# Package 'astsa'

August 13, 2022

**Type** Package

**Title** Applied Statistical Time Series Analysis

**Version** 1.16

**Date** 2022-08-31

**Depends** R (>= 3.5)

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

**Description** Data sets and scripts to accompany Time Series Analysis and Its Applica-
tions: With R Examples (4th ed), by R.H. Shumway and D.S. Stoffer. Springer Texts in Statis-
tics, 2017, <DOI:10.1007/978-3-319-52452-8>, and Time Series: A Data Analysis Approach Us-
ing R. Chapman-Hall, 2019, <DOI:10.1201/9780429273285>.

**URL** https://github.com/nickpoison/astsa/,

https://www.stat.pitt.edu/stoffer/tsa4/,

https://www.stat.pitt.edu/stoffer/tsda/

**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)*

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### Description

Includes data and scripts to accompany 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: | 1.16 |
| Date: | 2022-08-31 |
| 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

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

The webpages for the texts are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## Examples

```
acf1(rnorm(100))

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

# show it to your mom:
acf1(soi, col=6, 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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In addition, the News and ChangeLog files are at https://github.com/nickpoison/astsa/blob/master/NEWS.md.

The webpages for the texts are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## 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

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## Examples

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

acfm(diff(log(econ5)), gg=TRUE, acf=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 |
| `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,

$$y_t = \phi_0 + \phi_1 y_{t-1} + \ldots + \phi_p y_{t-p} + \sigma z_t,$$

where $z_t$ is standard Gaussian noise. With $\Phi$ being the (p+1)-dimensional vector of the $\phi$s, 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 $\gamma^2$ as `prior_var_phi`.

The algorithm is efficient and converges quickly. Further details can be found in Example 8.36 of Douc, R., Moulines, E., & 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 are returned invisibly and various quantiles are displayed.

## Author(s)

D.S. Stoffer

## Source

Based on the scirpt `arp.mcmc` used in Douc, Moulines, & Stoffer (2014).

## 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## Examples

```
ar.mcmc(rec, 2)
```

---

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

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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---

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

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

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**

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

**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 $\pi$-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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## 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.

The webpages for the texts are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

### Examples

```
# View the astsa palette
par(mfrow=c(3,1))
barplot(rep(1,8), col=1:8, main='astsa palette', names=1:8)
barplot(rep(1,8), col=astsa.col(1:8, .7), main='transparency', names=1:8)
barplot(rep(1,8), col=astsa.col(3:6, .5), main='pastelity', names=rep(3:6, 2))


# 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')
```

---

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](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/](https://github.com/nickpoison/astsa/).

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

The webpages for the texts are [https://www.stat.pitt.edu/stoffer/tsa4/](https://www.stat.pitt.edu/stoffer/tsa4/) and [https://www.stat.pitt.edu/stoffer/tsda/](https://www.stat.pitt.edu/stoffer/tsda/).

### 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

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

| 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

---

blood                           *Daily Blood Work*

---

## 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

The format is: mts [1:91, 1:3]

## Details

This is the data set used in Chapter 6 with NA as the missing data code.

## 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## See Also

HCT, PLT, WBC

## Examples

```
tsplot(blood, type="o", pch=19)
```

## 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

ccf2                            *Cross Correlation*

---

### Description

Produces a nice graphic of the sample CCF of two time series. The actual CCF values are returned invisibly.

## 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## 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)
```

---

chicken                    *Monthly price of a pound of chicken*

---

### Description

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

### Usage

```
data("chicken")
```

### 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 are <https://www.stat.pitt.edu/stoffer/tsa4/> and <https://www.stat.pitt.edu/stoffer/tsda/>.

---

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

---

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

detrend                       *Detrend a Time Series*

---

### Description

Returns a time series with the trend removed. The trend can be estimated using polynomial regression 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## See Also

[trend](#)

## Examples

```
tsplot(cbind(salmon, detrend(salmon)))

tsplot(detrend(salmon, lowess=TRUE))
```

---

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

---

dna2vector                              *Convert DNA Sequence to Indicator Vectors*

---

**Description**

Takes a DNA sequence (string) 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 DNA sequence as 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

##== and if you want 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## See Also

`specenv`

## Examples

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

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


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

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

---

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## 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.

## Usage

    data(econ5)

## 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

---

| EM0 | *EM Algorithm for Time Invariant State Space Models* |
|---|---|

---

## Description

Estimation of the parameters in a simple state space via the EM algorithm.

## Usage

```
EM0(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 |

## 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

EM1 *EM Algorithm for General State Space Models*

---

## Description

Estimation of the parameters in the general state space model via the EM algorithm. Inputs are not allowed; see the note.

## Usage

```
EM1(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

Inputs are not allowed (and hence not estimated). The script uses Ksmooth1 and everything related to inputs are set equal to zero when it is called.

It would be relatively easy to include estimates of 'Ups' and 'Gam' because conditional on the states, these are just regression coefficients. If you decide to alter EM1 to include estimates of the 'Ups' or 'Gam', feel free to notify me with a workable example and I'll include it in the next update.

## 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

EQ5                              *Seismic Trace of Earthquake number 5*

---

### Description

Seismic trace of an earthquake [two phases or arrivals along the surface, the primary wave ($t = 1, \dots, 1024$) and the shear wave ($t = 1025, \dots, 2048$)] 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

### 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

---

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

---

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

### See Also

eqexp

---

FDR                           *Basic False Discovery Rate*

---

### Description

Computes the basic false discovery rate given a vector of p-values.

### 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. |

## Source

<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](https://github.com/nickpoison/astsa/blob/master/NEWS.md).

The webpages for the texts are <https://www.stat.pitt.edu/stoffer/tsa4/> and [https://www.stat.pitt.edu/stoffer/tsda/](https://www.stat.pitt.edu/stoffer/tsda/).

---

| ffbs | *Forward Filter Backward Sampling* |
|------|-----------------------------------|

---

## Description

FFBS algorithm for state space models

## Usage

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

## 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. |
| Ups | State input matrix; use Ups = 0 if not needed. |
| Gam | Observation input matrix; use Gam = 0 if not needed. |
| sQ | Pre-state error covariance matrix is Q = t(sQ)%*%sQ – see details below. In the univariate case, it is the standard deviation. |
| sR | Pre-observation error covariance matrix is R = t(sR)%*%sR – see details below. In the univariate case, it is the standard deviation. |
| input | matrix or vector of inputs having the same row dimension as y; use input = 0 if not needed |

## 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 $\Theta$ 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 $R = sR'sR$.

$x_t$ is p-dimensional and $y_t$ is q-dimensional. With everything being conformable, $u_t$ is $r \times 1$ vector of inputs, $\Upsilon$ is $p \times r$ and $\Gamma$ is $q \times r$; either of these matrices may be the zero matrix.

## Value

xs              A p-dimensional matrix of sampled states

x0n             The sampled initial state (because R is 1-based)

## Note

The script uses `Kfilter1`. To match the input, `sQ` and `sR` are transposed prior to calling `Kfilter1`. Also, if $A_t$ is constant wrt time, it is not necessary to input an array; see the example.

## 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## Examples

```
## Not run:

## -- this is just one pass - see FUN WITH ASTSA for the real fun --##
# generate some data
 set.seed(1)
 sQ  = 1; sR = 3; n = 100
 mu0 = 0; Sigma0 = 10; x0 = rnorm(1,mu0,Sigma0)
 w = rnorm(n,0,sQ); v = rnorm(n,0,sR)
 x = c(x0 + w[1]);  y = c(x[1] + v[1])   # initialize
for (t in 2:n){
  x[t] = x[t-1] + w[t]
  y[t] = x[t] + v[t]
  }
## run one pass of FFBS, plot data, states and sampled states
run = ffbs(y,A=1,mu0=0,Sigma0=10,Phi=1,Ups=0,Gam=0,sQ=1,sR=3,input=0)
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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

### 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

**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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

**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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

### 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

### 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

**See Also**

gtemp_land, gtemp_ocean, globtemp, globtempl, gtemp

---

gtemp_land                      *Global mean land temperature deviations - updated to 2017*

---

**Description**

Annual temperature anomalies (in degress centigrade) averaged over the Earth's land area from 1880 to 2017.

**Format**

The format is: Time-Series [1:138] from 1880 to 2017: -0.62 -0.45 -0.47 -0.62 -0.82 ...

**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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## See Also

gtemp_ocean, globtemp, globtempl, gtemp2

---

gtemp_ocean                     *Global mean ocean temperature deviations - updated to 2017*

---

## 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 2017.

## Format

The format is: Time-Series [1:138] from 1880 to 2009: -0.05 0.01 0.00 -0.06 -0.15 ...

## 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

**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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## Examples

```
plot(hor, type='c')                        # plot data and
text(hor, labels=1:4, col=c(1,4,2,6), cex=.9)  # add quarter labels
#
plot(stl(hor, s.window=15))  # fit structural model
```

---

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

Kfilter0                *Kalman Filter - Time Invariant Model*

---

### Description

Returns the filtered values for the basic time invariant state-space model; inputs are not allowed.

### Usage

```
Kfilter0(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

`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

| 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

Kfilter1                          *Kalman Filter - Model may be time varying or have inputs*

---

### Description

Returns both the predicted and filtered values for a linear state space model. Also evaluates the likelihood at the given parameter values.

### Usage

```
Kfilter1(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

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

| | |
|---|---|
| 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

---

| Kfilter2 | *Kalman Filter - Model may be time varying or have inputs or correlated errors* |
|---|---|

---

### 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.

### Usage

```
Kfilter2(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

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

| | |
|---|---|
| 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

Ksmooth0                          *Kalman Filter and Smoother - Time invariant model without inputs*

---

## Description

Returns both the filtered values and smoothed values for the state-space model.

## Usage

```
Ksmooth0(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

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

| | |
|---|---|
| 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

Ksmooth1 *Kalman Filter and Smoother - General model*

---

### Description

Returns both the filtered and the smoothed values for the state-space model.

### Usage

```
Ksmooth1(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

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

| | |
|---|---|
| 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

| | |
|---|---|
| Ksmooth2 | *Kalman Filter and Smoother - General model, may have correlated errors* |

---

## Description

Returns the filtered and smoothed values for the state-space model. This is the smoother companion to Kfilter2.

## Usage

```
Ksmooth2(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

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

| 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

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

| 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, bgl ='white', ltcol=1, box.col=8, ...)
```

## 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 |
| bgl | background of the ACF legend; default is `'white'` |
| ltcol | legend text color; default is black |
| box.col | color of the border of the ACF legend; default is `'gray(62)'` |
| ... | 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## 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. 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, bgl ='white', ltcol=1, box.col=8, ...)
```

### 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 |
| bgl | background of the ACF legend; default is 'white' |
| ltcol | legend text color; default is black |
| box.col | color of the border of the ACF legend; default is 'gray(62)' |
| ... | 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

### See Also

lag1.plot

## Examples

```
lag2.plot(soi, rec, max.lag=3)
lag2.plot(soi, rec, 8, cex=1.1, pch=19, col=5, bgl='transparent', 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 |

## 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

---

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## 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(.5,.5) %*% (P%^%50)

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

---

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 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## 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
ts.plot(mdeaths, fdeaths, col=1:2)   # an R data set, male/female monthly deaths ...
dog = mvspec(cbind(mdeaths,fdeaths), 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.

## Usage

```
data(nyse)
```

## Format

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

## 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

### 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

**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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## 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.

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## 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 polymatrix package https://github.com/namezys/polymatrix

### 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

### 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

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

| 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**

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

**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**

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

**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.

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## 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/.

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

The webpages for the texts are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

### 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.

The webpages for the texts are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

| 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

### 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

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

### See Also

`sarima.for`, `sarima.sim`

### Examples

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

(dog <- sarima(log(AirPassengers),0,1,1,0,1,1,12))
summary(dog$fit)  # fit has all the returned arima() values

plot(resid(dog$fit))  # plot the innovations (residuals)
sarima(log(AirPassengers),0,1,1,0,1,1,12,details=FALSE)$BIC  # print model BIC only

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

# 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

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## 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 over-ridden 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

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## 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
tsplot(sarima.sim(ma=-.8, d=1, mean=.1))

## SAR(1) example from text
Months = c("J","F","M","A","M","J","J","A","S","O","N","D")
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
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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## 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.

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

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

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## See Also

[sleep2](sleep2)

## Examples

```
## Not run:
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(-0.33,0), bty='n', lty=1, col=2:3, legend=c('sleep state',
        'number of \nmovements'))

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

### See Also

sleep1

## Examples

```
## Not run:
par(xpd = NA, oma = c(0,0,0,8) )
tsplot(sleep2[[1]][2:3], type='s', col=2:3, spag=TRUE, gg=TRUE)
legend('topright', inset=c(-0.33,0), bty='n', lty=1, col=2:3, legend=c('sleep state',
        'number of \nmovements'))

x = dna2vector(sleep2[[3]]$state[1:119], alphabet=c('1','2','3','4','5'))  # never awake
specenv(x, spans=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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

### See Also

[rec](#)

---

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

---

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

---

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

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

### Arguments

| | |
|---|---|
| data | 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 | 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 arguments. |

**Details**

Uses ar to fit the best AR model based on pseudo AIC or BIC. No likelihood is calculated unless method='mle' is used, however, the calculations 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

**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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

---

ssm                             *State Space Model*

---

### Description

Fits a simple univariate state space model, $x[t]$ = alpha + phi $x[t-1]$ + $w[t]$, and $y[t]$ = A $x[t]$ + $v[t]$. The parameters alpha, phi, sigma[w] and sigma[v] are estimated; parameter phi may be fixed. State predictions 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. 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.

## 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

---

| 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 <span style="color:red">FUN WITH ASTSA</span>.

The most recent version of the package can be found at <span style="color:red">https://github.com/nickpoison/astsa/</span>.

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

The webpages for the texts are <span style="color:red">https://www.stat.pitt.edu/stoffer/tsa4/</span> and <span style="color:red">https://www.stat.pitt.edu/stoffer/tsda/</span>.

---

| 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**

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

---

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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

---

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 (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 for random walk Metropolis - default is `tuning * 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 $\epsilon_t$ are independent standard normal white noise. The model is fit using a technique described in the paper listed in the source. 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 are <https://www.stat.pitt.edu/stoffer/tsa4/> and <https://www.stat.pitt.edu/stoffer/tsda/>.

## 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 |

## 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

---

| 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

### 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## 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 4) and second the color of the trend (default is 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 and error bounds invisibly (see details).

## 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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

## See Also

detrend

## Examples

```
## Not run:
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, ...)
```

## 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. |
| `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://musicaficionado.blog/2017/11/08/gris-gris-by-dr-john/` |
| `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. |
| `...` | other graphical parameteres; see [par](par). |

## Author(s)

D.S. Stoffer

## References

You can find demonstrations of astsa capabilities at [FUN WITH ASTSA](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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## Examples

```
## Not run:
tsplot(soi, col=4, main="Southern Oscillation Index")
#
tsplot(1:453, soi, ylab='SOI', xlab='Month')
#
tsplot(climhyd, ncolm=2, gg=TRUE, col=2:7, lwd=2)  # gris-gris plot
#
x <- replicate(100, cumsum(rcauchy(1000))/1:1000)
tsplot(x, col=1:8, main='No LLN For You', spaghetti=TRUE)

## 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 are `https://www.stat.pitt.edu/stoffer/tsa4/` and `https://www.stat.pitt.edu/stoffer/tsda/`.

## 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

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 are https://www.stat.pitt.edu/stoffer/tsa4/ and https://www.stat.pitt.edu/stoffer/tsda/.

### See Also

unemp

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varve                         *Annual Varve Series*

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### 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 ...

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WBC                          *White Blood Cell Levels*

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**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.

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**See Also**

blood, HCT, PLT

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