Package 'astsa'

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Type Package

Title Applied Statistical Time Series Analysis

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BugReports https://github.com/nickpoison/astsa/issues

Description
Contains data sets and scripts for analyzing time series in both the frequency and time domains including state space modeling as well as supporting the texts Time Series Analysis and Its Applications: With R Examples (4th ed), by R.H. Shumway and D.S. Stoffer. Springer Texts in Statistics, 2017, <DOI:10.1007/978-3-319-52452-8>, and Time Series: A Data Analysis Approach Using R. Chapman-Hall, 2019, <DOI:10.1201/9780429273285>.

URL https://dsstoffer.github.io/, https://nickpoison.github.io/

License GPL-3

LazyLoad yes

LazyData yes

R topics documented:

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astsa-package   *Applied Statistical Time Series Analysis (more than just data)*

Description

Contains data sets and scripts for analyzing time series in both the frequency and time domains including state space modeling as well as supporting the texts Time Series Analysis and Its Applications: With R Examples (4th ed, 2017) and Time Series: A Data Analysis Approach Using R, (1st ed, 2019).

Details

Package:	astsa
Type:	Package
Version:	2.0
Date:	2023-01-10
License:	GPL-3
LazyLoad:	yes
LazyData:	yes

Author(s)

David Stoffer <stoffer@pitt.edu>

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

acf1	*Plot and print ACF or PACF of a time series*

Description

Produces a plot (and a printout) of the sample ACF or PACF. The zero lag value of the ACF is removed.

Usage

```
acf1(series, max.lag = NULL, plot = TRUE, main = NULL, ylim = NULL, pacf = FALSE,
     ylab = NULL, na.action = na.pass, ...)
```

Arguments

series	The data. Does not have to be a time series object.
max.lag	Maximum lag. Can be omitted. Defaults to $\sqrt{n}+10$ unless $n < 60$. If the series is seasonal, this will be at least 4 seasons by default.
plot	If TRUE (default), a graph is produced and the values are rounded and listed. If FALSE, no graph is produced and the values are listed but not rounded by the script.
main	Title of graphic; defaults to name of series.
ylim	Specify limits for the y-axis.
pacf	If TRUE, the sample PACF is returned instead of ACF.
ylab	Change y-axis label from default.
na.action	How to handle missing data; default is na.pass
...	Additional arguments passed to tsplot

Details

Will print and/or plot the sample ACF or PACF (if pacf=TRUE). The zero lag of the ACF (which is always 1) has been removed. If plot=TRUE, a graph is produced and the values are rounded and listed. If FALSE, no graph is produced and the values are listed but not rounded by the script. The error bounds are approximate white noise bounds, $-1/n \pm 2/\sqrt{n}$; no other option is given.

Value

ACF   The sample ACF or PACF

Author(s)

D.S. Stoffer

References

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Examples

```
acf1(rnorm(100))

acf1(sarima.sim(ar=.9), pacf=TRUE)

# show it to your mom:
acf1(soi, col=2:7, lwd=4, gg=TRUE)
```

---

acf2   *Plot and print ACF and PACF of a time series*

Description

Produces a simultaneous plot (and a printout) of the sample ACF and PACF on the same scale. The zero lag value of the ACF is removed.

Usage

```
acf2(series, max.lag = NULL, plot = TRUE, main = NULL, ylim = NULL,
     na.action = na.pass, ...)
```

Arguments

series   The data. Does not have to be a time series object.

max.lag   Maximum lag. Can be omitted. Defaults to $\sqrt{n}+10$ unless $n < 60$. If the series is seasonal, this will be at least 4 seasons by default.

plot   If TRUE (default), a graph is produced and the values are rounded and listed. If FALSE, no graph is produced and the values are listed but not rounded by the script.

main	Title of graphic; defaults to name of series.
ylim	Specify limits for the y-axis.
na.action	How to handle missing data; default is `na.pass`
...	Additional arguments passed to [tsplot](#)

Details

Will print and/or plot the sample ACF and PACF on the same scale. The zero lag of the ACF (which is always 1) has been removed. If `plot=TRUE`, a graph is produced and the values are rounded and listed. If FALSE, no graph is produced and the values are listed but not rounded by the script. The error bounds are approximate white noise bounds, $-1/n \pm 2/\sqrt{n}$; no other option is given.

Value

ACF	The sample ACF
PACF	The sample PACF

Author(s)

D.S. Stoffer

References

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Examples

```
acf2(rnorm(100))

acf2(rnorm(100), 25, main='')  # no title

acf2(rnorm(100), plot=FALSE)[,'ACF']  # print only ACF

acf2(soi, col=2:7, lwd=4, gg=TRUE)  # mother's day present
```

---

acfm   *ACF and CCF for Multiple Time Series*

Description

Produces a grid of plots of the sample ACF (diagonal) and CCF (off-diagonal).

Usage

```
acfm(series, max.lag = NULL,  na.action = na.pass, ylim = NULL,
     acf.highlight = TRUE, ...)
```

Arguments

series	Multiple time series (at least 2 columns of time series)
max.lag	Maximum lag. Can be omitted. Defaults to $\sqrt{n}+10$ unless $n < 60$. If the series is seasonal, this will be at least 4 seasons by default.
na.action	How to handle missing data; default is na.pass
ylim	Specify limits for the all correlation axes. If NULL (default) the values are a little wider than the min and max of all values.
acf.highlight	If TRUE (default), the diagonals (ACFs) are highlighted.
...	Additional arguments passed to tsplot

Details

Produces a grid of plots of the sample ACF (diagonal) and CCF (off-diagonal). The plots in the grid are estimates of corr{x(t+LAG), y(t)}. Thus x leads y if LAG is positive and x lags y if LAG is negative.

Author(s)

D.S. Stoffer

References

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Examples

```
acfm(diff(log(econ5)))

acfm(diff(log(econ5)), gg=TRUE, acf.highlight=FALSE)
```

---

ar.mcmc	*Fit Bayesian AR Model*

Description

Uses Gibbs sampling to fit an AR model to time series data.

Usage

```
ar.mcmc(xdata, porder, n.iter = 1000, n.warmup = 100, plot = TRUE, col = 4,
        prior_var_phi = 50, prior_sig_a = 1, prior_sig_b = 2)
```

Arguments

xdata	time series data (univariate only)
porder	autoregression order
n.iter	number of iterations for the sampler
n.warmup	number of startup iterations for the sampler (these are removed)
plot	if TRUE (default) returns two graphics, (1) the draws after warmup and (2) a scatterplot matrix of the draws with histograms on the diagonal
col	color of the plots
prior_var_phi	prior variance of the vector of AR coefficients; see details
prior_sig_a	first prior for the variance component; see details
prior_sig_b	second prior for the variance component; see details

Details

Assumes a normal-inverse gamma model,

$$x_t = \phi_0 + \phi_1 x_{t-1} + \cdots + \phi_p x_{t-p} + \sigma z_t,$$

where z_t is standard Gaussian noise. With Φ being the (p+1)-dimensional vector of the ϕs, the priors are $\Phi \mid \sigma \sim N(0, \sigma^2 V_0)$ and $\sigma^2 \sim IG(a, b)$, where $V_0 = \gamma^2 I$. Defaults are given for the hyperparameters, but the user may choose (a, b) as (prior_sig_a, prior_sig_b) and γ^2 as prior_var_phi.

The algorithm is efficient and converges quickly. Further details can be found in Example 8.36 of Douc, Moulines, & Stoffer, D. (2014). *Nonlinear Time Series: Theory, Methods and Applications with R Examples*. CRC press. ISBN 9781466502253.

Value

In addition to the graphics (if plot is TRUE), the draws of each parameter (phi0, phi1, ..., sigma) are returned invisibly and various quantiles are displayed.

Author(s)

D.S. Stoffer

Source

Based on the script `arp.mcmc` used in Douc, Moulines, & Stoffer, D. (2014).   *Nonlinear Time Series: Theory, Methods and Applications with R Examples*. CRC press. ISBN 9781466502253.

References

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Examples

```
## Not run:

u = ar.mcmc(rec, 2)

tsplot(u, ncolm=2, col=4)  # plot the traces

apply(u, 2, ESS)    # effective sample sizes

## End(Not run)
```

---

ar1miss   *AR with Missing Values*

Description

Data used in Chapter 6

Format

The format is: Time-Series [1:100] with NA for missing values.

References

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arf   *Simulated ARFIMA*

Description

1000 simulated observations from an ARFIMA(1, 1, 0) model with $\phi = .75$ and $d = .4$.

Format

The format is: Time-Series [1:1000] from 1 to 1000: -0.0294 0.7487 -0.3386 -1.0332 -0.2627 ...

References

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---

arma.spec   *Spectral Density of an ARMA Model*

Description

Gives the ARMA spectrum, tests for causality, invertibility, and common zeros.

Usage

```
arma.spec(ar = 0, ma = 0, var.noise = 1, n.freq = 500,
          main='from specified model', frequency=1, ylim=NULL, ...)
```

Arguments

ar	vector of AR parameters
ma	vector of MA parameters
var.noise	variance of the noise
n.freq	number of frequencies
main	title of graphic
frequency	for seasonal models, adjusts the frequency scale
ylim	optional; specify limits for the y-axis
...	additional arguments

Details

The basic call is `arma.spec(ar, ma)` where `ar` and `ma` are vectors containing the model parameters. Use `log='y'` if you want the plot on a log scale. If the model is not causal or invertible an error message is given. If there are approximate common zeros, a spectrum will be displayed and a warning will be given; e.g., `arma.spec(ar= .9, ma= -.9)` will yield a warning and the plot will be the spectrum of white noise.

Value

`freq`	frequencies - returned invisibly
`spec`	spectral ordinates - returned invisibly

Author(s)

D.S. Stoffer

References

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Examples

```
arma.spec(ar = c(1, -.9), ma = .8)

arma.spec(ar = c(1, -.9), log='y')

arma.spec(ar = c(1, -.9), main='AR(2)', gg=TRUE, col=5, lwd=2)

arma.spec(ar=c(rep(0,11),.4), ma=.5, col=5, lwd=3, frequency=12)
```

ARMAtoAR   *Convert ARMA Process to Infinite AR Process*

Description

Gives the π-weights in the invertible representation of an ARMA model.

Usage

```
ARMAtoAR(ar = 0, ma = 0, lag.max=20)
```

Arguments

`ar`	vector of AR coefficients
`ma`	vector of MA coefficients
`lag.max`	number of pi-weights desired

Value

A vector of coefficients.

References

You can find demonstrations of astsa capabilities at [FUN WITH ASTSA](#).

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

Examples

```
ARMAtoAR(ar=.9, ma=.5, 10)
```

---

astsa.col	*astsa color palette with transparency*

Description

Modifies the opacity level of the astsa color palette.

Usage

```
astsa.col(col = 1, alpha = 1)
```

Arguments

`col`	numerical vector representing colors (default is 1 or 'black') - see Examples
`alpha`	factor in [0,1] setting the opacity (default is 1)

Value

a color vector using the astsa color palette at the chosen transparency level

Note

The astsa color palette is attached when the package is attached. The colors follow the R pattern of shades of: (1) black, (2) red, (3) green, (4) blue, (5) cyan, (6) magenta, (7) gold, (8) gray. The opacity of these colors can be changed easily using this script. Values are recycled, e.g., col=9 is the same as col=1.

The astsa palette was developed from two basic ideas. The first is the general idea that time series should be plotted using dark colors. The second is personal in that we prefer to anchor plots with the best blue, dodgerblue3. From there, we used the website https://www.color-hex.com/ to pick colors of type 2 to 7 that complement dodgerblue3.

Author(s)

D.S.Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

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Examples

```
# plotting 2 series that touch (but in a nice way)
tsplot(cbind(gtemp_land, gtemp_ocean), col=astsa.col(c(4,2), .5), lwd=2, spaghetti=TRUE,
       type='o', pch=20, ylab="Temperature Deviations")
legend('topleft', legend=c("Land Only", "Ocean Only"), col=c(4,2), lwd=2, pch=20, bty='n')

# View the astsa palette
barplot(rep(1,8), col=1:8, main='astsa palette', names=1:8)
```

---

autoParm   *autoParm - Structural Break Estimation Using AR Models*

Description

Uses minimum description length (MDL) to fit piecewise AR processes with the goal of detecting changepoints in time series. Optimization is accomplished via a genetic algorithm (GA).

Usage

```
autoParm(xdata, Pi.B = NULL, Pi.C = NULL, PopSize = 70, generation = 70, P0 = 20,
         Pi.P = 0.3, Pi.N = 0.3, NI = 7)
```

Arguments

xdata	time series (of length n at least 100) to be analyzed; the ts attributes are stripped prior to the analysis
Pi.B	probability of being a breakpoint in initial stage; default is 10/n. Does not need to be specified.
Pi.C	probability of conducting crossover; default is (n-10)/n. Does not need to be specified.
PopSize	population size (default is 70); the number of chromosomes in each generation. Does not need to be specified.
generation	number of iterations; default is 70. Does not need to be specified.
P0	maximum AR order; default is 20. Does not need to be specified.
Pi.P	probability of taking parent's gene in mutation; default is 0.3. Does not need to be specified.
Pi.N	probability of taking -1 in mutation; default is 0.3 Does not need to be specified.
NI	number if islands; default is 7. Does not need to be specified.

Details

Details my be found in Davis, Lee, & Rodriguez-Yam (2006). Structural break estimation for nonstationary time series models. JASA, 101, 223-239. doi:10.1198/016214505000000745

Value

Returns three values, (1) the breakpoints including the endpoints, (2) the number of segments, and (3) the segment AR orders. See the examples.

Note

The GA is a stochastic optimization procedure and consequently will give different results at each run. It is a good idea to run the algorithm a few times before coming to a final decision.

Author(s)

D.S. Stoffer

Source

The code is adapted from R code provided to us by Rex Cheung (https://www.linkedin.com/in/rexcheung).

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

See Also

autoSpec

Examples

```
## Not run:

##-- simulation
x1 = sarima.sim(ar=c(1.69, -.81), n=500)
x2 = sarima.sim(ar=c(1.32, -.81), n=500)
x = c(x1, x2)

##-- look at the data
tsplot(x)

##-- run procedure
autoParm(x)

##-- output (yours will be slightly different -
##--         the nature of GA)
# returned breakpoints include the endpoints
# $breakpoints
# [1]    1  514 1000
#
# $number_of_segments
# [1] 2
#
# $segment_AR_orders
# [1] 2 2

## End(Not run)
```

---

autoSpec   *autoSpec - Changepoint Detection of Narrowband Frequency Changes*

Description

Uses changepoint detection to discover if there have been slight changes in frequency in a time series. The autoSpec procedure uses minimum description length (MDL) to do nonparametric spectral estimation with the goal of detecting changepoints. Optimization is accomplished via a genetic algorithm (GA).

Usage

```
autoSpec(xdata, Pi.B = NULL, Pi.C = NULL, PopSize = 70, generation = 70, m0 = 10,
        Pi.P = 0.3, Pi.N = 0.3, NI = 7, taper = .5, min.freq = 0, max.freq = .5)
```

Arguments

xdata	time series (of length n at least 100) to be analyzed; the ts attributes are stripped prior to the analysis
Pi.B	probability of being a breakpoint in initial stage; default is 10/n. Does not need to be specified.
Pi.C	probability of conducting crossover; default is (n-10)/n. Does not need to be specified.
PopSize	population size (default is 70); the number of chromosomes in each generation. Does not need to be specified.
generation	number of iterations; default is 70. Does not need to be specified.
m0	maximum width of the Bartlett kernel is 2*m0 + 1; default is 10. Does not need to be specified.
Pi.P	probability of taking parent's gene in mutation; default is 0.3. Does not need to be specified.
Pi.N	probability of taking -1 in mutation; default is 0.3 Does not need to be specified.
NI	number if islands; default is 7. Does not need to be specified.
taper	half width of taper used in spectral estimate; .5 (default) is full taper Does not need to be specified.
min.freq, max.freq	
	the frequency range (min.freq, max.freq) over which to calculate the Whittle likelihood; the default is (0, .5). Does not need to be specified. If min > max, the roles are reversed, and reset to the default if either is out of range.

Details

Details my be found in Stoffer, D. S. (2023). AutoSpec: Detection of narrowband frequency changes in time series. Statistics and Its Interface, 16(1), 97-108. doi:10.4310/21SII703

Value

Returns three values, (1) the breakpoints including the endpoints, (2) the number of segments, and (3) the segment kernel orders. See the examples.

Note

The GA is a stochastic optimization procedure and consequently will give different results at each run. It is a good idea to run the algorithm a few times before coming to a final decision.

Author(s)

D.S. Stoffer

Source

The genetic algorithm code is adapted from R code provided to us by Rex Cheung (`https://www.linkedin.com/in/rexche`
The code originally supported Aue, Cheung, Lee, & Zhong (2014). Segmented model selection in quantile regression using the minimum description length principle. JASA, 109, 1241-1256. A similar version also supported Davis, Lee, & Rodriguez-Yam (2006). Structural break estimation for nonstationary time series models. JASA, 101, 223-239.

References

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The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

autoParm

Examples

```
## Not run:

##-- simulation
set.seed(1)
num = 500
t   = 1:num
w   = 2*pi/25
d   = 2*pi/150
x1  = 2*cos(w*t)*cos(d*t) + rnorm(num)
x2  = cos(w*t) + rnorm(num)
x   = c(x1,x2)

##-- plot and periodogram (all action below 0.1)
tsplot(x, main='not easy to see the change')
mvspec(x)

##-- run procedure
autoSpec(x, max.freq=.1)

##-- output (yours will be slightly different -
##--         the nature of GA)
# returned breakpoints include the endpoints
# $breakpoints
# [1]    1  503 1000
#
# $number_of_segments
# [1] 2
#
```

```
# $segment_kernel_orders_m
# [1] 2 4


##-- plot everything
par(mfrow=c(3,1))
tsplot(x, col=4)
 abline(v=503, col=6, lty=2, lwd=2)
mvspec(x[1:502],    kernel=bart(2), taper=.5, main='segment 1', col=4, xlim=c(0,.25))
mvspec(x[503:1000], kernel=bart(4), taper=.5, main='segment 2', col=4, xlim=c(0,.25))

## End(Not run)
```

---

bart   *Bartlett Kernel*

Description

Smoothing (triangular) kernel that decreases one unit from the center.

Usage

```
bart(m)
```

Arguments

m   non-negative integer specifying the kernel width, which is 2m + 1. If m has length
                  larger than one, the convolution of the kernel is returned.

Details

Uses kernel from the stats package to construct a Bartlett (triangular) kernel of width 2m + 1; see
help(kernel) for further details.

Value

Returns an object of class tskernel with the coefficients, the kernel dimension, and attribute
"Bartlett".

Author(s)

D.S. Stoffer

References

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Examples

```
plot(bart(4), ylim=c(0,.2))
```

BCJ   *Daily Returns of Three Banks*

Description

Daily returns of three banks, 1. Bank of America [boa], 2. Citibank [citi], and 3. JP Morgan Chase [jpm], from 2005 to 2017.

Format

The format is: Time-Series [1:3243, 1:3] from 2005 to 2017: -0.01378 -0.01157 -0.00155 -0.01084 0.01252 ... with column names "boa" "citi" "jpm" .

Source

Gong & Stoffer (2021). A Note on Efficient Fitting of Stochastic Volatility Models. *Journal of Time Series Analysis*, 42(2), 186-200.

`https://github.com/nickpoison/Stochastic-Volatility-Models`

References

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Examples

```
tsplot(BCJ, col=2:4)
```

| beamd | *Infrasonic Signal from a Nuclear Explosion* |

Description

Infrasonic signal from a nuclear explosion.

Usage

```
data(beamd)
```

Format

A data frame with 2048 observations (rows) on 3 numeric variables (columns): sensor1, sensor2, sensor3.

Details

This is a data frame consisting of three columns (that are not time series objects). The data are an infrasonic signal from a nuclear explosion observed at sensors on a triangular array.

References

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| birth | *U.S. Monthly Live Births* |

Description

Monthly live births (adjusted) in thousands for the United States, 1948-1979.

Format

The format is: Time-Series [1:373] from 1948 to 1979: 295 286 300 278 272 268 308 321 313 308 ...

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

blood	*Daily Blood Work with Missing Values*

Description

Multiple time series of measurements made for 91 days on the three variables, log(white blood count) [WBC], log(platelet) [PLT] and hematocrit [HCT]. Missing data code is NA.

Format

Time-Series [1:91, 1:3] from 1 to 91: 2.33 1.89 2.08 1.82 1.82 ...

..$: NULL ..$: chr [1:3] "WBC" "PLT" "HCT"

Details

This data set is used in Chapter 6 for a missing data example.

Source

Jones, R.H. (1984). Fitting multivariate models to unequally spaced data. In *Time Series Analysis of Irregularly Observed Data*, pp. 158-188. E. Parzen, ed. Lecture Notes in Statistics, 25, New York: Springer-Verlag.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

HCT, PLT, WBC

Examples

```
tsplot(blood, type='o', pch=19, cex=1.1, col=2:4, gg=TRUE, xlab='day')
```

bnrf1ebv *Nucleotide sequence - BNRF1 Epstein-Barr*

Description

Nucleotide sequence of the BNRF1 gene of the Epstein-Barr virus (EBV): 1=A, 2=C, 3=G, 4=T. The data are used in Chapter 7.

Format

The format is: Time-Series [1:3954] from 1 to 3954: 1 4 3 3 1 1 3 1 3 1 ...

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

bnrf1hvs *Nucleotide sequence - BNRF1 of Herpesvirus saimiri*

Description

Nucleotide sequence of the BNRF1 gene of the herpesvirus saimiri (HVS): 1=A, 2=C, 3=G, 4=T. The data are used in Chapter 7.

Format

The format is: Time-Series [1:3741] from 1 to 3741: 1 4 3 2 4 4 3 4 4 4 ...

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

---

cardox   *Monthly Carbon Dioxide Levels at Mauna Loa*

Description

Monthly mean carbon dioxide (in ppm) measured at Mauna Loa Observatory, Hawaii. This is an update to co2 in the datasets package.

Format

The format is: Time-Series [1:729] from March, 1958 to November 2018: 315.71 317.45 317.50 317.10 ...

Details

The carbon dioxide data measured as the mole fraction in dry air, on Mauna Loa constitute the longest record of direct measurements of CO2 in the atmosphere. They were started by C. David Keeling of the Scripps Institution of Oceanography in March of 1958 at a facility of the National Oceanic and Atmospheric Administration. NOAA started its own CO2 measurements in May of 1974, and they have run in parallel with those made by Scripps since then. Data are reported as a dry mole fraction defined as the number of molecules of carbon dioxide divided by the number of molecules of dry air multiplied by one million (ppm).

Source

https://gml.noaa.gov/ccgg/trends/

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

---

ccf2   *Cross Correlation*

Description

Calculates and plots the sample CCF of two time series.

Usage

```
ccf2(x, y, max.lag = NULL, main = NULL, ylab = "CCF", plot = TRUE,
         na.action = na.pass, type = c("correlation", "covariance"), ...)
```

Arguments

x, y	univariate time series
max.lag	maximum lag for which to calculate the CCF
main	plot title - if NULL, uses x and y names
ylab	vertical axis label; default is 'CCF'
plot	if TRUE (default) a graphic is produced and the values are returned invisibly. Otherwise, the values are returned.
na.action	how to handle missing values; default is na.pass
type	default is cross-correlation; an option is cross-covariance
...	additional arguments passed to tsplot

Details

This will produce a graphic of the sample corr[x(t+lag), y(t)] from -max.lag to max.lag. Also, the (rounded) values of the CCF are returned invisibly unless plot=FALSE. Similar details apply to the cross-covariance.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

Examples

```
ccf2(soi, rec, plot=FALSE)  # now you see it
ccf2(soi, rec)              # now you don't

# happy birthday mom
ccf2(soi, rec, col=rainbow(36, v=.8), lwd=4, gg=TRUE)
```

---

chicken   *Monthly price of a pound of chicken*

Description

Poultry (chicken), Whole bird spot price, Georgia docks, US cents per pound

Format

The format is: Time-Series [1:180] from August 2001 to July 2016: 65.6 66.5 65.7 64.3 63.2 ...

Source

https://www.indexmundi.com/commodities/

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

---

climhyd   *Lake Shasta inflow data*

Description

Lake Shasta inflow data. This is a data frame.

Format

A data frame with 454 observations (rows) on the following 6 numeric variables (columns): Temp, DewPt, CldCvr, WndSpd, Precip, Inflow.

Details

The data are 454 months of measured values for the climatic variables: air temperature, dew point, cloud cover, wind speed, precipitation, and inflow, at Lake Shasta, California. The man-made lake is famous for the placard stating, "We don't swim in your toilet, so don't pee in our lake."

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

cmort	*Cardiovascular Mortality from the LA Pollution study*

Description

Average weekly cardiovascular mortality in Los Angeles County; 508 six-day smoothed averages obtained by filtering daily values over the 10 year period 1970-1979.

Format

The format is: Time-Series [1:508] from 1970 to 1980: 97.8 104.6 94.4 98 95.8 ...

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

lap

---

cpg   *Hard Drive Cost per GB*

Description

Median annual cost per gigabyte (GB) of storage.

Format

The format is: Time-Series [1:29] from 1980 to 2008: 213000.00 295000.00 260000.00 175000.00
160000.00 ...

Details

The median annual cost of hard drives used in computers. The data are retail prices per GB taken
from a sample of manufacturers.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/
blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at
https://nickpoison.github.io/.

---

detrend   *Detrend a Time Series*

Description

Returns a time series with the trend removed. The trend can be estimated using polynomial regres-
sion or using a lowess fit.

Usage

```
detrend(series, order = 1, lowess = FALSE, lowspan = 2/3)
```

Arguments

series	The time series to be detrended.
order	Order of the polynomial used to estimate the trend with a linear default (order=1) unless lowess is TRUE.
lowess	If TRUE, lowess is used to find the trend. The default is FALSE.
lowspan	The smoother span used for lowess.

Value

The detrended series is returned.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`trend`

Examples

```
tsplot( cbind(salmon, detrend(salmon)), gg=TRUE, main='Norwegian Salmon USD/KG' )
```

---

djia *Dow Jones Industrial Average*

Description

Daily DJIA values from April 2006 - April 2016

Format

The format is: xts [1:2518, 1:5] 11279 11343 11347 11337 11283 ...
- attr(*, "class")= chr [1:2] "xts" "zoo"
..$: chr [1:5] "Open" "High" "Low" "Close" "Volume"

Source

The data were obtained via the TTR package and Yahoo financial data. Unfortunately, this does not work now. It seems like the R package quantmod is a good bet and Yahoo still has financial data.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

dna2vector   *Convert DNA Sequence to Indicator Vectors*

Description

Takes a string (e.g., a DNA sequence) of general form (e.g., FASTA) and converts it to a sequence of indicator vectors for use with the Spectral Envelope (specenv).

Usage

```
dna2vector(data, alphabet = NULL)
```

Arguments

data	A single string.
alphabet	The particular alphabet being used. The default is alphabet=c("A", "C", "G", "T").

Details

Takes a string of categories and converts it to a matrix of indicators. The data can then be used by the script specenv, which calculates the Spectral Envelope of the sequence (or subsequence). Many different type of sequences can be used, including FASTA and GenBank, as long as the data is a string of categories.

The indicator vectors (as a matrix) are returned invisibly in case the user forgets to put the results in an object wherein the screen would scroll displaying the entire sequence. In other words, the user should do something like xdata = dna2vector(data) where data is the original sequence.

As an example, if the DNA sequence is in a FASTA file, say sequence.fasta, remove the first line, which will look like >V01555.2 .... Then the following code can be used to read the data into the session, create the indicator sequence and save it as a compressed R data file:

```
fileName <- 'sequence.fasta'      # name of FASTA file
data     <- readChar(fileName, file.info(fileName)$size)  # input the sequence
myseq    <- dna2vector(data)      # convert it to indicators

##== to compress and save the data ==##
save(myseq, file='myseq.rda')
##== and then load it when needed ==##
load('myseq.rda')
```

Value

matrix of indicator vectors; returned invisibly

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`specenv`

Examples

```
# Epstein-Barr virus (entire sequence included in astsa)
xdata = dna2vector(EBV)
head(xdata)

# part of EBV with  1, 2, 3, 4 for "A", "C", "G", "T"
xdata = dna2vector(bnrf1ebv)
head(xdata)

# raw GenBank sequence
data <-
c("1 agaattcgtc ttgctctatt caccccttact tttcttcttg cccgttctct ttcttagtat
  61 gaatccagta tgcctgcctg taattgttgc gccctacctc ttttggctgg cggctattgc")
xdata = dna2vector(data, alphabet=c('a', 'c', 'g', 't'))
head(xdata)

# raw FASTA sequence
data <-
 c("AGAATTCGTCTTGCTCTATTCACCCTTACTTTTCTTCTTGCCCGTTCTCTTTCTTAGTATGAATCCAGTA
    TGCCTGCCTGTAATTGTTGCGCCCTACCTCTTTTGGCTGGCGGCTATTGCCGCCTCGTGTTTCACGGCCT")
xdata = dna2vector(data)
head(xdata)
```

EBV   *Entire Epstein-Barr Virus (EBV) Nucleotide Sequence*

Description

EBV nucleotide sequence - 172281 bp as a single string

Format

The format is: chr "AGAATTCGTCTT ..."

Note

EBV is not useful on its own, but using 'dna2vector', different regions can be explored. For example, ebv = dna2vector(EBV)

Source

https://www.ncbi.nlm.nih.gov/nuccore/V01555.2

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

See Also

dna2vector

---

econ5   *Five Quarterly Economic Series*

Description

Multiple time series of quarterly U.S. unemployment, GNP, consumption, and government and private investment, from 1948-III to 1988-II.

Format

Multiple time series with 161 observations (rows) on the following 5 numeric variables (columns): unemp, gnp, consum, govinv, prinv.

Source

Young, P.C. and Pedregal, D.J. (1999). Macro-economic relativity: government spending, private investment and unemployment in the USA 1948-1998. *Structural Change and Economic Dynamics*, 10, 359-380.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

EM   *EM Algorithm for State Space Models*

Description

Estimation of the parameters in general linear state space models via the EM algorithm. Missing data may be entered as NA or as zero (0), however, use NAs if zero (0) can be an observation. Inputs in both the state and observation equations are allowed. This script replaces EM0 and EM1.

Usage

```
EM(y, A, mu0, Sigma0, Phi, Q, R, Ups = NULL, Gam = NULL, input = NULL,
    max.iter = 100, tol = 1e-04)
```

Arguments

y	data matrix (n x q), vector or time series, n = number of observations, q = number of series. Use NA or zero (0) for missing data, however, use NAs if zero (0) can be an observation.
A	measurement matrices; can be constant or an array with dimension dim=c(q,p,n) if time varying. Use NA or zero (0) for missing data.
mu0	initial state mean vector (p x 1)
Sigma0	initial state covariance matrix (p x p)
Phi	state transition matrix (p x p)
Q	state error matrix (p x p)
R	observation error matrix (q x q - diagonal only)
Ups	state input matrix (p x r); leave as NULL (default) if not needed
Gam	observation input matrix (q x r); leave as NULL (default) if not needed
input	NULL (default) if not needed or a matrix (n x r) of inputs having the same row dimension (n) as y
max.iter	maximum number of iterations
tol	relative tolerance for determining convergence

Details

This script replaces EM0 and EM1 by combining all cases and allowing inputs in the state and observation equations. It uses version 1 of the new Ksmooth script (hence correlated errors is not allowed).

The states x_t are p-dimensional, the data y_t are q-dimensional, and the inputs u_t are r-dimensional for $t = 1, \ldots, n$. The initial state is $x_0 \sim N(\mu_0, \Sigma_0)$.

The general model is

$$x_t = \Phi x_{t-1} + \Upsilon u_t + w_t \quad w_t \sim iid\ N(0, Q)$$

$$y_t = A_t x_{t-1} + \Gamma u_t + v_t \quad v_t \sim iid\ N(0, R)$$

where $w_t \perp v_t$. The observation noise covariance matrix is assumed to be diagonal and it is forced to diagonal otherwise.

The measurement matrices A_t can be constant or time varying. If time varying, they should be entered as an array of dimension dim = c(q,p,n). Otherwise, just enter the constant value making sure it has the appropriate $q \times p$ dimension.

Value

Phi	Estimate of Phi
Q	Estimate of Q
R	Estimate of R
Ups	Estimate of Upsilon (NULL if not used)
Gam	Estimate of Gamma (NULL if not used)
mu0	Estimate of initial state mean
Sigma0	Estimate of initial state covariance matrix
like	-log likelihood at each iteration
niter	number of iterations to convergence
cvg	relative tolerance at convergence

Note

The script does not allow for constrained estimation directly, however, constrained estimation is possible with some extra manipulations. There is an example of constrained estimation using EM at FUN WITH ASTSA, where the fun never stops.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`Kfilter`, `Ksmooth`

Examples

```
# example used for ssm()
# x[t] = Ups + Phi x[t-1] + w[t]
# y[t] = x[t] + v[t]
y = gtemp_land
A = 1; Phi = 1; Ups = 0.01
Q = 0.001; R = 0.01
mu0 = -0.6; Sigma0 = 0.02
input = rep(1, length(y))
( em = EM(y, A, mu0, Sigma0, Phi, Q, R, Ups, Gam=NULL, input) )
```

ENSO   *El Nino - Southern Oscillation*

Description

Southern Oscillation Index (SOI), 1/1951 to 10/2022; anomalies are departures from the 1981-2010 base period.

Format

The format is: Time-Series [1:862] from 1951 to 2022: 1.5 0.9 -0.1 -0.3 -0.7 0.2 -1 -0.2 -1.1 -1 ...

Details

The El Niño - Southern Oscillation (ENSO) is a recurring climate pattern involving changes in the temperature of waters in the central and eastern tropical Pacific Ocean.

The data have been detrended and seasonally adjusted. For raw SOI data (from a different time period), see `soi`.

Source

`https://www.ncei.noaa.gov/access/monitoring/enso/soi`

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`soi`

EQ5   *Seismic Trace of Earthquake number 5*

Description

Seismic trace of an earthquake [two phases or arrivals along the surface, the primary wave ($t = 1, \ldots, 1024$) and the shear wave ($t = 1025, \ldots, 2048$)] recorded at a seismic station.

Format

The format is: Time-Series [1:2048] from 1 to 2048: 0.01749 0.01139 0.01512 0.01477 0.00651 ...

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`eqexp`

EQcount   *EQ Counts*

Description

Series of annual counts of major earthquakes (magnitude 7 and above) in the world between 1900 and 2006.

Format

The format is: Time-Series [1:107] from 1900 to 2006: 13 14 8 10 16 26 ...

Source

Zucchini and MacDonald (2009). Hidden Markov Models for Time Series: An Introduction using R. CRC Press.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

---

eqexp   *Earthquake and Explosion Seismic Series*

Description

This is a data frame of the earthquake and explosion seismic series used throughout the text.

Format

A data frame with 2048 observations (rows) on 17 variables (columns). Each column is a numeric vector.

Details

The matrix has 17 columns, the first eight are earthquakes, the second eight are explosions, and the last column is the Novaya Zemlya event of unknown origin.

The column names are: EQ1, EQ2,...,EQ8; EX1, EX2,...,EX8; NZ. The first 1024 observations correspond to the P wave, the second 1024 observations correspond to the S wave.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

ESS   *Effective Sample Size (ESS)*

Description

Estimates the ESS of a given vector of samples.

Usage

```
ESS(trace, tol = 1e-08)
```

Arguments

trace	vector of sampled values from an MCMC run (univariate only)
tol	ESS is returned as zero if the estimated spectrum at frequency zero is less than this value

Details

Uses `spec.ic` to estimate the spectrum of the input at frequency zero (spec0). Then, ESS is estimated as ESS = length(trace)*var(trace)/spec0.

Value

Returns the estimated ESS of the input.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

Examples

```
# Fit an AR(2) to the Recruitment series
u = ar.mcmc(rec, porder=2, n.iter=1000, plot=FALSE)  # it's efficient
# then calculate the ESSs
apply(u, 2, ESS)
```

EXP6   *Seismic Trace of Explosion number 6*

Description

Seismic trace of an explosion [two phases or arrivals along the surface, the primary wave ($t = 1, \ldots, 1024$) and the shear wave ($t = 1025, \ldots, 2048$)] recorded at a seismic station.

Format

The format is: Time-Series [1:2048] from 1 to 2048: -0.001837 -0.000554 -0.002284 -0.000303 -0.000721 ...

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

eqexp

FDR   *Basic False Discovery Rate*

Description

Computes the basic false discovery rate given a vector of p-values and returns the index of the maximal p-value satisfying the FDR condition.

Usage

```
FDR(pvals, qlevel = 0.05)
```

Arguments

pvals	a vector of pvals on which to conduct the multiple testing
qlevel	the proportion of false positives desired

Value

fdr.id	NULL if no significant tests, or the index of the maximal p-value satisfying the FDR condition.

Note

This is used primarily in Chapter 7.

Source

Built off of https://www.stat.berkeley.edu/~paciorek/code/fdr/fdr.R.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

---

ffbs   *Forward Filtering Backward Sampling*

Description

FFBS algorithm for state space models

Usage

```
ffbs(y, A, mu0, Sigma0, Phi, sQ, sR, Ups = NULL, Gam = NULL, input = NULL)
```

Arguments

y	Data matrix, vector or time series.
A	Observation matrix. Can be constant or an array with dim=c(q,p,n) if time varying.
mu0	Initial state mean.
Sigma0	Initial state covariance matrix.
Phi	State transition matrix.

sQ	State error covariance matrix is `Q = sQ%*%t(sQ)` – see details below. In the univariate case, it is the standard deviation.
sR	Observation error covariance matrix is `R = sR%*%t(sR)` – see details below. In the univariate case, it is the standard deviation.
Ups	State input matrix.
Gam	Observation input matrix.
input	matrix or vector of inputs having the same row dimension as y.

Details

Refer to Section 6.12 of edition 4 text. For a linear state space model, the FFBS algorithm provides a way to sample a state sequence $x_{0:n}$ from the posterior $\pi(x_{0:n} \mid \Theta, y_{1:n})$ with parameters Θ and data $y_{1:n}$ as described in Procedure 6.1.

The general model is

$$x_t = \Phi x_{t-1} + \Upsilon u_t + sQ\, w_t \quad w_t \sim iid\, N(0, I)$$

$$y_t = A_t x_{t-1} + \Gamma u_t + sR\, v_t \quad v_t \sim iid\, N(0, I)$$

where $w_t \perp v_t$. Consequently the state noise covariance matrix is $Q = sQ\, sQ'$ and the observation noise covariance matrix is $R = sR\, sR'$ and sQ, sR do not have to be square as long as everything is conformable.

x_t is p-dimensional, y_t is q-dimensional, and u_t is r-dimensional. Note that $sQ\, w_t$ has to be p-dimensional, but w_t does not, and $sR\, v_t$ has to be q-dimensional, but v_t does not.

Value

Xs	An array of sampled states
X0n	The sampled initial state (because R is 1-based)

Note

The script uses Kfilter. If A_t is constant wrt time, it is not necessary to input an array; see the example. The example below is just one pass of the algorithm; see the example at FUN WITH ASTSA for the real fun.

Author(s)

D.S. Stoffer

Source

Shumway & Stoffer (2017) Edition 4, Section 6.12.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

Examples

```
## Not run:

## -- this is just one pass --##
# generate some data
 set.seed(1)
 sQ  = 1; sR = 3; n = 100
 mu0 = 0; Sigma0 = 10; x0 = rnorm(1,mu0,Sigma0)
 w = rnorm(n); v = rnorm(n)
 x = c(x0 + sQ*w[1]);  y = c(x[1] + sR*v[1])   # initialize
for (t in 2:n){
  x[t] = x[t-1] + sQ*w[t]
  y[t] = x[t] + sR*v[t]
  }

## run one pass of FFBS, plot data, states and sampled states
run = ffbs(y, A=1, mu0=0, Sigma0=10, Phi=1, sQ=1, sR=3)
tsplot(cbind(y,run$Xs), spaghetti=TRUE, type='o', col=c(8,4), pch=c(1,NA))
legend('topleft', legend=c("y(t)","xs(t)"), lty=1, col=c(8,4), bty="n", pch=c(1,NA))

## End(Not run)
```

---

flu   *Monthly pneumonia and influenza deaths in the U.S., 1968 to 1978.*

Description

Monthly pneumonia and influenza deaths per 10,000 people in the United States for 11 years, 1968 to 1978.

Usage

```
data(flu)
```

Format

The format is: Time-Series [1:132] from 1968 to 1979: 0.811 0.446 0.342 0.277 0.248 ...

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

fmri	*fMRI - complete data set*

Description

Data (as a vector list) from an fMRI experiment in pain, listed by location and stimulus. The data are BOLD signals when a stimulus was applied for 32 seconds and then stopped for 32 seconds. The signal period is 64 seconds and the sampling rate was one observation every 2 seconds for 256 seconds ($n = 128$). The number of subjects under each condition varies.

Details

The LOCATIONS of the brain where the signal was measured were [1] Cortex 1: Primary Somatosensory, Contralateral, [2] Cortex 2: Primary Somatosensory, Ipsilateral, [3] Cortex 3: Secondary Somatosensory, Contralateral, [4] Cortex 4: Secondary Somatosensory, Ipsilateral, [5] Caudate, [6] Thalamus 1: Contralateral, [7] Thalamus 2: Ipsilateral, [8] Cerebellum 1: Contralateral and [9] Cerebellum 2: Ipsilateral.

The TREATMENTS or stimuli (and number of subjects in each condition) are [1] Awake-Brush (5 subjects), [2] Awake-Heat (4 subjects), [3] Awake-Shock (5 subjects), [4] Low-Brush (3 subjects), [5] Low-Heat (5 subjects), and [6] Low-Shock (4 subjects). Issue the command summary(fmri) for further details. In particular, awake (Awake) or mildly anesthetized (Low) subjects were subjected levels of periodic brushing (Brush), application of heat (Heat), and mild shock (Shock) effects.

As an example, fmri$L1T6 (Location 1, Treatment 6) will show the data for the four subjects receiving the Low-Shock treatment at the Cortex 1 location; note that fmri[[6]] will display the same data.

Source

Joseph F. Antognini, Michael H. Buonocore, Elizabeth A. Disbrow, Earl Carstens, Isoflurane anesthesia blunts cerebral responses to noxious and innocuous stimuli: a fMRI study, Life Sciences, Volume 61, Issue 24, 1997, Pages PL349-PL354, ISSN 0024-3205, `https://doi.org/10.1016/S0024-3205(97)00960-0`.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

fmri1   *fMRI Data Used in Chapter 1*

Description

A data frame that consists of average fMRI BOLD signals at eight locations.

Usage

```
data(fmri1)
```

Format

The format is: mts [1:128, 1:9]

Details

Multiple time series consisting of fMRI BOLD signals at eight locations (in columns 2-9, column 1 is time period), when a stimulus was applied for 32 seconds and then stopped for 32 seconds. The signal period is 64 seconds and the sampling rate was one observation every 2 seconds for 256 seconds ($n = 128$). The columns are labeled: "time" "cort1" "cort2" "cort3" "cort4" "thal1" "thal2" "cere1" "cere2".

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

fmri

---

gas *Gas Prices*

Description

New York Harbor conventional regular gasoline weekly spot price FOB (in cents per gallon) from 2000 to mid-2010.

Format

The format is: Time-Series [1:545] from 2000 to 2010: 70.6 71 68.5 65.1 67.9 ...

Details

Pairs with series `oil`

Source

Data were obtained from: `https://www.eia.gov/dnav/pet/pet_pri_spt_s1_w.htm`

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`oil`

---

gdp *Quarterly U.S. GDP*

Description

Seasonally adjusted quarterly U.S. GDP from 1947(1) to 2018(3).

Format

The format is: Time-Series [1:287] from 1947 to 2018: 2033 2028 2023 2055 2086 ...

Source

https://tradingeconomics.com/united-states/gdp

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

---

globtemp   *Global mean land-ocean temperature deviations to 2015*

Description

Global mean land-ocean temperature deviations (from 1951-1980 average), measured in degrees centigrade, for the years 1880-2015. This was an update of gtemp, but gtemp_land and gtemp_ocean are the most recent updates.

Format

The format is: Time-Series [1:136] from 1880 to 2015: -0.2 -0.11 -0.1 -0.2 -0.28 -0.31 -0.3 -0.33 -0.2 -0.11 ...

Details

The data were changed after 2011, so there are discrepancies between this data set and gtemp. The differences are explained in the following document: www1.ncdc.noaa.gov/pub/data/ghcn/v3/GHCNM-v3.2.0-FAQ.pdf.

Source

https://data.giss.nasa.gov/gistemp/graphs/

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

See Also

gtemp_land, gtemp_ocean, globtempl, gtemp, gtemp2

---

globtempl	*Global mean land (only) temperature deviations to 2015*

Description

Global mean [land only] temperature deviations (from 1951-1980 average), measured in degrees centigrade, for the years 1880-2015. This is an update of gtemp2. Note the data file is globtemp-el not globtemp-one; the el stands for land. The data files gtemp_land and gtemp_ocean are the most recent updates.

Usage

```
data("globtempl")
```

Format

The format is: Time-Series [1:136] from 1880 to 2015: -0.53 -0.51 -0.41 -0.43 -0.72 -0.56 -0.7 -0.74 -0.53 -0.25 ...

Details

The data were changed after 2011, so there are discrepancies between this data set and gtemp2. The differences are explained in the following document:
www1.ncdc.noaa.gov/pub/data/ghcn/v3/GHCNM-v3.2.0-FAQ.pdf.

Source

https://data.giss.nasa.gov/gistemp/graphs/

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

See Also

gtemp_land, gtemp_ocean, globtemp, gtemp2, gtemp

---

gnp   *Quarterly U.S. GNP*

Description

Seasonally adjusted quarterly U.S. GNP from 1947(1) to 2002(3).

Format

The format is: Time-Series [1:223] from 1947 to 2002: 1489 1497 1500 1524 1547 ...

Source

<https://research.stlouisfed.org/>

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at <https://github.com/nickpoison/astsa/>.

In addition, the News and ChangeLog files are at <https://github.com/nickpoison/astsa/blob/master/NEWS.md>.

The webpages for the texts and some help on using R for time series analysis can be found at <https://nickpoison.github.io/>.

See Also

gdp

Grid   *A Better Add Grid to a Plot*

Description

Adds a grid to an existing plot with major and minor ticks. Works like R graphics grid() but the grid lines are solid and gray and minor ticks are produced by default.

Usage

```
Grid(nx = NULL, ny = nx, col = gray(0.9), lty = 1, lwd = par("lwd"), equilogs = TRUE,
   minor = TRUE, nxm = 2, nym = 2, tick.ratio = 0.5, xm.grid = TRUE, ym.grid = TRUE, ...)
```

Arguments

`nx, ny`	number of cells of the grid in x and y direction. When NULL, as per default, the grid aligns with the tick marks on the corresponding default axis (i.e., tickmarks as computed by axTicks). When NA, no grid lines are drawn in the corresponding direction.
`col`	color of the grid lines.
`lty`	line type of the grid lines.
`lwd`	line width of the grid lines.
`equilogs`	logical, only used when log coordinates and alignment with the axis tick marks are active. Setting equilogs = FALSE in that case gives non equidistant tick aligned grid lines.
`minor`	logical with TRUE (default) adding minor ticks.
`nxm, nym`	number of intervals in which to divide the area between major tick marks on the x-axis (y-axis). If minor=TRUE, should be > 1 or no minor ticks will be drawn.
`tick.ratio`	ratio of lengths of minor tick marks to major tick marks. The length of major tick marks is retrieved from par("tck").
`xm.grid, ym.grid`	
	if TRUE (default), adds grid lines at minor x-axis, y-axis ticks.
`...`	other graphical parameters;

Author(s)

D.S. Stoffer

Source

The code for `grid()` in R graphics and `minor.tick()` from the Hmisc package were combined.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

grid

---

gtemp   *Global mean land-ocean temperature deviations*

Description

This data file is old and is here only for compatibility. See `globtemp` and `gtemp_land`. The original description is: Global mean land-ocean temperature deviations (from 1951-1980 average), measured in degrees centigrade, for the years 1880-2009.

Format

The format is: Time-Series [1:130] from 1880 to 2009: -0.28 -0.21 -0.26 -0.27 -0.32 -0.32 -0.29 -0.36 -0.27 -0.17 ...

Source

https://data.giss.nasa.gov/gistemp/graphs/

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

See Also

gtemp_land, gtemp_ocean, globtemp, globtempl, gtemp2

---

gtemp2   *Global Mean Surface Air Temperature Deviations*

Description

This data file is old and is here only for compatibility. See `globtemp` and `gtemp_land`. The original description is: Similar to gtemp but the data are based only on surface air temperature data obtained from meteorological stations. The data are temperature deviations (from 1951-1980 average), measured in degrees centigrade, for the years 1880-2009.

Usage

data(gtemp2)

Format

The format is: Time-Series [1:130] from 1880 to 2009: -0.24 -0.19 -0.14 -0.19 -0.45 -0.32 -0.42 -0.54 -0.24 -0.05 ...

Source

```
https://data.giss.nasa.gov/gistemp/graphs/
```

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`gtemp_land`, `gtemp_ocean`, `globtemp`, `globtempl`, `gtemp`

---

gtemp_land	*Global mean land temperature deviations - updated to 2021*

Description

Annual temperature anomalies (in degress centigrade) averaged over the Earth's land area from 1880 to 2021.

Format

The format is: Time-Series [1:142] from 1880 to 2021: -0.6 -0.39 -0.49 -0.58 -0.75 -0.76 -0.6 -0.69 -0.54 -0.26 ...

Source

```
https://data.giss.nasa.gov/gistemp/graphs/
```

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

gtemp_ocean, globtemp, globtempl, gtemp2

---

gtemp_ocean *Global mean ocean temperature deviations - updated to 2021*

Description

Annual sea surface temperature anomalies averaged over the part of the ocean that is free of ice at all times (open ocean) from 1880 to 2021.

Format

The format is: Time-Series [1:142] from 1880 to 2021: -0.05 0.01 0 -0.06 -0.15 -0.21 -0.21 -0.24 -0.05 -0.04 ...

Source

https://data.giss.nasa.gov/gistemp/graphs/

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

See Also

gtemp_land, globtemp, globtempl, gtemp2

Hare *Snowshoe Hare*

Description

This is one of the classic studies of predator-prey interactions, the 90-year data set is the number, in thousands, of snowshoe hare pelts purchased by the Hudson's Bay Company of Canada. While this is an indirect measure of predation, the assumption is that there is a direct relationship between the number of pelts collected and the number of hare and lynx in the wild.

Usage

```
data("Hare")
```

Format

The format is: Time-Series [1:91] from 1845 to 1935: 19.6 19.6 19.6 12 28 ...

Note

This data set pairs with Lynx. The data are in units of one thousand.

Source

From Odum's "Fundamentals of Ecology", p. 191. Data listed at:
people.whitman.edu/~hundledr/courses/M250F03/LynxHare.txt.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

See Also

Lynx

HCT   *Hematocrit Levels*

Description

HCT: Measurements made for 91 days on the three variables, log(white blood count) [WBC], log(platelet) [PLT] and hematocrit [HCT]. Missing data code is 0 (zero).

Format

The format is: Time-Series [1:91] from 1 to 91: 30 30 28.5 34.5 34 32 30.5 31 33 34 ...

Details

See Examples 6.1 and 6.9 for more details.

Source

Jones, R.H. (1984). Fitting multivariate models to unequally spaced data. In *Time Series Analysis of Irregularly Observed Data*, pp. 158-188. E. Parzen, ed. Lecture Notes in Statistics, 25, New York: Springer-Verlag.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

See Also

blood, PLT, WBC

---

hor   *Hawaiian occupancy rates*

Description

Quarterly Hawaiian hotel occupancy rate (percent of rooms occupied) from 1982-I to 2015-IV

Format

The format is: Time-Series [1:136] from 1982 to 2015: 79 65.9 70.9 66.7 ...

Source

https://dbedt.hawaii.gov/economic/qser/tourism/

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

Examples

```
tsplot(hor, type='c')                      # plot data and
text(hor, labels=1:4, col=c(1,4,2,6), cex=.9)  # add quarter labels
```

---

jj   *Johnson and Johnson Quarterly Earnings Per Share*

Description

Johnson and Johnson quarterly earnings per share, 84 quarters (21 years) measured from the first quarter of 1960 to the last quarter of 1980.

Format

The format is: Time-Series [1:84] from 1960 to 1981: 0.71 0.63 0.85 0.44 0.61 0.69 0.92 0.55 0.72 0.77 ...

Details

This data set is also included with the R distribution as JohnsonJohnson

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

Kfilter   *Quick Kalman Filter*

Description

Returns both the predicted and filtered values for various linear state space models; it also evaluates the likelihood at the given parameter values. This script replaces Kfilter0, Kfilter1, and Kfilter2

Usage

```
Kfilter(y, A, mu0, Sigma0, Phi, sQ, sR, Ups = NULL, Gam = NULL,
        input = NULL, S = NULL, version = 1)
```

Arguments

y	data matrix (n x q), vector or time series, n = number of observations. Use NA or zero (0) for missing data.
A	can be constant or an array with dimension `dim=c(q,p,n)` if time varying (see details). Use NA or zero (0) for missing data.
mu0	initial state mean vector (p x 1)
Sigma0	initial state covariance matrix (p x p)
Phi	state transition matrix (p x p)
sQ	state error pre-matrix (see details)
sR	observation error pre-matrix (see details)
Ups	state input matrix (p x r); leave as NULL (default) if not needed
Gam	observation input matrix (q x r); leave as NULL (default) if not needed
input	NULL (default) if not needed or a matrix (n x r) of inputs having the same row dimension (n) as y
S	covariance matrix (p x q) between state and observation errors; not necessary to specify if not needed and only used if version=2.
version	either 1 (default) or 2; version 2 allows for correlated errors

Details

This script replaces `Kfilter0`, `Kfilter1`, and `Kfilter2` by combining all cases. The major difference is how to specify the covariance matrices; in particular, `sQ = t(cQ)` and `sR = t(cR)` where `cQ` and `cR` were used in `Kfilter0-1-2` scripts.

The states x_t are p-dimensional, the data y_t are q-dimensional, and the inputs u_t are r-dimensional for $t = 1, \ldots, n$. The initial state is $x_0 \sim N(\mu_0, \Sigma_0)$.

The measurement matrices A_t can be constant or time varying. If time varying, they should be entered as an array of dimension `dim = c(q,p,n)`. Otherwise, just enter the constant value making sure it has the appropriate $q \times p$ dimension.

Version 1 (default): The general model is

$$x_t = \Phi x_{t-1} + \Upsilon u_t + sQ\, w_t \quad w_t \sim iid\, N(0, I)$$

$$y_t = A_t x_{t-1} + \Gamma u_t + sR\, v_t \quad v_t \sim iid\, N(0, I)$$

where $w_t \perp v_t$. Consequently the state noise covariance matrix is $Q = sQ\, sQ'$ and the observation noise covariance matrix is $R = sR\, sR'$ and sQ, sR do not have to be square as long as everything is conformable. Notice the specification of the state and observation covariances has changed from the original scripts.

NOTE: If it is easier to model in terms of Q and R, simply input the square root matrices `sQ = Q %^% .5` and `sR = R %^% .5`.

Version 2 (correlated errors): The general model is

$$x_{t+1} = \Phi x_t + \Upsilon u_{t+1} + sQ\, w_t \quad w_t \sim iid\, N(0, I)$$

$$y_t = A_t x_{t-1} + \Gamma u_t + sR\, v_t \quad v_t \sim iid\, N(0, I)$$

where $\mathrm{Cov}(w_t, v_t) = S$.

NOTE: If it is easier to model in terms of Q and R, simply input the square root matrices `sQ = Q %^% .5` and `sR = R %^% .5`.

Note that in either version, $sQ\, w_t$ has to be p-dimensional, but w_t does not, and $sR\, v_t$ has to be q-dimensional, but v_t does not.

Value

Time varying values are returned as arrays.

Xp	one-step-ahead prediction of the state
Pp	mean square prediction error
Xf	filter value of the state
Pf	mean square filter error
like	the negative of the log likelihood
innov	innovation series
sig	innovation covariances
Kn	last value of the gain, needed for smoothing

Note

Note that `Kfilter` is similar to `Kfilter-0-1-2` except that only the essential values need to be entered (and come first in the statement); the optional values such as `input` are set to `NULL` by default if they are not needed. This version is faster than the older versions. The biggest change was to how the covairances are specified. For example, if you have code that used `Kfilter1`, just use `sQ = t(cQ)` and `sR = t(cR)` here.

NOTE: If it is easier to model in terms of Q and R, simply input the square root matrices `sQ = Q%^%.5` and `sR = R%^%.5`.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

Ksmooth

Examples

```
# generate some data
 set.seed(1)
 sQ  = 1; sR = 3; n = 100
 mu0 = 0; Sigma0 = 10; x0 = rnorm(1,mu0,Sigma0)
 w = rnorm(n); v = rnorm(n)
 x = c(x0 + sQ*w[1]);  y = c(x[1] + sR*v[1])   # initialize
for (t in 2:n){
  x[t] = x[t-1] + sQ*w[t]
  y[t] = x[t] + sR*v[t]
  }
# run and plot the filter
run = Kfilter(y, A=1, mu0, Sigma0, Phi=1, sQ, sR)
tsplot(cbind(y,run$Xf), spaghetti=TRUE, type='o', col=c(4,6), pch=c(1,NA), margins=1)
# CRAN tests need extra white space :( so margins=1 is not necessary otherwise
legend('topleft', legend=c("y(t)","Xf(t)"), lty=1, col=c(4,6), bty="n", pch=c(1,NA))
```

Ksmooth   *Quick Kalman Smoother*

Description

Returns the smoother values for various linear state space models. The predicted and filtered values and the likelihood at the given parameter values are also returned (via Kfilter). This script replaces Ksmooth0, Ksmooth1, and Ksmooth2.

Usage

```
Ksmooth(y, A, mu0, Sigma0, Phi, sQ, sR, Ups = NULL, Gam = NULL,
         input = NULL, S = NULL, version = 1)
```

Arguments

y	data matrix (n x q), vector or time series, n = number of observations. Use NA or zero (0) for missing data.
A	can be constant or an array with dimension dim=c(q,p,n) if time varying (see details). Use NA or zero (0) for missing data.
mu0	initial state mean vector (p x 1)
Sigma0	initial state covariance matrix (p x p)
Phi	state transition matrix (p x p)
sQ	state error pre-matrix (see details)
sR	observation error pre-matrix (see details)
Ups	state input matrix (p x r); leave as NULL (default) if not needed
Gam	observation input matrix (q x r); leave as NULL (default) if not needed

input	NULL (default) if not needed or a matrix (n x r) of inputs having the same row dimension (n) as y
S	covariance matrix (p x q) between state and observation errors; not necessary to specify if not needed and only used if version=2.
version	either 1 (default) or 2; version 2 allows for correlated errors

Details

This script replaces `Ksmooth0`, `Ksmooth1`, and `Ksmooth2` by combining all cases. The major difference is how to specify the covariance matrices; in particular, `sQ = t(cQ)` and `sR = t(cR)` where `cQ` and `cR` were used in `Kfilter0-1-2` scripts.

The states x_t are p-dimensional, the data y_t are q-dimensional, and the inputs u_t are r-dimensional for $t = 1, \ldots, n$. The initial state is $x_0 \sim N(\mu_0, \Sigma_0)$.

The measurement matrices A_t can be constant or time varying. If time varying, they should be entered as an array of dimension `dim = c(q,p,n)`. Otherwise, just enter the constant value making sure it has the appropriate $q \times p$ dimension.

Version 1 (default): The general model is

$$x_t = \Phi x_{t-1} + \Upsilon u_t + sQ\, w_t \quad w_t \sim iid\ N(0, I)$$

$$y_t = A_t x_{t-1} + \Gamma u_t + sR\, v_t \quad v_t \sim iid\ N(0, I)$$

where $w_t \perp v_t$. Consequently the state noise covariance matrix is $Q = sQ\, sQ'$ and the observation noise covariance matrix is $R = sR\, sR'$ and sQ, sR do not have to be square as long as everything is conformable. Notice the specification of the state and observation covariances has changed from the original scripts.

NOTE: If it is easier to model in terms of Q and R, simply input the square root matrices `sQ = Q %^% .5` and `sR = R %^% .5`.

Version 2 (correlated errors): The general model is

$$x_{t+1} = \Phi x_t + \Upsilon u_{t+1} + sQ\, w_t \quad w_t \sim iid\ N(0, I)$$

$$y_t = A_t x_{t-1} + \Gamma u_t + sR\, v_t \quad v_t \sim iid\ N(0, I)$$

where $\text{Cov}(w_t, v_t) = S$.

NOTE: If it is easier to model in terms of Q and R, simply input the square root matrices `sQ = Q %^% .5` and `sR = R %^% .5`.

Note that in either version, $sQ\, w_t$ has to be p-dimensional, but w_t does not, and $sR\, v_t$ has to be q-dimensional, but v_t does not.

Value

Time varying values are returned as arrays.

Xs	state smoothers
Ps	smoother mean square error
X0n	initial mean smoother

P0n	initial smoother covariance
J0	initial value of the J matrix
J	the J matrices
Xp	state predictors
Pp	mean square prediction error
Xf	state filters
Pf	mean square filter error
like	negative of the log likelihood
innov	innovation series
sig	innovation covariances
Kn	the value of the last Gain

Note

Note that `Ksmooth` is similar to `Ksmooth-0-1-2` except that only the essential values need to be entered (and come first in the statement); the optional values such as `input` are set to `NULL` by default if they are not needed. This version is faster than the older versions. The biggest change was to how the covarainces are specified. For example, if you have code that used `Ksmooth1`, just use `sQ = t(cQ)` and `sR = t(cR)` here.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at [FUN WITH ASTSA](#).

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

[Kfilter](#)

Examples

```
# generate some data
 set.seed(1)
 sQ  = 1; sR = 3; n = 100
 mu0 = 0; Sigma0 = 10; x0 = rnorm(1,mu0,Sigma0)
 w = rnorm(n); v = rnorm(n)
 x = c(x0 + sQ*w[1]);  y = c(x[1] + sR*v[1])   # initialize
for (t in 2:n){
```

```
   x[t] = x[t-1] + sQ*w[t]
   y[t] = x[t] + sR*v[t]
   }
# run and plot the filter
run = Ksmooth(y, A=1, mu0, Sigma0, Phi=1, sQ, sR)
tsplot(cbind(y,run$Xs), spaghetti=TRUE, type='o', col=c(4,6), pch=c(1,NA), margins=1)
# CRAN tests need extra white space :( so margins=1 is not necessary otherwise
legend('topleft', legend=c("y(t)","Xs(t)"), lty=1, col=c(4,6), bty="n", pch=c(1,NA))
```

---

lag1.plot   *Lag Plot - one time series*

Description

Produces a grid of scatterplots of a series versus lagged values of the series.

Usage

```
lag1.plot(series, max.lag = 1, corr = TRUE, smooth = TRUE, col = gray(.1), lwl = 1,
          lwc = 2, bgl = gray(1,.65), ltcol = 1, box.col = 8, cex = .9, ...)
```

Arguments

series	the data
max.lag	maximum lag
corr	if TRUE, shows the autocorrelation value in a legend
smooth	if TRUE, adds a lowess fit to each scatterplot
col	color of points; default is gray(.1)
lwl	width of lowess line; default is 1
lwc	color of lowess line; default is 2 (red)
bgl	background of the ACF legend; default is semitransparent white
ltcol	legend text color; default is black
box.col	color of the border of the ACF legend; default is 'gray(62)'
cex	size of points; default is .9
...	additional graphical arguments

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

[`lag2.plot`](#)

Examples

```
lag1.plot(log(varve), max.lag=9)
lag1.plot(soi, 12, cex=1, pch=19, col=astsa.col(4, .3), gg=TRUE, corr=FALSE)
```

`lag2.plot`	*Lag Plot - two time series*

Description

Produces a grid of scatterplots of one series versus another lagged. The first named series is the one that gets lagged.

Usage

```
lag2.plot(series1, series2, max.lag = 0, corr = TRUE, smooth = TRUE, col = gray(.1),
          lwl = 1, lwc = 2, bgl = gray(1,.65), ltcol = 1, box.col = 8, cex = .9, ...)
```

Arguments

`series1`	first series (the one that gets lagged)
`series2`	second series
`max.lag`	maximum number of lags
`corr`	if TRUE, shows the cross-correlation value in a legend
`smooth`	if TRUE, adds a lowess fit to each scatterplot
`col`	color of points; default is `gray(.1)`
`lwl`	width of lowess line; default is 1
`lwc`	color of lowess line; default is 2 (red)
`bgl`	background of the ACF legend; default is semitransparent white
`ltcol`	legend text color; default is black
`box.col`	color of the border of the ACF legend; default is `'gray(62)'`
`cex`	size of points; default is .9
`...`	additional graphical parameters

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`lag1.plot`

Examples

```
lag2.plot(soi, rec, max.lag=3)
lag2.plot(soi, rec, 8, cex=1.1, pch=19, col=5, lwl=2)
```

LagReg   *Lagged Regression*

Description

Performs lagged regression as discussed in Chapter 4.

Usage

```
LagReg(input, output, L = c(3, 3), M = 40, threshold = 0,
        inverse = FALSE)
```

Arguments

input	input series
output	output series
L	degree of smoothing; see spans in the help file for `spec.pgram`.
M	must be even; number of terms used in the lagged regression
threshold	the cut-off used to set small (in absolute value) regression coeffcients equal to zero
inverse	if TRUE, will fit a forward-lagged regression

Details

For a bivariate series, `input` is the input series and `output` is the output series. The degree of smoothing for the spectral estimate is given by L; see `spans` in the help file for `spec.pgram`. The number of terms used in the lagged regression approximation is given by M, which must be even. The threshold value is the cut-off used to set small (in absolute value) regression coeffcients equal to zero (it is easiest to run LagReg twice, once with the default threshold of zero, and then again after inspecting the resulting coeffcients and the corresponding values of the CCF). Setting inverse=TRUE will fit a forward-lagged regression; the default is to run a backward-lagged regression. The script is based on code that was contributed by Professor Doug Wiens, Department of Mathematical and Statistical Sciences, University of Alberta.

Value

Graphs of the estimated impulse response function, the CCF, and the output with the predicted values superimposed.

`beta`	Estimated coefficients
`fit`	The output series, the fitted values, and the residuals

Note

See Chapter 4 of the text for an example.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

lap	*LA Pollution-Mortality Study*

Description

LA Pollution-Mortality Study (1970-1979, weekly data).

Format

The format is: mts [1:508, 1:11]

Details

columns are time series	with names
(1) Total Mortality	tmort
(2) Respiratory Mortality	rmort
(3) Cardiovascular Mortality	cmort
(4) Temperature	tempr
(5) Relative Humidity	rh
(6) Carbon Monoxide	co
(7) Sulfur Dioxide	so2
(8) Nitrogen Dioxide	no2
(9) Hydrocarbons	hycarb
(10) Ozone	o3
(11) Particulates	part

Note

Details may be found in `http://www.sungpark.net/ShumwayAzariPawitan88.pdf`

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

lead   *Leading Indicator*

Description

Leading indicator, 150 months; taken from Box and Jenkins (1970).

Usage

```
data(lead)
```

Format

The format is: Time-Series [1:150] from 1 to 150: 10.01 10.07 10.32 9.75 10.33 ...

Details

This is also the R time series BJsales.lead: The sales time series BJsales and leading indicator BJsales.lead each contain 150 observations. The objects are of class "ts".

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`sales`

Lynx   *Canadian Lynx*

Description

This is one of the classic studies of predator-prey interactions, the 90-year data set is the number, in thousands, of lynx pelts purchased by the Hudson's Bay Company of Canada. While this is an indirect measure of predation, the assumption is that there is a direct relationship between the number of pelts collected and the number of hare and lynx in the wild.

Usage

```
data("Lynx")
```

Format

The format is: Time-Series [1:91] from 1845 to 1935: 30.1 45.1 49.1 39.5 21.2 ...

Note

The data are in units of one thousand. This data set pairs with Hare and is NOT the same as lynx.

Source

From Odum's "Fundamentals of Ecology", p. 191. Additional information at
`http://people.whitman.edu/~hundledr/courses/M250F03/M250.html`

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`Hare`

---

matrixpwr	*Powers of a Square Matrix*

Description

`matrixpwr` computes powers of a square matrix including negative powers for nonsingular matrices.

`%^%` is a more intuitive interface as an operator.

Usage

```
matrixpwr(A, power)

A %^% power
```

Arguments

A	a square matrix
power	single numeric

Details

Raises matrix to the specified power. The matrix must be square and if `power < 0`, the matrix must be nonsingular.

Note that `%^%` is defined as `"%^%" <- function(A, power) matrixpwr(A, power)`

If `power = 0`, the identity matrix is returned.

Value

Returns matrix raised to the given power.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

Examples

```
# 2-state Markov transition matrix to steady state
( P = matrix(c(.7,.4,.3,.6), 2) )
P %^% 50

# surround with parentheses if used in an expression
c(.2, .8) %*% (P %^% 50)

# Inverse square root
var(econ5) %^% -.5
```

Months   *Month Labels*

Description

Provides labels for the (English) months of the year to be used in plotting monthly time series.

Format

The format is: chr [1:12] "J" "F" "M" "A" "M" "J" "J" "A" "S" "O" "N" "D"

Note

Hi Kids. The months of the year in English are:

January, February, March, April, May, June, July, August, September, October, November, December.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

Examples

```
sAR = sarima.sim(sar=.9, S=12, n=36)
tsplot(sAR, type='c')
points(sAR, pch=Months, cex=1.1, font=4, col=1:4)
```

---

mvspec   *Univariate and Multivariate Spectral Estimation*

Description

This is `spec.pgram` with a few changes in the defaults and written so you can easily extract the estimate of the multivariate spectral matrix as `fxx`. The bandwidth calculation has been changed to the more practical definition given in the text and this can be used to replace `spec.pgram`.

Usage

```
mvspec(x, spans = NULL, kernel = NULL, taper = 0, pad = 0,
       fast = TRUE, demean = FALSE, detrend = TRUE,
       plot = TRUE, log='n', type = NULL, na.action = na.fail,
       nxm=2, nym=1, main=NULL, ...)
```

Arguments

x	univariate or multivariate time series (i.e., the p columns of x are time series)
spans	specify smoothing; same as `spec.pgram`
kernel	specify kernel; same as `spec.pgram`
taper	specify taper; same as `spec.pgram` with different default
pad	specify padding; same as `spec.pgram`
fast	specify use of FFT; same as `spec.pgram`
demean	if TRUE, series is demeaned first; same as `spec.pgram`
detrend	if TRUE, series is detrended first; same as `spec.pgram`
plot	plot the estimate; same as `spec.pgram`
log	same as `spec.pgram` but default is `'no'`
type	type of plot to be drawn, defaults to lines
na.action	same as `spec.pgram`
nxm, nym	the number of minor tick mark divisions on x-axis, y-axis; the default is one minor tick on the x-axis and none on the y-axis
main	title of the graphics; if NULL, a suitable title is generated
...	graphical arguments passed to `plot.spec`

Details

This is built off of `spec.pgram` from the stats package with a few changes in the defaults and written so you can easily extract the estimate of the multivariate spectral matrix as `fxx`. The default for the plot is NOT to plot on a log scale and the graphic will have a grid. The bandwidth calculation has been changed to the more practical definition given in the text, $(L_h/n.used) * frequency(x)$. Also, the bandwidth is no longer displayed in the graphic. Although meant to be used to easily obtain multivariate spectral estimates, this script can be used for univariate time series. Note that the script does not taper by default (`taper=0`); this forces the user to do "conscious tapering".

Value

An object of class "spec", which is a list containing at least the following components:

`fxx`	spectral matrix estimates; an array of dimensions `dim = c(p,p,nfreq)`
`freq`	vector of frequencies at which the spectral density is estimated.
`spec`	vector (for univariate series) or matrix (for multivariate series) of estimates of the spectral density at frequencies corresponding to freq.
`details`	matrix with columns: frequency, period, spectral ordinate(s)
`coh`	NULL for univariate series. For multivariate time series, a matrix containing the squared coherency between different series. Column i + (j - 1) * (j - 2)/2 of coh contains the squared coherency between columns i and j of x, where i < j.
`phase`	NULL for univariate series. For multivariate time series a matrix containing the cross-spectrum phase between different series. The format is the same as coh.
`Lh`	Number of frequencies (approximate) used in the band.
`n.used`	Sample length used for the FFT
`df`	Degrees of freedom (may be approximate) associated with the spectral estimate.
`bandwidth`	Bandwidth (may be approximate) associated with the spectral estimate.
`method`	The method used to calculate the spectrum.

The results are returned invisibly if plot is true.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

Examples

```
# real raw periodogram
mvspec(soi)
mvspec(soi, log='y')  # on a log scale

# smooth and some details printed
mvspec(soi, spans=c(7,7), taper=.5)$details[1:45,]

# multivariate example
deth = cbind(mdeaths, fdeaths)    # two R data sets, male/female monthly deaths ...
tsplot(deth, type='b', col=c(4,6), spaghetti=TRUE, pch=c('M','F'))
dog = mvspec(deth, spans=c(3,3), taper=.1)
dog$fxx        # look a spectral matrix estimates
dog$bandwidth  # bandwidth with time unit = year
dog$df         # degrees of freedom
plot(dog, plot.type="coherency")  # plot of squared coherency
```

---

nyse   *Returns of the New York Stock Exchange*

Description

Returns of the New York Stock Exchange (NYSE) from February 2, 1984 to December 31, 1991.

Format

The format is: Time-Series [1:2000] from 1 to 2000: 0.00335 -0.01418 -0.01673 0.00229 -0.01692 ...

Note

Various packages have data sets called nyse. Consequently, it may be best to specify this data set as nyse = astsa::nyse to avoid conflicts.

Source

S+GARCH module - Version 1.1 Release 2: 1998

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

---

oil   *Crude oil, WTI spot price FOB*

Description

Crude oil, WTI spot price FOB (in dollars per barrel), weekly data from 2000 to mid-2010.

Format

The format is: Time-Series [1:545] from 2000 to 2010: 26.2 26.1 26.3 24.9 26.3 ...

Details

pairs with the series gas

Source

Data were obtained from the URL: www.eia.doe.gov/dnav/pet/pet_pri_spt_s1_w.htm

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

See Also

gas

---

part   *Particulate levels from the LA pollution study*

Description

Particulate series corresponding to cmort from the LA pollution study.

Format

The format is: Time-Series [1:508] from 1970 to 1980: 72.7 49.6 55.7 55.2 66 ...

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

[lap](#)

PLT   *Platelet Levels*

Description

PLT: Measurements made for 91 days on the three variables, log(white blood count) [WBC], log(platelet) [PLT] and hematocrit [HCT]. Missing data code is 0 (zero).

Usage

```
data(PLT)
```

Format

The format is: Time-Series [1:91] from 1 to 91: 4.47 4.33 4.09 4.6 4.41 ...

Details

See Examples 6.1 and 6.9 for more details.

Source

Jones, R.H. (1984). Fitting multivariate models to unequally spaced data. In *Time Series Analysis of Irregularly Observed Data*, pp. 158-188. E. Parzen, ed. Lecture Notes in Statistics, 25, New York: Springer-Verlag.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

[blood](), [HCT](), [WBC]()

---

polio	*Poliomyelitis cases in US*

Description

Monthly time series of poliomyelitis cases reported to the U.S. Centers for Disease Control for the years 1970 to 1983, 168 observations.

Format

The format is: Time-Series [1:168] from 1970 to 1984: 0 1 0 0 1 3 9 2 3 5 ...

Details

The data were originally modelled by Zeger (1988) "A Regression Model for Time Series of Counts," *Biometrika*, 75, 822-835.

Source

Data taken from the gamlss.data package; see https://www.gamlss.com/.

References

You can find demonstrations of astsa capabilities at [FUN WITH ASTSA](https://github.com/nickpoison/astsa/blob/master/fun_with_astsa/fun_with_astsa.md).

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

Examples

```
tsplot(polio, type='s')
```

---

polyMul   *Multiplication of Two Polynomials*

Description

Multiplication of two polynomials.

Usage

```
polyMul(p, q)
```

Arguments

p	coefficients of first polynomial
q	coefficients of second polynomial

Details

inputs are vectors of coefficients a, b, c, ..., in order of power $ax^0 + bx^1 + cx^2 + ...$

Value

coefficients of the product in order of power

Author(s)

D.S. Stoffer

Source

based on code from the polynom package https://CRAN.R-project.org/package=polynom

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

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The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

Examples

```
a = 1:3  # 1 + 2x + 3x^2
b = 1:2  # 1 + 2x
polyMul(a, b)
# [1] 1 4 7 6
# 1 + 4x + 7x^2 + 6x^3
```

---

prodn   *Monthly Federal Reserve Board Production Index*

Description

Monthly Federal Reserve Board Production Index (1948-1978, n = 372 months).

Usage

```
data(prodn)
```

Format

The format is: Time-Series [1:372] from 1948 to 1979: 40.6 41.1 40.5 40.1 40.4 41.2 39.3 41.6 42.3 43.2 ...

References

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---

qinfl   *Quarterly Inflation*

Description

Quarterly inflation rate in the Consumer Price Index from 1953-Ito 1980-II, n = 110 observations.

Format

The format is: Time-Series [1:110] from 1953 to 1980: 1.673 3.173 0.492 -0.327 -0.333 ...

Details

pairs with qintr (interest rate)

Source

Newbold, P. and T. Bos (1985). *Stochastic Parameter Regression Models*. Beverly Hills: Sage.

References

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See Also

`qintr`

---

qintr	*Quarterly Interest Rate*

Description

Quarterly interest rate recorded for Treasury bills from 1953-Ito 1980-II, n = 110 observations.

Format

The format is: Time-Series [1:110] from 1953 to 1980: 1.98 2.15 1.96 1.47 1.06 ...

Details

pairs with qinfl (inflation)

Source

Newbold, P. and T. Bos (1985). *Stochastic Parameter Regression Models*. Beverly Hills: Sage.

References

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The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`qinfl`

---

rec   *Recruitment (number of new fish index)*

Description

Recruitment (index of the number of new fish) for a period of 453 months ranging over the years 1950-1987. Recruitment is loosely defined as an indicator of new members of a population to the first life stage at which natural mortality stabilizes near adult levels.

Usage

```
data(rec)
```

Format

The format is: Time-Series [1:453] from 1950 to 1988: 68.6 68.6 68.6 68.6 68.6 ...

Details

can pair with soi (Southern Oscillation Index)

Source

Data furnished by Dr. Roy Mendelssohn of the Pacific Fisheries Environmental Laboratory, NOAA (personal communication). Further discussion of the concept of Recruitment may be found here: derekogle.com/fishR/examples/oldFishRVignettes/StockRecruit.pdf

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

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See Also

soi

---

sales   *Sales*

Description

Sales, 150 months; taken from Box and Jenkins (1970).

Format

The format is: Time-Series [1:150] from 1 to 150: 200 200 199 199 199 ...

Details

This is also the R data set `BJsales`: The sales time series `BJsales` and leading indicator `BJsales.lead` each contain 150 observations. The objects are of class "ts".

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

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The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`lead`

---

salmon   *Monthly export price of salmon*

Description

Farm Bred Norwegian Salmon, export price, US Dollars per Kilogram

Format

The format is: Time-Series [1:166] from September 2003 to June 2017: 2.88 3.16 2.96 3.12 3.23 3.32 3.45 3.61 3.48 3.21 ...

Source

`https://www.indexmundi.com/commodities/`

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

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---

salt   *Salt Profiles*

Description

Salt profiles taken over a spatial grid set out on an agricultural field, 64 rows at 17-ft spacing.

Usage

```
data(salt)
```

Format

The format is: Time-Series [1:64] from 1 to 64: 6 6 6 3 3 3 4 4 4 1.5 ...

Details

pairs with `saltemp`, temperature profiles on the same grid

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

saltemp

---

saltemp *Temperature Profiles*

Description

Temperature profiles over a spatial grid set out on an agricultural field, 64 rows at 17-ft spacing.

Usage

```
data(saltemp)
```

Format

The format is: Time-Series [1:64] from 1 to 64: 5.98 6.54 6.78 6.34 6.96 6.51 6.72 7.44 7.74 6.85 ...

Details

pairs with `salt`, salt profiles on the same grid

References

You can find demonstrations of astsa capabilities at [FUN WITH ASTSA](#).

The most recent version of the package can be found at <https://github.com/nickpoison/astsa/>.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at <https://nickpoison.github.io/>.

See Also

[salt](#)

---

sarima *Fit ARIMA Models*

Description

Fits ARIMA models (with diagnostics) in a short command. It can also be used to perform regression with autocorrelated errors.

Usage

```
sarima(xdata, p, d, q, P = 0, D = 0, Q = 0, S = -1,
       details = TRUE, xreg=NULL, Model=TRUE,
       fixed=NULL, tol = sqrt(.Machine$double.eps),
       no.constant = FALSE, ...)
```

Arguments

`xdata`	univariate time series
`p`	AR order (must be specified)
`d`	difference order (must be specified)
`q`	MA order (must be specified)
`P`	SAR order; use only for seasonal models
`D`	seasonal difference; use only for seasonal models
`Q`	SMA order; use only for seasonal models
`S`	seasonal period; use only for seasonal models
`xreg`	Optionally, a vector or matrix of external regressors, which must have the same number of rows as xdata.
`Model`	if TRUE (default), the model orders are printed on the diagnostic plot.
`fixed`	optional numeric vector of the same length as the total number of parameters. If supplied, only parameters corresponding to NA entries will be estimated.
`details`	if FALSE, turns off the diagnostic plot and the output from the nonlinear optimization routine, which is `optim`. The default is TRUE.
`tol`	controls the relative tolerance (reltol in `optim`) used to assess convergence. The default is `sqrt(.Machine$double.eps)`, the R default.
`no.constant`	controls whether or not sarima includes a constant in the model. In particular, if there is no differencing (d = 0 and D = 0) you get the mean estimate. If there is differencing of order one (either d = 1 or D = 1, but not both), a constant term is included in the model. These two conditions may be overridden (i.e., no constant will be included in the model) by setting this to TRUE; e.g., `sarima(x,1,1,0,no.constant=TRUE)`. Otherwise, no constant or mean term is included in the model. If regressors are included (via `xreg`), this is ignored.
`...`	additional graphical arguments

Details

If your time series is in x and you want to fit an ARIMA(p,d,q) model to the data, the basic call is `sarima(x,p,d,q)`. The values p,d,q, must be specified as there is no default. The results are the parameter estimates, standard errors, AIC, AICc, BIC (as defined in Chapter 2) and diagnostics. To fit a seasonal ARIMA model, the basic call is `sarima(x,p,d,q,P,D,Q,S)`. For example, `sarima(x,2,1,0)` will fit an ARIMA(2,1,0) model to the series in x, and `sarima(x,2,1,0,0,1,1,12)` will fit a seasonal ARIMA$(2, 1, 0) * (0, 1, 1)_{12}$ model to the series in x. The difference between the information criteria given by `sarima()` and `arima()` is that they differ by a scaling factor of the effective sample size.

Value

`fit`	the `arima` object
`degrees_of_freedom`	
	Error degrees of freedom
`ttable`	a little t-table with two-sided p-values

AIC	value of the AIC - all ICs are the values reported in `fit` divided by the essential number of observations (after differencing)
AICc	value of the AICc
BIC	value of the BIC

References

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The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`sarima.for`, `sarima.sim`

Examples

```
# easy to use
sarima(rec,2,0,0)  # data, p, d, and q
sarima(rec, 2,0,0, details=FALSE)$ttable  # print t-table only

(dog <- sarima(log(AirPassengers), 0,1,1, 0,1,1,12))
str(dog$fit, vec.len=1) # fit has all the returned arima values
tsplot(resid(dog$fit))  # plot the innovations (residuals)

# fixed parameters
x = sarima.sim( ar=c(0,-.9), n=200 ) + 50
sarima(x, 2,0,0, fixed=c(0,NA,NA))  # phi1 fixed, phi2 and mean free

# fun with diagnostics
sarima(log(AirPassengers), 0,1,1, 0,1,1,12, gg=TRUE, col=4)
```

---

sarima.for	*ARIMA Forecasting*

Description

ARIMA forecasting.

Usage

```
sarima.for(xdata,n.ahead,p,d,q,P=0,D=0,Q=0,S=-1,tol=sqrt(.Machine$double.eps),
        no.constant=FALSE, plot=TRUE, plot.all=FALSE,
        xreg = NULL, newxreg = NULL, fixed=NULL, ...)
```

Arguments

xdata	univariate time series
n.ahead	forecast horizon (number of periods)
p	AR order
d	difference order
q	MA order
P	SAR order; use only for seasonal models
D	seasonal difference; use only for seasonal models
Q	SMA order; use only for seasonal models
S	seasonal period; use only for seasonal models
tol	controls the relative tolerance (reltol) used to assess convergence. The default is sqrt(.Machine$double.eps), the R default.
no.constant	controls whether or not a constant is included in the model. If no.constant=TRUE, no constant is included in the model. See [sarima](#) for more details.
plot	if TRUE (default) the data (or some of it) and the forecasts and bounds are plotted
plot.all	if TRUE, all the data are plotted in the graphic; otherwise, only the last 100 observations are plotted in the graphic.
xreg	Optionally, a vector or matrix of external regressors, which must have the same number of rows as the series. If this is used, newxreg MUST be specified.
newxreg	New values of xreg to be used for prediction. Must have at least n.ahead rows.
fixed	optional numeric vector of the same length as the total number of parameters. If supplied, only parameters corresponding to NA entries will be estimated.
...	additional graphical arguments

Details

For example, sarima.for(x,5,1,0,1) will forecast five time points ahead for an ARMA(1,1) fit to x. The output prints the forecasts and the standard errors of the forecasts, and supplies a graphic of the forecast with +/- 1 and 2 prediction error bounds.

Value

pred	the forecasts
se	the prediction (standard) errors

References

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See Also

[sarima](#)

Examples

```
sarima.for(log(AirPassengers),12,0,1,1,0,1,1,12)

# fun with the graphic
sarima.for(log(AirPassengers),12,0,1,1,0,1,1,12, gg=TRUE, col=4, main='arf')

#  with regressors:
nummy   = length(soi)
n.ahead = 24
nureg   = time(soi)[nummy] + seq(1,n.ahead)/12
sarima.for(soi,n.ahead,2,0,0,2,0,0,12, xreg=time(soi), newxreg=nureg)
```

---

sarima.sim *ARIMA Simulation*

Description

Simulate data from (seasonal) ARIMA models.

Usage

```
sarima.sim(ar = NULL, d = 0, ma = NULL, sar = NULL, D = 0, sma = NULL, S = NULL,
           n = 500, rand.gen = rnorm, innov = NULL, burnin = NA, t0 = 0, ...)
```

Arguments

ar	coefficients of AR component (does not have to be specified)
d	order of regular difference (does not have to be specified)
ma	coefficients of MA component (does not have to be specified)
sar	coefficients of SAR component (does not have to be specified)
D	order of seasonal difference (does not have to be specified)
sma	coefficients of SMA component (does not have to be specified)
S	seasonal period (does not have to be specified)
n	desired sample size (defaults to 500)
rand.gen	optional; a function to generate the innovations (defaults to normal)
innov	an optional times series of innovations. If not provided, rand.gen is used.
burnin	length of burn-in (a non-negative integer). If NA (the default) a reasonable value is selected.
t0	start time (defaults to 0)

...   additional arguments applied to the innovations. For rand.gen, the standard deviation of the innovations generated by rnorm can be specified by sd or the mean by mean (see details and examples). In addition, rand.gen may be overridden using a preset sequence of innovations specifying innov (see details and examples).

Details

Will generate a time series of length n from the specified SARIMA model using simplified input.

The use of the term mean in ... refers to the generation of normal innovations. For example, sarima.sim(ar=.9, mean=5) will generate data using N(5,1) or 5+N(0,1) innovations, so that the constant in the model is 5 and the mean of the AR model is 5/(1-.9) = 50. In sarima.sim(ma=.9, mean=5), however, the model mean is 5 (the constant). Also, a random walk with drift = .1 can be generated by sarima.sim(d=1, mean=.1, burnin=0), which is equivalent to cumsum(rnorm(500, mean=.1)). The same story goes if sd is specified; i.e., it's applied to the innovations. Because anything specified in ... refers to the innovations, a simpler way to generate a non-zero mean is to add the value outside the call; see the examples.

If innov is used to input the innovations and override rand.gen, be sure that length(innov) is at least n + burnin. If the criterion is not met, the script will return less than the desired number of values and a warning will be given.

Value

A time series of length n from the specified SARIMA model with the specified frequency if the model is seasonal and start time t0.

Note

The model autoregressive polynomial ('AR side' = AR x SAR) is checked for causality and the model moving average polynomial ('MA side' = MA x SMA) is checked invertibility. The script stops and reports an error at the first violation of causality or invertibility; i.e., it will not report multiple errors.

Author(s)

D.S. Stoffer

References

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Examples

```
## AR(2) with mean 50 [n = 500 is default]
y = sarima.sim(ar=c(1.5,-.75)) + 50
tsplot(y)

## ARIMA(0,1,1) with drift ['mean' refers to the innovations]
tsplot(sarima.sim(ma=-.8, d=1, mean=.1))

## SAR(1) example from text
sAR = sarima.sim(sar=.9, S=12, n=36)
tsplot(sAR, type='c')
points(sAR, pch=Months, cex=1.1, font=4, col=1:4)

## SARIMA(0,1,1)x(0,1,1)_12 - B&J's favorite
set.seed(101010)
tsplot(sarima.sim(d=1, ma=-.4, D=1, sma=-.6, S=12, n=120))

## infinite variance t-errors
tsplot(sarima.sim(ar=.9, rand.gen=function(n, ...) rt(n, df=2) ))

## use your own innovations
dog = rexp(150, rate=.5)*sign(runif(150,-1,1))
tsplot(sarima.sim(n=100, ar=.99, innov=dog, burnin=50))

## generate seasonal data but no P, D or Q - you will receive
## a message to make sure that you wanted to do this on purpose:
tsplot(sarima.sim(ar=c(1.5,-.75), n=144, S=12), ylab='doggy', xaxt='n')
mtext(seq(0,144,12), side=1, line=.5, at=0:12)
```

---

scatter.hist	*Scatterplot with Marginal Histograms*

Description

Draws a scatterplot with histograms in the margins.

Usage

```
scatter.hist(x, y, xlab = NULL, ylab = NULL, title = NULL, pt.size = 1,
             hist.col = gray(0.82), pt.col = gray(0.1, 0.25), pch = 19,
             reset.par = TRUE, ...)
```

Arguments

x	vector of x-values
y	corresponding vector of y-values
xlab	x-axis label (defaults to name of x)

`ylab`	y-axis label (defaults to name of y)
`title`	plot title (optional)
`pt.size`	size of points in scatterplot
`hist.col`	color for histograms
`pt.col`	color of points in scatterplot
`pch`	scatterplot point character
`reset.par`	reset graphics - default is TRUE; set to FALSE to add on to scatterplot
`...`	other graphical parameters

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

Examples

```
scatter.hist(tempr, cmort, hist.col=astsa.col(5,.4), pt.col=5, pt.size=1.5, reset=FALSE)
lines(lowess(tempr, cmort), col=6)
```

SigExtract	*Signal Extraction And Optimal Filtering*

Description

Performs signal extraction and optimal filtering as discussed in Chapter 4.

Usage

```
SigExtract(series, L = c(3, 3), M = 50, max.freq = 0.05)
```

Arguments

`series`	univariate time series to be filtered
`L`	degree of smoothing (may be a vector); see `spans` in `spec.pgram` for more details
`M`	number of terms used in the lagged regression approximation
`max.freq`	truncation frequency, which must be larger than 1/M.

Details

The basic function of the script, and the default setting, is to remove frequencies above 1/20 (and, in particular, the seasonal frequency of 1 cycle every 12 time points). The sampling frequency of the time series is set to unity prior to the analysis.

Value

Returns plots of (1) the original and filtered series, (2) the estiamted spectra of each series, (3) the filter coefficients and the desired and attained frequency response function. The filtered series is returned invisibly.

Note

The script is based on code that was contributed by Professor Doug Wiens, Department of Mathematical and Statistical Sciences, University of Alberta.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

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In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

sleep1 *Sleep State and Movement Data - Group 1*

Description

Sleep-state and number of movements of infants taken from a study on the effects of prenatal exposure to alcohol. This is Group 1 where the mothers did not drink alcohol during pregnancy.

Format

List of 12 (by subjects) :'data.frame': 120 obs. of 3 variables: .. min : int [1:120] minute (1 to 120) .. state: int [1:120] sleep state 1 to 6 with NA missing (see details) .. mvmnt: int [1:120] number of movements

Details

Per minute sleep state, for approximately 120 minutes, is categorized into one of six possible states, non-REM: NR1 [1] to NR4 [4], and REM [5], or AWAKE [6]. NA means no state is recorded for that minute (if there, it occurs at end of the session). Group 1 (this group) is from mothers who abstained from drinking during pregnancy. In addition, the number of movements per minute are listed.

Source

Stoffer, D. S., Scher, M. S., Richardson, G. A., Day, N. L., Coble, P. A. (1988). A Walsh-Fourier Analysis of the Effects of Moderate Maternal Alcohol Consumption on Neonatal Sleep-State Cycling. Journal of the American Statistical Association, 83(404), 954-963. `https://doi.org/10.2307/2290119`

Stoffer, D. S. (1990). Multivariate Walsh-Fourier Analysis. Journal of Time Series Analysis, 11(1), 57-73. `https://doi.org/10.1111/j.1467-9892.1990.tb00042.x`

References

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The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

sleep2

Examples

```
## Not run:

# plot data
par(xpd = NA, oma=c(0,0,0,8) )
tsplot(sleep1[[1]][2:3], type='s', col=2:3, spag=TRUE, gg=TRUE)
legend('topright', inset=c(-0.3,0), bty='n', lty=1, col=2:3, legend=c('sleep state',
        'number of \nmovements'))
## you may have to change the first value of 'inset' in the legend to get it to fit

# spectral analysis
x = dna2vector(sleep1[[1]]$state[1:115], alphabet=c('1','2','3','4','5'))  # never awake
specenv(x, spans=c(3,3))
abline(v=1/60, lty=2, col=8)

## End(Not run)
```

---

sleep2   *Sleep State and Movement Data - Group 2*

Description

Sleep-state and number of movements of infants taken from a study on the effects of prenatal exposure to alcohol. This is Group 2 where the mothers drank alcohol in moderation during pregnancy.

Format

List of 12 (by subjects) :'data.frame': 120 obs. of 3 variables: .. min : int [1:120] minute (1 to 120) .. state: int [1:120] sleep state 1 to 6 with NA missing (see details) .. mvmnt: int [1:120] number of movements

Details

Per minute sleep state, for approximately 120 minutes, is categorized into one of six possible states, non-REM: NR1 [1] to NR4 [4], and REM [5], or AWAKE [6]. NA means no state is recorded for that minute (if there, it occurs at end of the session). Group 2 (this group) is from mothers who drank alcohol in moderation during pregnancy. In addition, the number of movements per minute are listed.

Source

Stoffer, D. S., Scher, M. S., Richardson, G. A., Day, N. L., Coble, P. A. (1988). A Walsh-Fourier Analysis of the Effects of Moderate Maternal Alcohol Consumption on Neonatal Sleep-State Cycling. Journal of the American Statistical Association, 83(404), 954-963. `https://doi.org/10.2307/2290119`

Stoffer, D. S. (1990). Multivariate Walsh-Fourier Analysis. Journal of Time Series Analysis, 11(1), 57-73. `https://doi.org/10.1111/j.1467-9892.1990.tb00042.x`

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

sleep1

Examples

```
## Not run:

# plot data
par(xpd = NA, oma=c(0,0,0,8) )
tsplot(sleep2[[3]][2:3], type='s', col=2:3, spag=TRUE, gg=TRUE)
legend('topright', inset=c(-0.3,0), bty='n', lty=1, col=2:3, legend=c('sleep state',
        'number of \nmovements'))
## you may have to change the first value of 'inset' in the legend to get it to fit

# spectral analysis
x = dna2vector(sleep1[[1]]$state[1:115], alphabet=c('1','2','3','4','5'))  # never awake
specenv(x, spans=c(3,3))
abline(v=1/60, lty=2, col=8)

## End(Not run)
```

---

so2   *SO2 levels from the LA pollution study*

Description

Sulfur dioxide levels from the LA pollution study

Format

The format is: Time-Series [1:508] from 1970 to 1980: 3.37 2.59 3.29 3.04 3.39 2.57 2.35 3.38 1.5 2.56 ...

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

See Also

lap

---

soi *Southern Oscillation Index*

Description

Southern Oscillation Index (SOI) for a period of 453 months ranging over the years 1950-1987.

Format

The format is: Time-Series [1:453] from 1950 to 1988: 0.377 0.246 0.311 0.104 -0.016 0.235 0.137 0.191 -0.016 0.29 ...

Details

pairs with rec (Recruitment)

Source

Data furnished by Dr. Roy Mendelssohn of the Pacific Fisheries Environmental Laboratory, NOAA (personal communication).

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

See Also

rec, ENSO

---

soiltemp *Spatial Grid of Surface Soil Temperatures*

Description

A 64 by 36 matrix of surface soil temperatures.

Format

The format is: num [1:64, 1:36] 6.7 8.9 5 6.6 6.1 7 6.5 8.2 6.7 6.6 ...

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

sp500.gr   *Returns of the S&P 500*

Description

Daily growth rate of the S&P 500 from 2001 though 2011.

Format

The format is: Time Series; Start = c(2001, 2); End = c(2011, 209); Frequency = 252

Source

Douc, Moulines, & Stoffer (2014). *Nonlinear Time Series: Theory, Methods and Applications with R Examples*. CRC Press. ISBN: <9781466502253>

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

sp500w   *Weekly Growth Rate of the Standard and Poor's 500*

Description

Weekly closing returns of the SP 500 from 2003 to September, 2012.

Format

An 'xts' object on 2003-01-03 to 2012-09-28; Indexed by objects of class: [Date] TZ: UTC

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

spec.ic   *Estimate Spectral Density of a Time Series from AR Fit*

Description

Fits an AR model to data and computes (and by default plots) the spectral density of the fitted model based on AIC (default) or BIC.

Usage

```
spec.ic(xdata, BIC = FALSE, order.max = 30, main = NULL, plot = TRUE,
        detrend = FALSE, method=NULL, ...)
```

Arguments

xdata	a univariate time series.
BIC	if TRUE, fit is based on BIC. If FALSE (default), fit is based on AIC.
order.max	maximum order of models to fit. Defaults to 30.
main	plot title. Defaults to name of series, method and chosen order.
plot	if TRUE (default) produces a graphic of the estimated AR spectrum.
detrend	if TRUE, detrends the data first. Default is FALSE.
method	method of estimation - a character string specifying the method to fit the model chosen from the following: "yule-walker", "burg", "ols", "mle", "yw". Defaults to "yule-walker".
...	additional graphical arguments.

Details

Uses `ar` to fit the best AR model based on pseudo AIC or BIC. Using `method='mle'` will be slow. The minimum centered AIC and BIC values and the spectral and frequency ordinates are returned silently.

Value

[[1]]	Matrix with columns: ORDER, AIC, BIC
[[2]]	Matrix with columns: freq, spec

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`ar`, `spec.ar`

Examples

```
## Not run:
# AIC
spec.ic(soi)
spec.ic(sunspotz, method='burg', col=4)

# BIC after detrending on log scale
spec.ic(soi, BIC=TRUE, detrend=TRUE, log='y')

# plot AIC and BIC without spectral estimate
tsplot(0:30, spec.ic(soi, plot=FALSE)[[1]][,2:3], type='o', xlab='order', nxm=5)

## End(Not run)
```

---

specenv	*Spectral Envelope*

Description

Computes the spectral envelope of categorical-valued or real-valued time series.

Usage

```
specenv(xdata, section = NULL, spans = NULL, kernel = NULL, taper = 0,
        significance = 1e-04, plot = TRUE, ylim = NULL, real = FALSE, ...)
```

Arguments

xdata	For categorical-valued sequences, a matrix with rows that are indicators of the categories represented by the columns, possibly a sequence converted using [dna2vector](). For real-valued sequences, a matrix with at least two columns that are various transformations of the data.
section	of the form `start:end` where `start < end` are positive integers; specifies the section used in the analysis - default is the entire sequence.
spans	specify smoothing used in mvspec.
kernel	specify kernel to be used in mvspec.
taper	specify amount of tapering to be used in mvspec.
significance	significance threshold exhibited in plot - default is .0001; set to NA to cancel
plot	if TRUE (default) a graphic of the spectral envelope is produced
ylim	limits of the spectral envelope axis; if NULL (default), a suitable range is calculated.
real	FALSE (default) for categorical-valued sequences and TRUE for real-valued sequences.
...	other graphical parameters.

Details

Calculates the spectral envelope for categorical-valued series as discussed in
`https://www.stat.pitt.edu/stoffer/dss_files/spenv.pdf`
and summarized in
`https://doi.org/10.1214/ss/1009212816`.
Alternately, calculates the spectral envelope for real-valued series as discussed in
`https://doi.org/10.1016/S0378-3758(96)00044-4`.

These concepts are also presented (with examples) in Section 7.9 (Chapter 7) of Time Series Analysis and Its Applications: With R Examples: `https://www.stat.pitt.edu/stoffer/tsa4/`.

For categorical-valued series, the input xdata must be a matrix of indicators which is perhaps a sequence preprocessed using [dna2vector]().

For real-valued series, the input xdata should be a matrix whose columns are various transformations of the univariate series.

The script does not detrend the data prior to estimating spectra. If this is an issue, then detrend the data prior to using this script.

Value

By default, will produce a graph of the spectral envelope and an approximate significance threshold. A matrix containing: frequency, spectral envelope ordinates, and (1) the scalings of the categories in the order of the categories in the alphabet or (2) the coefficients of the transformations, is returned invisibly.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

dna2vector

Examples

```
## Not run:
# a DNA sequence
data  = bnrf1ebv
xdata = dna2vector(data)
u = specenv(xdata, section=1:1000, spans=c(7,7))
head(u)  # scalings are for A, C, G, and last one T=0 always

# a real-valued series (nyse returns)
x = astsa::nyse
xdata = cbind(x, abs(x), x^2)
u = specenv(xdata, real=TRUE,  spans=c(3,3))
# plot optimal transform at freq = .001
beta = u[2, 3:5]
b = beta/beta[2]  # makes abs(x) coef=1
gopt = function(x) { b[1]*x+b[2]*abs(x)+b[3]*x^2 }
curve(gopt, -.2, .2, col=4, lwd=2, panel.first=Grid())
g2 = function(x) { b[2]*abs(x) } # corresponding to |x|
curve(g2, -.2,.2, add=TRUE, col=6)
```

```
## End(Not run)
```

---

speech   *Speech Recording*

Description

A small .1 second (1000 points) sample of recorded speech for the phrase "aaa...hhh".

Format

The format is: Time-Series [1:1020] from 1 to 1020: 1814 1556 1442 1416 1352 ...

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

ssm   *State Space Model*

Description

Fits a simple univariate state space model to data. The parameters are estimated (the state regression parameter may be fixed). State predictions, filters, and smoothers and corresponding error variances are evaluated at the estimates. The sample size must be at least 20.

Usage

```
ssm(y, A, phi, alpha, sigw, sigv, fixphi = FALSE)
```

Arguments

y	data
A	measurement value (fixed constant)
phi	initial value of phi, may be fixed
alpha	initial value for alpha
sigw	initial value for sigma[w]
sigv	initial value for sigma[v]
fixphi	if TRUE, the phi parameter is fixed

Details

The script works for a specific univariate state space model,

$$x_t = \alpha + \phi x_{t-1} + w_t \quad \text{and} \quad y_t = A x_t + v_t.$$

The initial state conditions use a default calculation and cannot be specified. The parameter estimates are printed and the script returns the state predictors and smoothers. The regression parameter ϕ may be fixed.

Value

At the MLEs, these are returned invisibly:

Xp	time series - state prediction, x_t^{t-1}
Pp	corresponding MSPEs, P_t^{t-1}
Xf	time series - state filter, x_t^t
Pf	corresponding MSEs, P_t^t
Xs	time series - state smoother, x_t^n
Ps	corresponding MSEs, P_t^n

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

Examples

```
## Not run:

u = ssm(gtemp_land, A=1, alpha=.01, phi=1, sigw=.05, sigv=.15)
tsplot(gtemp_land, type='o', col=4)
lines(u$Xs, col=6, lwd=2)

## End(Not run)
```

---

star   *Variable Star*

Description

The magnitude of a star taken at midnight for 600 consecutive days. The data are taken from the classic text, The Calculus of Observations, a Treatise on Numerical Mathematics, by E.T. Whittaker and G. Robinson, (1923, Blackie and Son, Ltd.).

Format

The format is: Time-Series [1:600] from 1 to 600: 25 28 31 32 33 33 32 ...

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at <https://github.com/nickpoison/astsa/>.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at <https://nickpoison.github.io/>.

---

stoch.reg   *Frequency Domain Stochastic Regression*

Description

Performs frequency domain stochastic regression discussed in Chapter 7.

Usage

```
stoch.reg(data, cols.full, cols.red, alpha, L, M, plot.which)
```

Arguments

data	data matrix
cols.full	specify columns of data matrix that are in the full model
cols.red	specify columns of data matrix that are in the reduced model (use NULL if there are no inputs in the reduced model)
alpha	test size
L	smoothing - see spans in spec.pgram
M	number of points in the discretization of the integral
plot.which	coh or F.stat, to plot either the squared-coherencies or the F-statistics, respectively

Value

`power.full`	spectrum under the full model
`power.red`	spectrum under the reduced model
`Betahat`	regression parameter estimates
`eF`	pointwise (by frequency) F-tests
`coh`	coherency

Note

See Chapter 7 of the text for examples. The script is based on code that was contributed by Professor Doug Wiens, Department of Mathematical and Statistical Sciences, University of Alberta.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

sunspotz	*Biannual Sunspot Numbers*

Description

Biannual smoothed (12-month moving average) number of sunspots from June 1749 to December 1978; n = 459. The "z" on the end is to distinguish this series from the one included with R (called `sunspots`).

Format

The format is: Time Series: Start = c(1749, 1) End = c(1978, 1) Frequency = 2

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

SV.mcmc *Fit Bayesian Stochastic Volatility Model*

Description

Fits a stochastic volatility model to a univariate time series of returns.

Usage

```
SV.mcmc(y, nmcmc = 1000, burnin = 100, init = NULL, hyper = NULL, tuning = NULL,
        sigma_MH = NULL, npart = NULL, mcmseed = NULL)
```

Arguments

y	single time series of returns
nmcmc	number of iterations for the MCMC procedure
burnin	number of iterations to discard for the MCMC procedure
init	initial values of (phi, sigma, beta) - default is `c(0.9, 0.5, .1)`
hyper	hyperparameters for bivariate normal distribution of (phi, sigma); user inputs (mu_phi, mu_q, sigma_phi, sigma_q, rho) - default is `c(0.9, 0.5, 0.075, 0.3, -0.25)`
tuning	tuning parameter - default is `.03`
sigma_MH	covariance matrix used for random walk Metropolis; it will be scaled by `tuning` in the script - default is `matrix(c(1,-.25,-.25,1), nrow=2, ncol=2)`
npart	number of particles used in particle filter - default is `10`
mcmseed	seed for mcmc - default is `90210`

Details

The log-volatility process is x_t and the returns are y_t. The SV model is

$$x_t = \phi x_{t-1} + \sigma w_t \qquad y_t = \beta \exp\{\frac{1}{2}x_t\}\epsilon_t$$

where w_t and ϵ_t are independent standard normal white noise.

The model is fit using a technique described in the paper listed below (in the Source section) where the state parameters (ϕ, σ) are sampled simultaneously with a bivariate normal prior specified in the arguments `init` and `hyper`.

Two graphics are returned: (1) the three parameter traces [with effective sample sizes (ESS)], their ACFs, and their histograms with the .025, .5, and .975 quantiles displayed, and (2) the log-volatility posterior mean along with corresponding .95 credible intervals.

Value

Returned invisibly:

`phi`	vector of sampled state AR parameter
`sigma`	vector of sampled state error stnd deviation
`beta`	vector of sampled observation error scale
`log.vol`	matrix of sampled log-volatility
`options`	values of the input arguments

Note

Except for the data, all the other inputs have defaults. The time to run and the acceptance rate are returned at the end of the analysis. The acceptance rate should be around 28% and this can be adjusted using the tuning parameter.

Author(s)

D.S. Stoffer

Source

Gong & Stoffer (2021). A note on efficient fitting of stochastic volatility models. *Journal of Time Series Analysis*, 42(2), 186-200. https://github.com/nickpoison/Stochastic-Volatility-Models

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

Examples

```
## Not run:
#--   A minimal example  --##
myrun <- SV.mcmc(sp500w)   # results in object myrun - don't forget it

str(myrun)                 # an easy way to see the default input options

## End(Not run)
```

SVfilter   *Switching Filter (for Stochastic Volatility Models)*

Description

Performs a special case switching filter when the observational noise is a certain mixture of normals. Used to fit a stochastic volatility model.

Usage

```
SVfilter(num, y, phi0, phi1, sQ, alpha, sR0, mu1, sR1)
```

Arguments

num	number of observations
y	time series of returns
phi0	state constant
phi1	state transition parameter
sQ	state standard deviation
alpha	observation constant
sR0	observation error standard deviation for mixture component zero
mu1	observation error mean for mixture component one
sR1	observation error standard deviation for mixture component one

Value

xp	one-step-ahead prediction of the volatility
Pp	mean square prediction error of the volatility
like	the negative of the log likelihood at the given parameter values

Note

See Example 6.23 in Chapter 6 of the text.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

---

tempr   *Temperatures from the LA pollution study*

Description

Temperature series corresponding to cmort from the LA pollution study.

Format

The format is: Time-Series [1:508] from 1970 to 1980: 72.4 67.2 62.9 72.5 74.2 ...

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

[lap](#)

---

test.linear   *Test Linearity of a Time Series via Normalized Bispectrum*

Description

Produces a plot of the tail probabilities of a normalized bispectrum of a series under the assumption the model is a linear process with iid innovations.

Usage

```
test.linear(series, color = TRUE, detrend = FALSE)
```

Arguments

series	the time series (univariate only)
color	if FALSE, the graphic is produced in gray scale
detrend	if TRUE, the series is detrended first

Value

prob	matrix of tail probabilities - returned invisibly

Note

The null hypothesis is that the data are from a linear process with i.i.d. innovations. Under the null hypothesis, the bispectrum is constant over all frequencies. Chi-squared test statistics are formed in blocks to measure departures from the null hypothesis and the corresponding p-values are displayed in a graphic and returned invisibly. Details are in Hinich, M. and Wolinsky, M. (2005). Normalizing bispectra. *Journal of Statistical Planning and Inference*, 130, 405–411.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

Examples

```
## Not run:
test.linear(nyse)  # :(
test.linear(soi)   # :)

## End(Not run)
```

---

trend   *Estimate Trend*

Description

Estimates the trend (polynomial or lowess) of a time series and returns a graphic of the series with the trend and error bounds superimposed.

Usage

```
trend(series, order = 1, lowess = FALSE, lowspan = .75, robust = TRUE,
        col = c(4, 6), ylab = NULL, ...)
```

Arguments

`series`	The time series to be analyzed (univariate only).
`order`	Order of the polynomial used to estimate the trend with a linear default (order=1) unless `lowess` is TRUE.
`lowess`	If TRUE, `loess` from the stats package is used to fit the trend. The default is FALSE.
`lowspan`	The smoother span used for lowess.
`robust`	If TRUE (default), the lowess fit is robust.
`col`	Vector of two colors for the graphic, first the color of the data (default is blue [4]) and second the color of the trend (default is magenta [6]). Both the data and trend line will be the same color if only one value is given.
`ylab`	Label for the vertical axis (default is the name of the series).
`...`	Other graphical parameters.

Details

Produces a graphic of the time series with the trend and a .95 pointwise confidence interval superimposed. The trend estimate and the error bounds are returned invisibly.

Value

Produces a graphic and returns the trend estimate `fit` and error bounds `lwr` and `upr` invisibly (see details) and with the same time series attributes as the input `series`.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`detrend`

Examples

```
## Not run:

par(mfrow=2:1)
trend(soi)
trend(soi, lowess=TRUE)

## End(Not run)
```

---

tsplot   *Time Series Plot*

Description

Produces a nice plot of univariate or multiple time series in one easy line.

Usage

```
tsplot(x, y=NULL, main=NULL, ylab=NULL, xlab='Time', type=NULL,
        margins=.25, ncolm=1, byrow=TRUE, minor=TRUE, nxm=2, nym=1,
        xm.grid=TRUE, ym.grid =TRUE, col=1, gg=FALSE, spaghetti=FALSE,
        pch=NULL, lty=1, lwd=1, mgpp=0, ...)
```

Arguments

x, y	time series to be plotted; if both present, x will be the time index.
main	add a plot title - the default is no title.
ylab	y-axis label - the default is the name of the ts object.
xlab	x-axis label - the default is 'Time'.
type	type of plot - the default is line.
margins	inches to add (or subtract) to the margins. Input one value to apply to all margins or a vector of length 4 to add (or subtract) to the (bottom, left, top, right) margins.
ncolm	for multiple time series, the number of columns to plot.
byrow	for multiple time series - if TRUE (default), plot series row wise; if FALSE, plot series column wise.
minor, nxm, nym	if minor=TRUE, the number of minor tick marks on x-axis, y-axis. minor=FALSE removes both or set either to 0 or 1 to remove. The default is one minor tick on the x-axis and none on the y-axis.
xm.grid, ym.grid	
	if TRUE (default), adds grid lines at minor x-axis, y-axis ticks.
col	line color(s), can be a vector for multiple time series.
gg	if TRUE, will produce a gris-gris plot (gray graphic interior with white grid lines); the default is FALSE. The grammar of astsa is voodoo; see https://www.youtube.com/watch?v=
spaghetti	if TRUE, will produce a spaghetti plot (all series on same plot).

pch	plot symbols (default is 1, circle); can be a vector for multiple plots.
lty	line type (default is 1, solid line); can be a vector for multiple plots.
lwd	line width (default is 1); can be a vector for multiple plots.
mgpp	this is used to adjust (add to) the mgp graphics parameters settings (?par), which are c(1.6,.6,0) here; the R default is c(3,1,0). This will be helpful in moving an axis label farther from the axis if necessary.
...	other graphical parameteres; see par.

Value

Produces a graphic and returns it invisibly so it can be saved in an R variable with the ability to replay it; see recordPlot.

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

Examples

```
## Not run:

# minimal
tsplot(soi)
# prettified
tsplot(soi, col=4, main="Southern Oscillation Index")

# compare these
par(mfrow=2:1)
tsplot(1:453, soi, ylab='SOI', xlab='Month')
# now recklessly add to the margins and add to mgp to get to the default
tsplot(1:453, soi, ylab='SOI', xlab='Month', margins=c(2,3,4,5), las=1, mgpp=c(1.4,.4,0))

# gris-gris multiple plot
tsplot(climhyd, ncolm=2, gg=TRUE, col=2:7, lwd=2)

# spaghetti (and store it in an object - ?recordPlot for details)
x <- replicate(100, cumsum(rcauchy(1000))/1:1000)
u <- tsplot(x, col=1:8, main='No LLN For You', spaghetti=TRUE)
u    #  plot on demand

## End(Not run)
```

---

unemp   *U.S. Unemployment*

Description

Monthly U.S. Unemployment series (1948-1978, n = 372)

Usage

```
data(unemp)
```

Format

The format is: Time-Series [1:372] from 1948 to 1979: 235 281 265 241 201 ...

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

See Also

`UnempRate`

UnempRate   *U.S. Unemployment Rate*

Description

Monthly U.S. unemployment rate in percent unemployed (Jan, 1948 - Nov, 2016, n = 827)

Format

The format is: Time-Series [1:827] from 1948 to 2017: 4 4.7 4.5 4 3.4 3.9 3.9 3.6 3.4 2.9 ...

Source

`https://data.bls.gov/timeseries/LNU04000000/`

References

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See Also

`unemp`

---

varve   *Annual Varve Series*

Description

Sedimentary deposits from one location in Massachusetts for 634 years, beginning nearly 12,000 years ago.

Format

The format is: Time-Series [1:634] from 1 to 634: 26.3 27.4 42.3 58.3 20.6 ...

References

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The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

WBC   *White Blood Cell Levels*

Description

WBC: Measurements made for 91 days on the three variables, log(white blood count) [WBC], log(platelet) [PLT] and hematocrit [HCT]. Missing data code is 0 (zero).

Format

The format is: Time-Series [1:91] from 1 to 91: 2.33 1.89 2.08 1.82 1.82 ...

Details

See Examples 6.1 amd 6.9 for more details.

Source

Jones, R.H. (1984). Fitting multivariate models to unequally spaced data. In *Time Series Analysis of Irregularly Observed Data*, pp. 158-188. E. Parzen, ed. Lecture Notes in Statistics, 25, New York: Springer-Verlag.

References

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In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

See Also

blood, HCT, PLT

---

xA_readme   *Scripts marked with an 'x' are scheduled to be phased out*

Description

Scripts marked with an 'x' are scheduled to be phased out.

Format

The format is: chr "Scripts marked with an 'x' are scheduled to be phased out"

Details

Scripts marked with an 'x' are scheduled to be phased out.

Author(s)

D.S. Stoffer

Source

Scripts marked with an 'x' are scheduled to be phased out.

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

---

xEM0   *EM Algorithm for Time Invariant State Space Models - This script has been superseded by* EM.

Description

Estimation of the parameters in a simple state space via the EM algorithm. NOTE: This script has been superseded by EM. Note that scripts starting with an x are scheduled to be phased out.

Usage

```
xEM0(num, y, A, mu0, Sigma0, Phi, cQ, cR, max.iter = 50, tol = 0.01)
```

Arguments

num	number of observations
y	observation vector or time series
A	time-invariant observation matrix
mu0	initial state mean vector
Sigma0	initial state covariance matrix
Phi	state transition matrix
cQ	Cholesky-like decomposition of state error covariance matrix Q – see details below
cR	Cholesky-like decomposition of state error covariance matrix R – see details below
max.iter	maximum number of iterations
tol	relative tolerance for determining convergence

Details

cQ and cR are the Cholesky-type decompositions of Q and R. In particular, Q = t(cQ)%*%cQ and R = t(cR)%*%cR is all that is required (assuming Q and R are valid covariance matrices).

Value

Phi	Estimate of Phi
Q	Estimate of Q
R	Estimate of R
mu0	Estimate of initial state mean
Sigma0	Estimate of initial state covariance matrix
like	-log likelihood at each iteration
niter	number of iterations to convergence
cvg	relative tolerance at convergence

Note

NOTE: This script has been superseded by EM

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

---

xEM1	*EM Algorithm for General State Space Models - This script has been superseded by EM.*

Description

Estimation of the parameters in the general state space model via the EM algorithm. Inputs are not allowed; see the note. NOTE: This script has been superseded by EM and scripts starting with an x are scheduled to be phased out.

Usage

```
xEM1(num, y, A, mu0, Sigma0, Phi, cQ, cR, max.iter = 100, tol = 0.001)
```

Arguments

num	number of observations
y	observation vector or time series; use 0 for missing values
A	observation matrices, an array with dim=c(q,p,n); use 0 for missing values
mu0	initial state mean
Sigma0	initial state covariance matrix
Phi	state transition matrix
cQ	Cholesky-like decomposition of state error covariance matrix Q – see details below
cR	R is diagonal here, so cR = sqrt(R) – also, see details below
max.iter	maximum number of iterations
tol	relative tolerance for determining convergence

Details

cQ and cR are the Cholesky-type decompositions of Q and R. In particular, Q = t(cQ)%*%cQ and R = t(cR)%*%cR is all that is required (assuming Q and R are valid covariance matrices).

Value

Phi	Estimate of Phi
Q	Estimate of Q
R	Estimate of R
mu0	Estimate of initial state mean
Sigma0	Estimate of initial state covariance matrix
like	-log likelihood at each iteration
niter	number of iterations to convergence
cvg	relative tolerance at convergence

Note

NOTE: This script has been superseded by EM

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

---

xKfilter0   *Kalman Filter - This script has been superseded by* `Kfilter`

Description

Returns the filtered values for the basic time invariant state-space model; inputs are not allowed. NOTE: This script has been superseded by `Kfilter`. Note that scripts starting with an x are scheduled to be phased out.

Usage

```
xKfilter0(num, y, A, mu0, Sigma0, Phi, cQ, cR)
```

Arguments

num	number of observations
y	data matrix, vector or time series
A	time-invariant observation matrix
mu0	initial state mean vector
Sigma0	initial state covariance matrix
Phi	state transition matrix
cQ	Cholesky-type decomposition of state error covariance matrix Q – see details below
cR	Cholesky-type decomposition of observation error covariance matrix R – see details below

Details

NOTE: This script has been superseded by `Kfilter`

Value

xp	one-step-ahead state prediction
Pp	mean square prediction error
xf	filter value of the state
Pf	mean square filter error
like	the negative of the log likelihood
innov	innovation series
sig	innovation covariances
Kn	last value of the gain, needed for smoothing

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

xKfilter1   *Kalman Filter - This script has been superseded by* `Kfilter`.

Description

Returns both the predicted and filtered values for a linear state space model. Also evaluates the likelihood at the given parameter values. NOTE: This script has been superseded by `Kfilter`. Note that scripts starting with an x are scheduled to be phased out.

Usage

```
xKfilter1(num, y, A, mu0, Sigma0, Phi, Ups, Gam, cQ, cR, input)
```

Arguments

num	number of observations
y	data matrix, vector or time series
A	time-varying observation matrix, an array with dim=c(q,p,n)
mu0	initial state mean
Sigma0	initial state covariance matrix
Phi	state transition matrix
Ups	state input matrix; use Ups = 0 if not needed
Gam	observation input matrix; use Gam = 0 if not needed
cQ	Cholesky-type decomposition of state error covariance matrix Q – see details below
cR	Cholesky-type decomposition of observation error covariance matrix R – see details below
input	matrix or vector of inputs having the same row dimension as y; use input = 0 if not needed

Details

NOTE: This script has been superseded by `Kfilter`

Value

xp	one-step-ahead prediction of the state
Pp	mean square prediction error
xf	filter value of the state
Pf	mean square filter error
like	the negative of the log likelihood
innov	innovation series
sig	innovation covariances
Kn	last value of the gain, needed for smoothing

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

xKfilter2 *Kalman Filter - This script has been superseded by* Kfilter.

Description

Returns the filtered values for the state space model. In addition, the script returns the evaluation of the likelihood at the given parameter values and the innovation sequence. NOTE: This script has been superseded by Kfilter. Note that scripts starting with an x are scheduled to be phased out.

Usage

```
xKfilter2(num, y, A, mu0, Sigma0, Phi, Ups, Gam, Theta, cQ, cR,
          S, input)
```

Arguments

num	number of observations
y	data matrix, vector or time series
A	time-varying observation matrix, an array with dim = c(q,p,n)
mu0	initial state mean
Sigma0	initial state covariance matrix
Phi	state transition matrix
Ups	state input matrix; use Ups = 0 if not needed
Gam	observation input matrix; use Gam = 0 if not needed
Theta	state error pre-matrix
cQ	Cholesky decomposition of state error covariance matrix Q – see details below
cR	Cholesky-type decomposition of observation error covariance matrix R – see details below
S	covariance-type matrix of state and observation errors
input	matrix or vector of inputs having the same row dimension as y; use input = 0 if not needed

Details

NOTE: This script has been superseded by Kfilter

Value

xp	one-step-ahead prediction of the state
Pp	mean square prediction error
xf	filter value of the state
Pf	mean square filter error
like	the negative of the log likelihood
innov	innovation series
sig	innovation covariances
K	last value of the gain, needed for smoothing

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

xKsmooth0	*Kalman Filter and Smoother - This script has been superseded by* Ksmooth

Description

Returns both the filtered values and smoothed values for the state-space model. NOTE: This script has been superseded by Ksmooth. Note that scripts starting with an x are scheduled to be phased out.

Usage

```
xKsmooth0(num, y, A, mu0, Sigma0, Phi, cQ, cR)
```

Arguments

num	number of observations
y	data matrix, vector or time series
A	time-invariant observation matrix
mu0	initial state mean vector
Sigma0	initial state covariance matrix
Phi	state transition matrix
cQ	Cholesky-type decomposition of state error covariance matrix Q – see details below
cR	Cholesky-type decomposition of observation error covariance matrix R – see details below

Details

NOTE: This script has been superseded by Ksmooth

Value

xs	state smoothers
Ps	smoother mean square error
x0n	initial mean smoother
P0n	initial smoother covariance
J0	initial value of the J matrix
J	the J matrices
xp	one-step-ahead prediction of the state
Pp	mean square prediction error
xf	filter value of the state
Pf	mean square filter error
like	the negative of the log likelihood
Kn	last value of the gain

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at `https://github.com/nickpoison/astsa/`.

In addition, the News and ChangeLog files are at `https://github.com/nickpoison/astsa/blob/master/NEWS.md`.

The webpages for the texts and some help on using R for time series analysis can be found at `https://nickpoison.github.io/`.

---

xKsmooth1   *Kalman Filter and Smoother - This script has been superseded by*
                         Ksmooth

Description

Returns both the filtered and the smoothed values for the state-space model. NOTE: This script has been superseded by Ksmooth. Note that scripts starting with an x are scheduled to be phased out.

Usage

```
xKsmooth1(num, y, A, mu0, Sigma0, Phi, Ups, Gam, cQ, cR, input)
```

Arguments

num	number of observations
y	data matrix, vector or time series
A	time-varying observation matrix, an array with dim=c(q,p,n)
mu0	initial state mean
Sigma0	initial state covariance matrix
Phi	state transition matrix
Ups	state input matrix; use Ups = 0 if not needed
Gam	observation input matrix; use Gam = 0 if not needed
cQ	Cholesky-type decomposition of state error covariance matrix Q – see details below
cR	Cholesky-type decomposition of observation error covariance matrix R – see details below
input	matrix or vector of inputs having the same row dimension as y; use input = 0 if not needed

Details

NOTE: This script has been superseded by Ksmooth

Value

xs	state smoothers
Ps	smoother mean square error
x0n	initial mean smoother
P0n	initial smoother covariance
J0	initial value of the J matrix
J	the J matrices
xp	one-step-ahead prediction of the state
Pp	mean square prediction error
xf	filter value of the state
Pf	mean square filter error
like	the negative of the log likelihood
Kn	last value of the gain

Author(s)

D.S. Stoffer

References

You can find demonstrations of astsa capabilities at FUN WITH ASTSA.

The most recent version of the package can be found at https://github.com/nickpoison/astsa/.

In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts and some help on using R for time series analysis can be found at https://nickpoison.github.io/.

---

xKsmooth2 *Kalman Filter and Smoother - This script has been superseded by* Ksmooth

---

Description

Returns the filtered and smoothed values for the state-space model. This is the smoother companion to Kfilter2. NOTE: This script has been superseded by Ksmooth. Note that scripts starting with an x are scheduled to be phased out.

Usage

```
xKsmooth2(num, y, A, mu0, Sigma0, Phi, Ups, Gam, Theta, cQ, cR,
          S, input)
```

Arguments

num	number of observations
y	data matrix, vector or time series
A	time-varying observation matrix, an array with dim=c(q,p,n)
mu0	initial state mean
Sigma0	initial state covariance matrix
Phi	state transition matrix
Ups	state input matrix; use Ups = 0 if not needed
Gam	observation input matrix; use Gam = 0 if not needed
Theta	state error pre-matrix
cQ	Cholesky-type decomposition of state error covariance matrix Q – see details below
cR	Cholesky-type decomposition of observation error covariance matrix R – see details below
S	covariance matrix of state and observation errors
input	matrix or vector of inputs having the same row dimension as y; use input = 0 if not needed

Details

NOTE: This script has been superseded by Ksmooth

Value

xs	state smoothers
Ps	smoother mean square error
J	the J matrices
xp	one-step-ahead prediction of the state
Pp	mean square prediction error
xf	filter value of the state
Pf	mean square filter error
like	the negative of the log likelihood
Kn	last value of the gain

Author(s)

D.S. Stoffer

References

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Index