

# Package ‘astsa’

July 2, 2014

**Type** Package

**Title** Applied Statistical Time Series Analysis

**Version** 1.2

**Date** 2014-03-16

**Author** David Stoffer

**Maintainer** David Stoffer <stoffer@pitt.edu>

**Description** Data sets and scripts for Time Series Analysis and Its Applications: With R Examples by Shumway and Stoffer, 3rd edition

**URL** <http://www.stat.pitt.edu/stoffer/tsa3/>

**License** GPL-2

**LazyLoad** yes

**LazyData** yes

**NeedsCompilation** no

**Repository** CRAN

**Date/Publication** 2014-03-17 07:53:30

## R topics documented:

astsa-package	3
acf2	4
ar1boot	5
ar1miss	5
arf	6
arma.spec	6
beamd	7
birth	8
blood	8

bnrf1ebv . . . . .	9
bnrf1hvs . . . . .	9
climhyd . . . . .	10
cmort . . . . .	10
econ5 . . . . .	11
EM0 . . . . .	11
EM1 . . . . .	13
EQ5 . . . . .	14
eqexp . . . . .	15
EXP6 . . . . .	15
FDR . . . . .	16
flu . . . . .	16
fmri . . . . .	17
fmri1 . . . . .	18
gas . . . . .	18
gnp . . . . .	19
gtemp . . . . .	19
gtemp2 . . . . .	20
HCT . . . . .	21
jj . . . . .	21
Kfilter0 . . . . .	22
Kfilter1 . . . . .	23
Kfilter2 . . . . .	24
Ksmooth0 . . . . .	26
Ksmooth1 . . . . .	27
Ksmooth2 . . . . .	29
lag1.plot . . . . .	30
lag2.plot . . . . .	31
LagReg . . . . .	32
lap . . . . .	33
lead . . . . .	33
mvspec . . . . .	34
nyse . . . . .	36
oil . . . . .	36
part . . . . .	37
PLT . . . . .	37
prodn . . . . .	38
qinfl . . . . .	38
qintr . . . . .	39
rec . . . . .	40
sales . . . . .	40
salt . . . . .	41
saltemp . . . . .	42
sarima . . . . .	42
sarima.for . . . . .	44
SigExtract . . . . .	45
so2 . . . . .	46
soi . . . . .	46

<i>astsa-package</i>	3
soiltemp . . . . .	47
speech . . . . .	48
stoch.reg . . . . .	48
sunspotz . . . . .	49
SVfilter . . . . .	50
tempr . . . . .	51
unemp . . . . .	51
varve . . . . .	52
WBC . . . . .	52
<b>Index</b>	<b>54</b>

---

<i>astsa-package</i>	<i>Applied Statistical Time Series Analysis</i>
----------------------	---

---

### Description

Includes data and scripts to accompany *Time Series Analysis and Its Applications: With R Examples* (3rd ed) by R.H. Shumway and D.S. Stoffer. Springer Texts in Statistics, 2011.

### Details

Package:	astsa
Type:	Package
Version:	1.2
Date:	2014-03-16
License:	GPL-2
LazyLoad:	yes
LazyData:	yes

### Author(s)

David Stoffer <stoffer@pitt.edu>

### References

See the webpage for the text: <http://www.stat.pitt.edu/stoffer/tsa3/> or its mirror <http://lib.stat.cmu.edu/general/stoffer/tsa3/>

---

`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, ...)
```

**Arguments**

<code>series</code>	The data. Does not have to be a time series object.
<code>max.lag</code>	Maximum lag. Can be omitted. Defaults to $\sqrt{n} + 10$ unless $n < 50$ .
<code>...</code>	Additional arguments passed to <code>acf</code>

**Details**

This is basically a wrapper for `acf()` provided in `tseries`. The error bounds are approximate white noise bounds,  $0 \pm 2/\sqrt{n}$ ; no other option is given.

**Value**

ACF	The sample ACF
PACF	The sample PACF

**Author(s)**

D.S. Stoffer

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**Examples**

```
acf2(rnorm(100))  
acf2(rnorm(100), 25)
```

---

ar1boot

*Data used in Example 3.35 on page 137.*

---

**Description**

Data used in Example 3.35 on page 137.

**Usage**

```
data(ar1boot)
```

**Format**

The format is: Time-Series [1:100] from 1 to 100: 61.8 60.1 60.1 59.1 58.3 ...

---

ar1miss

*Data for Problem 6.14 on page 403.*

---

**Description**

Data for Problem 6.14 on page 403.

**Usage**

```
data(ar1miss)
```

**Format**

The format is: Time-Series [1:100] from 1 to 100: 1.01 0 1.05 1.75 2.25 ...

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

arf	<i>Simulated ARFIMA</i>
-----	-------------------------

---

**Description**

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

**Usage**

```
data(arf)
```

**Format**

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

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

arma.spec	<i>Spectral Density of an ARMA Model</i>
-----------	--

---

**Description**

Gives the ARMA spectrum (on a log scale), tests for causality, invertibility, and common zeros. See Example 4.6 on page 184.

**Usage**

```
arma.spec(ar = 0, ma = 0, var.noise = 1, n.freq = 500, ...)
```

**Arguments**

ar	vector of AR parameters
ma	vector of MA parameters
var.noise	variance of the noise
n.freq	number of frequencies
...	additional arguments

**Details**

The basic call is `arma.spec(ar, ma)` where `ar` and `ma` are vectors containing the model parameters. Use `log="no"` if you do not want the plot on a log scale. If the model is not causal or invertible an error message is given. If there are 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. See Example 4.6 on page 184.

**Value**

freq            frequencies - returned invisibly  
spec            spectral ordinates - returned invisibly

**Note**

In tsa3, this is called spec.arma.

**Author(s)**

D.S. Stoffer

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**Examples**

```
arma.spec(ar = c(1, -.9), ma = .8, log="no")
```

---

beamd

*Infrasonic Signal from a Nuclear Explosion*

---

**Description**

Infrasonic signal from a nuclear explosion. See Example 7.2 on page 421.

**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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

birth	<i>U.S. Monthly Live Births</i>
-------	---------------------------------

---

**Description**

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

**Usage**

```
data(birth)
```

**Format**

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

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

blood	<i>Daily Blood Work</i>
-------	-------------------------

---

**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.

**Usage**

```
data(blood)
```

**Format**

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

**Details**

This is the data set used in Example 6.1 and subsequently in Example 6.9 with 0 (zero) 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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[HCT, PLT, WBC](#)

**Examples**

```
## Not run: plot(blood, type="o", pch=19)
```

---

bnrf1ebv	<i>Nucleotide sequence - BNRF1 Epstein-Barr</i>
----------	---

---

**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 Section 7.9.

**Usage**

```
data(bnrf1ebv)
```

**Format**

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

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

bnrf1hvs	<i>Nucleotide sequence - BNRF1 of Herpesvirus saimiri</i>
----------	---

---

**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 Section 7.9.

**Usage**

```
data(bnrf1hvs)
```

**Format**

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

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

climhyd	<i>Lake Shasta infow data</i>
---------	-------------------------------

---

**Description**

Lake Shasta infow data; see Example 7.1. This is a data frame.

**Usage**

```
data(climhyd)
```

**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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

cmort	<i>Cardiovascular Mortality from the LA Pollution study</i>
-------	---

---

**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.

**Usage**

```
data(cmort)
```

**Format**

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

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[lap](#)

---

econ5

*Five Quarterly Economic Series*

---

**Description**

Data frame containing quarterly U.S. unemployment, GNP, consumption, and government and private investment, from 1948-III to 1988-II.

**Usage**

```
data(econ5)
```

**Format**

A data frame with 161 observations (rows) on the following 5 numeric variables (columns): unemp, gnp, consum, govinv, priv.

**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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

EM0

*EM Algorithm for Time Invariant State Space Models*

---

**Description**

Estimation of the parameters in the model (6.1)–(6.2) via the EM algorithm. See Example 6.8 on page 342

**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**

Practically, the script only requires that Q or R may be reconstructed as  $t(cQ) \times (cQ)$  or  $t(cR) \times (cR)$ , respectively.

**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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**Description**

Estimation of the parameters in the model (6.3) – (6.4) via the EM algorithm. For a demonstration, see Example 6.12 on page 357.

**Usage**

```
EM1(num, y, A, mu0, Sigma0, Phi, Ups, Gam, cQ, cR, input,
    max.iter = 50, tol = 0.01)
```

**Arguments**

num	number of observations
y	observation vector or time series; use 0 for missing values
A	observation matrices, an array with $\text{dim}=c(q, p, n)$ ; use 0 for missing values
mu0	initial state mean
Sigma0	initial state covariance matrix
Phi	state transition matrix
Ups	state input matrix; set to 0 if not used
Gam	observation input matrix; set to 0 if not used
cQ	Cholesky-like decomposition of state error covariance matrix Q – see details below
cR	R is diagonal here, so $cR = \text{sqrt}(R)$ – also, see details below
input	matrix or vector of inputs having the same row dimension as y; set to 0 if not used
max.iter	maximum number of iterations
tol	relative tolerance for determining convergence

**Details**

Practically, the script only requires that Q or R may be reconstructed as  $t(cQ)\%*(cQ)$  or  $t(cR)\%*(cR)$ , respectively.

**Value**

Phi	Estimate of Phi
Q	Estimate of Q
R	Estimate of R
mu0	Estimate of initial state mean

<code>Sigma0</code>	Estimate of initial state covariance matrix
<code>like</code>	-log likelihood at each iteration
<code>niter</code>	number of iterations to convergence
<code>cvg</code>	relative tolerance at convergence

**Author(s)**

D.S. Stoffer

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

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.

**Usage**

`data(EQ5)`

**Format**

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

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[eqexp](#)

---

eqexp

*Earthquake and Explosion Seismic Series*

---

### Description

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

### Usage

```
data(eqexp)
```

### 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

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

EXP6

*Seismic Trace of Explosion number 6*

---

### Description

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

### Usage

```
data(EXP6)
```

### Format

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

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[eqexp](#)

---

FDR	<i>Basic False Discovery Rate</i>
-----	-----------------------------------

---

**Description**

Computes the basic false discovery rate given a vector of p-values; see Example 7.4 on page 427 for a demonstration.

**Usage**

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

**Arguments**

pvals	a vector of pvals on which to conduct the multiple testing
qllevel	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.
--------	---

**References**

<http://www.stat.berkeley.edu/~paciorek/code/fdr/fdr.R>

---

flu	<i>Monthly pneumonia and influenza deaths in the U.S., 1968 to 1978.</i>
-----	--

---

**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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

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.

**Usage**

`data(fmri)`

**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.

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

`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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

`gas`*Gas Prices*

---

**Description**

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

**Usage**

```
data(gas)
```

**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**

[http://tonto.eia.doe.gov/dnav/pet/pet\\_pri\\_spt\\_s1\\_w.htm](http://tonto.eia.doe.gov/dnav/pet/pet_pri_spt_s1_w.htm)

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[oil](#)

---

gnp	<i>Quarterly U.S. GNP</i>
-----	---------------------------

---

**Description**

Quarterly U.S. GNP from 1947(1) to 2002(3).

**Usage**

data(gnp)

**Format**

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

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

gtemp	<i>Global mean land-ocean temperature deviations</i>
-------	--

---

**Description**

Global mean land-ocean temperature deviations (from 1951-1980 average), measured in degrees centigrade, for the years 1880-2009.

**Usage**

data(gtemp)

**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**

<http://data.giss.nasa.gov/gistemp/graphs/>

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[gtemp2](#)

---

gtemp2

*Global Mean Surface Air Temperature Deviations*

---

**Description**

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**

<http://data.giss.nasa.gov/gistemp/graphs/>

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[gtemp](#)

---

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).

**Usage**

data(HCT)

**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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[blood](#), [PLT](#), [WBC](#)

---

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.

**Usage**

data(jj)

**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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

 Kfilter0

*Kalman Filter - Time Invariant Model*


---

**Description**

Returns the filtered values in Property 6.1 on page 326 for the state-space model, (6.1) – (6.2). In addition, returns the evaluation of the likelihood at the given parameter values and the innovation sequence. For demonstrations, see Example 6.5 on page 331, and Example 6.10 on page 350.

**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**

Practically, the script only requires that Q or R may be reconstructed as  $t(cQ) \%*\% (cQ)$  or  $t(cR) \%*\% (cR)$ , respectively.

**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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

See also <http://www.stat.pitt.edu/stoffer/tsa3/chap6.htm> for an explanation of the difference between levels 0, 1, and 2.

---

Kfilter1

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

---

**Description**

Returns both the filtered values in Property 6.1 on page 326 for the state-space model, (6.3) – (6.4). For demonstrations, see Example 6.7 on page 338 and Example 6.9 on page 348.

**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

Practically, the script only requires that Q or R may be reconstructed as  $t(cQ) \times t(cQ)$  or  $t(cR) \times t(cR)$ , respectively.

### 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

<http://www.stat.pitt.edu/stoffer/tsa3/>

See also <http://www.stat.pitt.edu/stoffer/tsa3/chap6.htm> for an explanation of the difference between levels 0, 1, and 2.

---

Kfilter2

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

---

### Description

Returns the filtered values in Property 6.5 on page 354 for the state-space model, (6.97) – (6.99). In addition, the script returns the evaluation of the likelihood at the given parameter values and the innovation sequence. For demonstrations, see Example 6.11 on page 356 and Example 6.13 on page 361.



**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 <code>dim = c(q,p,n)</code>
mu0	initial state mean
Sigma0	initial state covariance matrix
Phi	state transition matrix
Ups	state input matrix; use <code>Ups = 0</code> if not needed
Gam	observation input matrix; use <code>Gam = 0</code> 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 <code>input = 0</code> if not needed

**Details**

Practically, the script only requires that Q or R may be reconstructed as `t(cQ)%*(cQ)` or `t(cR)%*(cR)`, respectively.

**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

<http://www.stat.pitt.edu/stoffer/tsa3/>

See also <http://www.stat.pitt.edu/stoffer/tsa3/chap6.htm> for an explanation of the difference between levels 0, 1, and 2.

---

Ksmooth0

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

---

## Description

Returns both the filtered values in Property 6.1 on page 326 and the smoothed values in Property 6.2 on page 330 for the state-space model, (6.1) – (6.2). For demonstrations, see Example 6.5 on page 331, and Example 6.10 on page 350.

## 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

Practically, the script only requires that Q or R may be reconstructed as  $t(cQ) \times (cQ)$  or  $t(cR) \times (cR)$ , respectively, which allows more flexibility.

## 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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

See also <http://www.stat.pitt.edu/stoffer/tsa3/chap6.htm> for an explanation of the difference between levels 0, 1, and 2.

---

Ksmooth1

*Kalman Filter and Smoother - General model*

---

**Description**

Returns both the filtered values in Property 6.1 on page 326 and the smoothed values in Property 6.2 on page 330 for the state-space model, (6.3) – (6.4). For demonstrations, see Example 6.7 on page 338 and Example 6.9 on page 348.

**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

Practically, the script only requires that Q or R may be reconstructed as  $t(cQ) \times (cQ)$  or  $t(cR) \times (cR)$ , respectively, which allows more flexibility.

### 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

<http://www.stat.pitt.edu/stoffer/tsa3/>

See also <http://www.stat.pitt.edu/stoffer/tsa3/chap6.htm> for an explanation of the difference between levels 0, 1, and 2.

---

Ksmooth2	<i>Kalman Filter and Smoother - General model, may have correlated errors</i>
----------	---

---

### Description

Returns the filtered and smoothed values in Property 6.5 on page 354 for the state-space model, (6.97) – (6.99). 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 $\text{dim}=\text{c}(q, p, n)$
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

Practically, the script only requires that Q or R may be reconstructed as  $\text{t}(cQ)\%*\%(\text{cQ})$  or  $\text{t}(cR)\%*\%(\text{cR})$ , respectively, which allows more flexibility.

**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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

See also <http://www.stat.pitt.edu/stoffer/tsa3/chap6.htm> for an explanation of the difference between levels 0, 1, and 2.

---

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)
```

**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

**Note**

In tsa3 this is called lag.plot1.

**Author(s)**

D.S. Stoffer

**References**<http://www.stat.pitt.edu/stoffer/tsa3/>**Examples**

```
data(soi)
lag1.plot(soi, 9)
```

---

`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)
```

**Arguments**

<code>series1</code>	first series (the one that gets lagged)
<code>series2</code>	second series
<code>max.lag</code>	maximum number of lags
<code>corr</code>	if TRUE, shows the cross-correlation value in a legend
<code>smooth</code>	if TRUE, adds a lowess fit to each scatterplot

**Note**

In `tsa3` this is called `lag.plot2`.

**Author(s)**

D.S. Stoffer

**References**<http://www.stat.pitt.edu/stoffer/tsa3/>**Examples**

```
data(soi, rec)
lag2.plot(soi, rec, 8)
```

---

LagReg *Lagged Regression*


---

**Description**

Performs lagged regression as discussed in Chapter 4, Section 4.10. See Example 4.24 on page 244 for a demonstration.

**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 coefficients 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 coefficients equal to zero (it is easiest to run LagReg twice, once with the default threshold of zero, and then again after inspecting the resulting coefficients 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**

The estimated impulse response function; see Example 4.24.

**Author(s)**

D.S. Stoffer

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>



---

lap	<i>LA Pollution-Mortality Study</i>
-----	-------------------------------------

---

**Description**

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

**Usage**

data(lap)

**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	temp
(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

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

lead	<i>Leading Indicator</i>
------	--------------------------

---

**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".

**See Also**

[sales](#)

---

 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. Can be used to replace `spec.pgram` for univariate series.

**Usage**

```
mvspec(x, spans = NULL, kernel = NULL, taper = 0, pad = 0,
       fast = TRUE, demean = FALSE, detrend = TRUE,
       plot = TRUE, na.action = na.fail, ...)
```

**Arguments**

<code>x</code>	univariate or multivariate time series (i.e., the <code>p</code> columns of <code>x</code> are time series)
<code>spans</code>	specify smoothing; same as <code>spec.pgram</code>
<code>kernel</code>	specify kernel; same as <code>spec.pgram</code>
<code>taper</code>	specify taper; same as <code>spec.pgram</code> with different default
<code>pad</code>	specify padding; same as <code>spec.pgram</code>
<code>fast</code>	specify use of FFT; same as <code>spec.pgram</code>
<code>demean</code>	if TRUE, series is demeaned first; same as <code>spec.pgram</code>
<code>detrend</code>	if TRUE, series is detrended first; same as <code>spec.pgram</code>
<code>plot</code>	plot the estimate; same as <code>spec.pgram</code>
<code>na.action</code>	same as <code>spec.pgram</code>
<code>...</code>	additional arguments; same as <code>spec.pgram</code>

## Details

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,  $(L_h/n.used) * frequency(x)$ . Although meant to be used to easily obtain multivariate spectral estimates, this script can be used in Chapter 4 for the spectral analysis of a univariate time series. Note that the script does not taper by default (`taper=0`); this forces the user to do "conscious tapering". See Example 7.12 on page 461 for a demonstration.

## Value

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

<code>fxx</code>	spectral matrix estimates; an array of dimensions <code>dim = c(p,p,nfreq)</code>
<code>freq</code>	vector of frequencies at which the spectral density is estimated.
<code>spec</code>	vector (for univariate series) or matrix (for multivariate series) of estimates of the spectral density at frequencies corresponding to <code>freq</code> .
<code>coh</code>	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 <code>coh</code> contains the squared coherency between columns $i$ and $j$ of $x$ , where $i < j$ .
<code>phase</code>	NULL for univariate series. For multivariate time series a matrix containing the cross-spectrum phase between different series. The format is the same as <code>coh</code> .
<code>Lh</code>	Number of frequencies (approximate) used in the band, as defined in (4.57) on page 204.
<code>n.used</code>	Sample length used for the FFT
<code>series</code>	The name of the time series.
<code>snames</code>	For multivariate input, the names of the component series.
<code>method</code>	The method used to calculate the spectrum.

The results are returned invisibly if `plot` is true.

## References

<http://www.stat.pitt.edu/stoffer/tsa3/>

## Examples

```
# univariate example
plot(co2) # co2 is an R data set
mvspec(co2, spans=c(5,5), taper=.5)

# 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$bandwidth/frequency(mdeaths) # ... with time unit = month
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

---

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.

**Usage**

data(oil)

**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**

[http://tonto.eia.doe.gov/dnav/pet/pet\\_pri\\_spt\\_s1\\_w.htm](http://tonto.eia.doe.gov/dnav/pet/pet_pri_spt_s1_w.htm)

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**[gas](#)

---

**part***Particulate levels from the LA pollution study*

---

**Description**

Particulate series corresponding to `cmort` from the LA pollution study.

**Usage**

```
data(part)
```

**Format**

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

**See Also**[lap](#)

---

**PLT***Platelet Levels*

---

**Description**

PLT: Measurements made for 91 days on the three variables,  $\log(\text{white blood count})$  [WBC],  $\log(\text{platelet})$  [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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

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

---

prodn	<i>Monthly Federal Reserve Board Production Index</i>
-------	---

---

**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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

qinfl	<i>Quarterly Inflation</i>
-------	----------------------------

---

**Description**

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

**Usage**

```
data(qinfl)
```

**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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[qintr](#)

---

qintr

*Quarterly Interest Rate*

---

**Description**

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

**Usage**

```
data(qintr)
```

**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**

See <http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[qinfl](#)

---

rec	<i>Recruitment (number of new fish)</i>
-----	---

---

**Description**

Recruitment (number of new fish) for a period of 453 months ranging over the years 1950-1987.

**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 Mendelsohn of the Pacific Fisheries Environmental Laboratory, NOAA (personal communication).

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[soi](#)

---

sales	<i>Sales</i>
-------	--------------

---

**Description**

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

**Usage**

data(sales)

**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".

**See Also**

[lead](#)

---

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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[saltemp](#)

---

saltemp	<i>Temperature Profiles</i>
---------	-----------------------------

---

**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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[salt](#)

---

sarima	<i>Fit ARIMA Models</i>
--------	-------------------------

---

**Description**

Fits ARIMA models including diagnostics in a short command. This is a front end to R's `arima()`.

**Usage**

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

**Arguments**

xdata	univariate time series
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
details	turns on or off the output from the nonlinear optimization routine, which is <code>optim</code> . The default is <code>TRUE</code> , use <code>details=FALSE</code> to turn off the output.
tol	controls the relative tolerance ( <code>reltol</code> in <code>optim</code> ) used to assess convergence. The default is <code>sqrt(.Machine\$double.eps)</code> , the R default.
no.constant	controls whether or not <code>sarima</code> 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 <code>TRUE</code> ; e.g., <code>sarima(x,1,1,0,no.constant=TRUE)</code> . Otherwise, no constant or mean term is included in the model. The idea is that if you difference more than once ( $d+D > 1$ ), any drift is likely to be removed. A possible work around if you think there is still drift when $d+D > 1$ , say $d=1$ and $D=1$ , then work with the differenced data, e.g., <code>sarima(diff(x),0,0,1,0,1,1,12)</code> .

**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 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`.

**Value**

fit	estimation results
AIC	value of the AIC
AICc	value of the AICc
BIC	value of the BIC

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[sarima.for](#)

**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.for

*ARIMA Forecasting*

---

**Description**

ARIMA forecasting - this is a front end to R's predict.Arima.

**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)
```

**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 <code>sqrt(.Machine\$double.eps)</code> , the R default.
no.constant	controls whether or not a constant is included in the model. If <code>no.constant=TRUE</code> , no constant is included in the model. See <a href="#">sarima</a> for more details.

**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 +/- 2 prediction error bounds.

**Value**

pred	the forecasts
se	the prediction (standard) errors

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[sarima](#)

**Examples**

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

---

SigExtract

*Signal Extraction And Optimal Filtering*

---

**Description**

Performs signal extraction and optimal filtering as discussed in Chapter 4, Section 4.11. See Example 4.25 on page 249 for a demonstration.

**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 estimated 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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

so2	<i>SO2 levels from the LA pollution study</i>
-----	---

---

**Description**

Sulfur dioxide levels from the LA pollution study

**Usage**

`data(so2)`

**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 ...

**See Also**

[lap](#)

---

soi	<i>Southern Oscillation Index</i>
-----	-----------------------------------

---

**Description**

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

**Usage**

`data(soi)`

**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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[rec](#)

---

soiltemp

*Spatial Grid of Surface Soil Temperatures*

---

**Description**

A 64 by 36 matrix of surface soil temperatures.

**Usage**

```
data(soiltemp)
```

**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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

speech	<i>Speech Recording</i>
--------	-------------------------

---

**Description**

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

**Usage**

```
data(speech)
```

**Format**

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

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

stoch.reg	<i>Frequency Domain Stochastic Regression</i>
-----------	---

---

**Description**

Performs frequency domain stochastic regression discussed in Chapter 7, Section 7.3.

**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. See Example 7.1 on page 417 for a demonstration.

**Author(s)**

D.S. Stoffer

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

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).

**Usage**

```
data(sunspotz)
```

**Format**

The format is: Time-Series [1:459] from 1749 to 1978: 89 84 70 49 47 48 41 32 17 12 ...

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

`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. See Example 6.18 page 380 and Example 6.19 page 383.

**Usage**

```
SVfilter(num, y, phi0, phi1, sQ, alpha, sR0, mu1, sR1)
```

**Arguments**

<code>num</code>	number of observations
<code>y</code>	time series of returns
<code>phi0</code>	state constant
<code>phi1</code>	state transition parameter
<code>sQ</code>	state standard deviation
<code>alpha</code>	observation constant
<code>sR0</code>	observation error standard deviation for mixture component zero
<code>mu1</code>	observation error mean for mixture component one
<code>sR1</code>	observation error standard deviation for mixture component one

**Value**

<code>xp</code>	one-step-ahead prediction of the volatility
<code>Pp</code>	mean square prediction error of the volatility
<code>like</code>	the negative of the log likelihood at the given parameter values

**Author(s)**

D.S. Stoffer

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

temp

*Temperatures from the LA pollution study*

---

**Description**

Temperature series corresponding to cmort from the LA pollution study.

**Usage**

```
data(temp)
```

**Format**

The format is: Time-Series [1:508] from 1970 to 1980: 72.4 67.2 62.9 72.5 74.2 ...

**See Also**

[lap](#)

---

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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

varve

*Annual Varve Series*

---

**Description**

Sedimentary deposits from one location in Massachusetts for 634 years, beginning nearly 12,000 years ago.

**Usage**

data(varve)

**Format**

The format is: Time-Series [1:634] from 1 to 634: 26.3 27.4 42.3 58.3 20.6 ...

**References**

<http://www.stat.pitt.edu/stoffer/tsa3/>

---

WBC

*White Blood Cell Levels*

---

**Description**

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

**Usage**

data(WBC)

**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 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**

<http://www.stat.pitt.edu/stoffer/tsa3/>

**See Also**

[blood](#), [HCT](#), [PLT](#)

# Index

## \*Topic **datasets**

ar1boot, 5  
ar1miss, 5  
arf, 6  
beamd, 7  
birth, 8  
blood, 8  
bnrf1ebv, 9  
bnrf1hvs, 9  
climhyd, 10  
cmort, 10  
econ5, 11  
EQ5, 14  
eqexp, 15  
EXP6, 15  
flu, 16  
fmri, 17  
fmri1, 18  
gas, 18  
gnp, 19  
gtemp, 19  
gtemp2, 20  
HCT, 21  
jj, 21  
lap, 33  
lead, 33  
nyse, 36  
oil, 36  
part, 37  
PLT, 37  
prodn, 38  
qinfl, 38  
qintr, 39  
rec, 40  
sales, 40  
salt, 41  
saltemp, 42  
so2, 46  
soi, 46

soiltemp, 47  
speech, 48  
sunspotz, 49  
tempr, 51  
unemp, 51  
varve, 52  
WBC, 52

## \*Topic **package**

astsa-package, 3

## \*Topic **ts**

acf2, 4  
arma.spec, 6  
astsa-package, 3  
EM0, 11  
EM1, 13  
Kfilter0, 22  
Kfilter1, 23  
Kfilter2, 24  
Ksmooth0, 26  
Ksmooth1, 27  
Ksmooth2, 29  
lag1.plot, 30  
lag2.plot, 31  
LagReg, 32  
mvspec, 34  
sarima, 42  
sarima.for, 44  
SigExtract, 45  
stoch.reg, 48  
SVfilter, 50

acf2, 4  
ar1boot, 5  
ar1miss, 5  
arf, 6  
arma.spec, 6  
astsa (astsa-package), 3  
astsa-package, 3  
  
beamd, 7

birth, 8  
blood, 8, 21, 38, 53  
bnrf1ebv, 9  
bnrf1hvs, 9  
  
climhyd, 10  
cmort, 10  
  
econ5, 11  
EM0, 11  
EM1, 13  
EQ5, 14  
eqexp, 14, 15, 16  
EXP6, 15  
  
FDR, 16  
flu, 16  
fmri, 17  
fmri1, 18  
  
gas, 18, 37  
gnp, 19  
gtemp, 19, 20  
gtemp2, 20, 20  
  
HCT, 9, 21, 38, 53  
  
jj, 21  
  
Kfilter0, 22  
Kfilter1, 23  
Kfilter2, 24  
Ksmooth0, 26  
Ksmooth1, 27  
Ksmooth2, 29  
  
lag1.plot, 30  
lag2.plot, 31  
LagReg, 32  
lap, 11, 33, 37, 46, 51  
lead, 33, 41  
  
mvspec, 34  
  
nyse, 36  
  
oil, 19, 36  
  
part, 37  
PLT, 9, 21, 37, 53  
prodn, 38  
  
qinfl, 38, 39  
qintr, 39, 39  
  
rec, 40, 47  
  
sales, 34, 40  
salt, 41, 42  
saltemp, 41, 42  
sarima, 42, 44, 45  
sarima.for, 44, 44  
SigExtract, 45  
so2, 46  
soi, 40, 46  
soiltemp, 47  
speech, 48  
stoch.reg, 48  
sunspotz, 49  
SVfilter, 50  
  
tempr, 51  
  
unemp, 51  
  
varve, 52  
  
WBC, 9, 21, 38, 52