

**Examples**

```r
set.seed(19860306)

## Artificial example
x <- ts(sin(2*pi*(3:97)/10) + 0.5*rnorm(length(3:97)),
  start = c(0, 3), frequency = 10)

plot.default(time(x)%>%1, x, xlab = "Phase")
lines(seasonal.ave(x), col = "blue")
lines(seasonal.ave(x, median), col = "green")
legend("bottomleft",
  legend = c("Mean averaging",
  "Median averaging"),
  col = c("blue", "green"),
  lty = "solid")

## Realistic example
data(nesterov.index, package = "marlvs")
x <- log(nesterov.index[, "mean"])
x[x < -Inf] <- -Inf

plot.default(time(x)%>%1, x, xlab = "Phase", pch = ".")
lines(seasonal.ave(x), col = "blue")
lines(seasonal.ave(x, median), col = "green")
legend("topleft",
  legend = c("Mean averaging",
  "Median averaging"),
  col = c("blue", "green"),
  lty = "solid")
```

**Description**

Extracts seasonal component of time series by fitting the data with a linear combination of smooth periodic functions.

**Usage**

```r
seasonal.smooth(x, basis = create.fourier.basis(nbasis = 3), lambda = 0, ...)
```

**Arguments**

- `x` A univariate time series.
- `basis` A functional basis object (see `basisfd`). By default, use a linear combination of `const.sin((2*pi)*t)` and `cos((2*pi)*t)`.
- `lambda` A nonnegative number specifying the amount of smoothing. By default, apply no additional smoothing.
- `...` Not currently used.
**Details**

Although it is possible to specify arbitrary functional basis object, the function will only work properly if the basis is periodical on the unit interval. It is recommended to use a Fourier basis with default period (`create.fourier.basis`).

Positive values of \( \lambda \) imply a restriction on roughness of the result. The more the value, the more smooth result is; see `smooth.basis` for more detailed description.

**Value**

A time series object with times from 0 to 1 and the same frequency as \( x \). The smoothing functional data object is stored in attribute `fd`.

**See Also**

`smooth.basisPar.fd` for functional data objects, `seasonal.ave` for alternative seasonal extraction method.

**Examples**

```r
set.seed(19860306)

## Artificial example
x <- ts(sin(2*pi*(3:97)/10) + 0.5*rnorm(length(3:97)),
start = c(0, 3), frequency = 10)

fourier3 <- seasonal.smooth(x)
fourier9 <- seasonal.smooth(x, create.fourier.basis(nbasis = 9))
fourier9s <- seasonal.smooth(x, create.fourier.basis(nbasis = 9), 1E-6)

plot.default(time(x), x, xlab = "Phase")
points(fourier3, pch = 20, col = "blue")
lines(attr(fourier3, "fd"), col = "blue")
points(fourier9, pch = 20, col = "green")
lines(attr(fourier9, "fd"), col = "green")
points(fourier9s, pch = 20, col = "red")
lines(attr(fourier9s, "fd"), col = "red")
legend("bottomleft",
  legend = c("Fourier-3 basis",
  "Fourier-9 basis",
  "Fourier-9 basis, smooth"),
  col = c("blue", "green", "red"),
  lty = "solid")

## Realistic example
data(nesterov.index, package = "marl1s")
x <- log(nesterov.index[, "mean"])
x[x < -10] <- -Inf

fourier3 <- seasonal.smooth(x)
fourier9 <- seasonal.smooth(x, create.fourier.basis(nbasis = 9))
fourier9s <- seasonal.smooth(x, create.fourier.basis(nbasis = 9), 1E-5)
```

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*seasonal.smooth*
**Description**

`sim.mar1s` simulates from MAR(1)S process.

`predict.mar1s` is a wrapper around `sim.mar1s` which estimates confidence intervals for the future values of the MAR(1)S process.

**Usage**

```r
sim.mar1s(object, n.ahead = 1, n.sim = 1, start.time = 0,
          xreg.absdata = NULL, init.absdata = NULL)
```

```r
## S3 method for class 'mar1s'
predict(object, n.ahead = 1, start.time = 0,
         xreg.absdata = NULL, init.absdata = NULL,
         probs = c(0.05, 0.5, 0.95), n.sim = 1000, ...)
```

**Arguments**

- `object` An object of class "mar1s" specifying the model parameters.
- `n.ahead` Number of steps ahead at which to simulate/predict.
- `n.sim` Number of simulations.
- `start.time` The sampling time for the first simulation step.
- `xreg.absdata` A matrix-like object with row count = `n.ahead`, specifying the values for the external regressors. If `NULL`, default values are used.
- `init.absdata` A vector specifying the initial values of the process. If `NULL`, default values are used.
- `probs` A vector of probabilities.
- `...` Arguments from previous methods.
Value

For sim.mar1s, a vector of simulated values.
For predict.mar1s, a vector of estimated quantiles.

See Also

compose.mar1s for MAR(1)S process formal definition and composition/decomposition functions,
fit.mar1s for fitting MAR(1)S process to data.

Examples

data(forest.fire, package = "mar1s")
data(nesterov.index, package = "mar1s")

## Univariate
mar1s <- fit.mar1s(forest.fire)

sim.mar1s(mar1s)
sim.mar1s(mar1s, n.sim = 6)
sim.mar1s(mar1s, n.ahead = 3)

predict(mar1s)
predict(mar1s, n.ahead = 10)
predict(mar1s, init.absdata = 100)

t <- seq(1/12, 11/12, 1/6)
p <- mapply(predict, start.time = t,
    MoreArgs = list(object = mar1s, probs = c(0.05, 0.95)))
plot(exp(mar1s$logseasonal), ylim = c(0, max(p)),
ylab = "Forest fire")
arrows(t, p[1], t, p[2],
    code = 3, angle = 90, length = 0.05)

## External regressors
mar1s <- fit.mar1s(forest.fire, nesterov.index[, "mean"])

sim.mar1s(mar1s)
sim.mar1s(mar1s, n.sim = 6)

predict(mar1s)
predict(mar1s, xreg.absdata = 10000)
predict(mar1s, init.absdata = c(100, 1000))
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