

# Package ‘ismev’

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**Title** An Introduction to Statistical Modeling of Extreme Values

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**Depends** R (>= 1.5.0)

**Description** Functions to support the computations carried out in ‘An Introduction to Statistical Modeling of Extreme Values’ by Stuart Coles. The functions may be divided into the following groups; maxima/minima, order statistics, peaks over thresholds and point processes.

**License** GPL (>= 2)

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dowjones	<i>Daily Closing Prices of The Dow Jones Index</i>
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### Description

The dowjones data frame has 1304 rows and 2 columns. The second column contains daily closing prices of the Dow Jones Index over the period 1996 to 2000. The first column contains a `POSIXct` object giving the dates of each observation.

### Usage

```
data(dowjones)
```

### Format

This data frame contains the following columns:

**Date** A `POSIXct` object containing dates.

**Index** A numeric vector containing daily closing prices of the Dow Jones Index.

### Source

Coles, S. G. (2001) *An Introduction to Statistical Modelling of Extreme Values*. London: Springer.

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engine	<i>Engine Failure Time Data</i>
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---

**Description**

The engine data frame has 32 rows and 2 columns. The first column contains the corrosion level, the second column gives the engine failure time.

**Usage**

```
data(engine)
```

**Format**

This data frame contains the following columns:

**Time** A numeric vector of corrosion levels.

**Corrosion** A numeric vector of failure times.

**Source**

Unknown.

---

euroex	<i>UK/Euro Exchange Rates</i>
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---

**Description**

A numeric vector of daily exchange rates between the Euro and UK sterling.

**Usage**

```
data(euroex)
```

**Format**

A vector containing 975 observations.

**Source**

Unknown.

---

exchange	<i>UK/US and UK/Canada Exchange Rates</i>
----------	---

---

### Description

The exchange data frame has 975 rows and 2 columns. The columns contain daily exchange rates; UK sterling against the US dollar (first column) and UK sterling against the Canadian dollar (second column). The rownames contain the corresponding dates in a character string with the format "2000/05/26". This can be converted into a POSIXct or POSIXlt object using `as.POSIXct` or `as.POSIXlt`.

### Usage

```
data(exchange)
```

### Format

This data frame contains the following columns:

**USD.GBP** US against UK exchange rate.

**CAD.GBP** Canada against UK exchange rate.

### Source

Coles, S. G. (2001) *An Introduction to Statistical Modelling of Extreme Values*. London: Springer.

---

fremantle	<i>Annual Maximum Sea Levels at Fremantle, Western Australia</i>
-----------	--

---

### Description

The fremantle data frame has 86 rows and 3 columns. The second column gives 86 annual maximum sea levels recorded at Fremantle, Western Australia, within the period 1897 to 1989. The first column gives the corresponding years. The third column gives annual mean values of the Southern Oscillation Index (SOI), which is a proxy for meteorological volatility.

### Usage

```
data(fremantle)
```

### Format

This data frame contains the following columns:

**Year** A numeric vector of years.

**SeaLevel** A numeric vector of annual sea level maxima.

**SOI** A numeric vector of annual mean values of the Southern Oscillation Index.

**Source**

Coles, S. G. (2001) *An Introduction to Statistical Modelling of Extreme Values*. London: Springer.

---

`gev.diag`*Diagnostic Plots for GEV Models*

---

**Description**

Produces diagnostic plots for GEV models using the output of the function `gev.fit`.

**Usage**

```
gev.diag(z)
```

**Arguments**

`z` An object returned by `gev.fit`.

**Value**

For stationary models four plots are produced; a probability plot, a quantile plot, a return level plot and a histogram of data with fitted density.

For non-stationary models two plots are produced; a residual probability plot and a residual quantile plot.

**See Also**

[gev.fit](#), [gev.prof](#)

**Examples**

```
data(portpirie)
ppfit <- gev.fit(portpirie[,2])
gev.diag(ppfit)
```

---

 gev.fit

 Maximum-likelihood Fitting of the GEV Distribution
 

---

### Description

Maximum-likelihood fitting for the generalized extreme value distribution, including generalized linear modelling of each parameter.

### Usage

```
gev.fit(xdat, ydat = NULL, mul = NULL, sigl = NULL, shl = NULL,
        mulink = identity, siglink = identity, shlink = identity,
        munit = NULL, siginit = NULL, shinit = NULL,
        show = TRUE, method = "Nelder-Mead", maxit = 10000, ...)
```

### Arguments

xdat	A numeric vector of data to be fitted.
ydat	A matrix of covariates for generalized linear modelling of the parameters (or NULL (the default) for stationary fitting). The number of rows should be the same as the length of xdat.
mul, sigl, shl	Numeric vectors of integers, giving the columns of ydat that contain covariates for generalized linear modelling of the location, scale and shape parameters respectively (or NULL (the default) if the corresponding parameter is stationary).
mulink, siglink, shlink	Inverse link functions for generalized linear modelling of the location, scale and shape parameters respectively.
munit, siginit, shinit	numeric of length equal to total number of parameters used to model the location, scale or shape parameter(s), resp. See Details section for default (NULL) initial values.
show	Logical; if TRUE (the default), print details of the fit.
method	The optimization method (see <a href="#">optim</a> for details).
maxit	The maximum number of iterations.
...	Other control parameters for the optimization. These are passed to components of the control argument of <a href="#">optim</a> .

### Details

For non-stationary fitting it is recommended that the covariates within the generalized linear models are (at least approximately) centered and scaled (i.e. the columns of ydat should be approximately centered and scaled).

Let  $m = \text{mean}(xdat)$  and  $s = \sqrt{6 * \text{var}(xdat) / \pi}$ . Then, initial values assigned when 'munit' is NULL are  $m - 0.57722 * s$  (stationary case). When 'siginit' is NULL, the initial value is taken to be  $s$ , and

when 'shinit' is NULL, the initial value is taken to be 0.1. When covariates are introduced (non-stationary case), these same initial values are used by default for the constant term, and zeros for all other terms. For example, if a GEV(  $\mu(t)=\mu_0+\mu_1*t$ , sigma, xi) is being fitted, then the initial value for  $\mu_0$  is  $m - 0.57722 * s$ , and 0 for  $\mu_1$ .

### Value

A list containing the following components. A subset of these components are printed after the fit. If show is TRUE, then assuming that successful convergence is indicated, the components nllh, mle and se are always printed.

trans	An logical indicator for a non-stationary fit.
model	A list with components $\mu_1$ , sig1 and sh1.
link	A character vector giving inverse link functions.
conv	The convergence code, taken from the list returned by <a href="#">optim</a> . A zero indicates successful convergence.
nllh	The negative logarithm of the likelihood evaluated at the maximum likelihood estimates.
data	The data that has been fitted. For non-stationary models, the data is standardized.
mle	A vector containing the maximum likelihood estimates.
cov	The covariance matrix.
se	A vector containing the standard errors.
vals	A matrix with three columns containing the maximum likelihood estimates of the location, scale and shape parameters at each data point.

### See Also

[gev.diag](#), [optim](#), [gev.prof](#)

### Examples

```
data(portpirie)
gev.fit(portpirie[,2])
```

---

gev.prof

*Profile Log-likelihoods for Stationary GEV Models*

---

### Description

Produce profile log-likelihoods for shape parameters and m year/block return levels for stationary GEV models using the output of the function `gev.fit`.

### Usage

```
gev.prof(z, m, xlow, xup, conf = 0.95, nint = 100)
gev.profxi(z, xlow, xup, conf = 0.95, nint = 100)
```

**Arguments**

<code>z</code>	An object returned by <code>gev.fit</code> . The object should represent a stationary model.
<code>m</code>	The return level (i.e. the profile likelihood is for the value that is exceeded with probability $1/m$ ).
<code>xlow, xup</code>	The least and greatest value at which to evaluate the profile likelihood.
<code>conf</code>	The confidence coefficient of the plotted profile confidence interval.
<code>nint</code>	The number of points at which the profile likelihood is evaluated.

**Value**

A plot of the profile likelihood is produced, with a horizontal line representing a profile confidence interval with confidence coefficient `conf`.

**See Also**

[gev.fit](#), [gev.diag](#)

**Examples**

```
data(portpirie)
ppfit <- gev.fit(portpirie[,2])
## Not run: gev.prof(ppfit, m = 10, 4.1, 5)
## Not run: gev.profxi(ppfit, -0.3, 0.3)
```

---

glass

*Breaking Strengths of Glass Fibres*

---

**Description**

A numeric vector containing breaking strengths of 63 glass fibres of length 1.5 centimetres, recorded under experimental conditions.

**Usage**

```
data(glass)
```

**Format**

A vector containing 63 observations.

**Source**

Smith, R. L. and Naylor, J. C. (1987) A comparison of maximum likelihood and Bayesian estimators for the three-parameter Weibull distribution. *Applied Statistics* **36**, 358–396.

**References**

Coles, S. G. (2001) *An Introduction to Statistical Modelling of Extreme Values*. London: Springer.

---

`gpd.diag`*Diagnostic Plots for GPD Models*

---

**Description**

Produces diagnostic plots for GPD models using the output of the function `gpd.fit`.

**Usage**

```
gpd.diag(z)
```

**Arguments**

`z` An object returned by `gpd.fit`.

**Value**

For stationary models four plots are produced; a probability plot, a quantile plot, a return level plot and a histogram of data with fitted density.

For non-stationary models two plots are produced; a residual probability plot and a residual quantile plot.

**See Also**

[gpd.fit](#), [gpd.prof](#), [pp.fit](#)

**Examples**

```
data(rain)
rnfit <- gpd.fit(rain, 10)
gpd.diag(rnfit)
```

---

`gpd.fit`*Maximum-likelihood Fitting for the GPD Model*

---

**Description**

Maximum-likelihood fitting for the GPD model, including generalized linear modelling of each parameter.

**Usage**

```
gpd.fit(xdat, threshold, npy = 365, ydat = NULL, sigl = NULL,
        shl = NULL, siglink = identity, shlink = identity, siginit = NULL,
        shinit = NULL, show = TRUE,
        method = "Nelder-Mead", maxit = 10000, ...)
```

**Arguments**

xdat	A numeric vector of data to be fitted.
threshold	The threshold; a single number or a numeric vector of the same length as xdat.
npv	The number of observations per year/block.
ydat	A matrix of covariates for generalized linear modelling of the parameters (or NULL (the default) for stationary fitting). The number of rows should be the same as the length of xdat.
sigl, shl	Numeric vectors of integers, giving the columns of ydat that contain covariates for generalized linear modelling of the scale and shape parameters respectively (or NULL (the default) if the corresponding parameter is stationary).
siglink, shlink	Inverse link functions for generalized linear modelling of the scale and shape parameters respectively.
siginit, shinit	numeric giving initial value(s) for parameter estimates. If NULL, default is $\sqrt{6 * \text{var}(xdat)}/\pi$ and 0.1 for the scale and shape parameters, resp. If using parameter covariates, then these values are used for the constant term, and zeros for all other terms.
show	Logical; if TRUE (the default), print details of the fit.
method	The optimization method (see <code>optim</code> for details).
maxit	The maximum number of iterations.
...	Other control parameters for the optimization. These are passed to components of the control argument of <code>optim</code> .

**Details**

For non-stationary fitting it is recommended that the covariates within the generalized linear models are (at least approximately) centered and scaled (i.e. the columns of ydat should be approximately centered and scaled).

**Value**

A list containing the following components. A subset of these components are printed after the fit. If show is TRUE, then assuming that successful convergence is indicated, the components nexc, nllh, mle, rate and se are always printed.

trans	An logical indicator for a non-stationary fit.
model	A list with components sigl and shl.
link	A character vector giving inverse link functions.
threshold	The threshold, or vector of thresholds.
nexc	The number of data points above the threshold.
data	The data that lie above the threshold. For non-stationary models, the data is standardized.

conv	The convergence code, taken from the list returned by <code>optim</code> . A zero indicates successful convergence.
nllh	The negative logarithm of the likelihood evaluated at the maximum likelihood estimates.
vals	A matrix with three columns containing the maximum likelihood estimates of the scale and shape parameters, and the threshold, at each data point.
mle	A vector containing the maximum likelihood estimates.
rate	The proportion of data points that lie above the threshold.
cov	The covariance matrix.
se	A vector containing the standard errors.
n	The number of data points (i.e. the length of <code>xdat</code> ).
npv	The number of observations per year/block.
xdata	The data that has been fitted.

**See Also**

[gpd.diag](#), [optim](#), [gpd.prof](#), [gpd.fitrage](#), [mrl.plot](#), [pp.fit](#)

**Examples**

```
data(rain)
gpd.fit(rain, 10)
```

---

`gpd.fitrage`

*Fitting the GPD Model Over a Range of Thresholds*

---

**Description**

Maximum-likelihood fitting for a stationary GPD model, over a range of thresholds. Graphs of parameter estimates which aid the selection of a threshold are produced.

**Usage**

```
gpd.fitrage(data, umin, umax, nint = 10, show = FALSE, ...)
```

**Arguments**

data	A numeric vector of data to be fitted.
umin, umax	The minimum and maximum thresholds at which the model is fitted.
nint	The number of fitted models.
show	Logical; if TRUE, print details of each fit.
...	Optional arguments to <code>gpd.fit</code> .

**Value**

Two graphs showing maximum likelihood estimates and confidence intervals of the shape and modified scale parameters over a range of thresholds are produced. A list object is returned invisibly with components: 'threshold' numeric vector of length 'nint' giving the thresholds used, 'mle' an 'nint X 3' matrix giving the maximum likelihood parameter estimates (columns are location, scale and shape respectively), 'se' an 'nint X 3' matrix giving the estimated standard errors for the parameter estimates (columns are location, scale and shape, resp.), 'ci.low', 'ci.up' 'nint X 3' matrices giving the lower and upper 95 intervals, resp. (columns same as for 'mle' and 'se').

**See Also**

[gpd.fit](#), [mrl.plot](#), [pp.fit](#), [pp.fitrangle](#)

**Examples**

```
## Not run: data(rain)
## Not run: gpd.fitrangle(rain, 10, 40)
```

---

gpd.prof

*Profile Log-likelihoods for Stationary GPD Models*

---

**Description**

Produce profile log-likelihoods for shape parameters and m year/block return levels for stationary GPD models using the output of the function `gpd.fit`.

**Usage**

```
gpd.prof(z, m, xlow, xup, npy = 365, conf = 0.95, nint = 100)
gpd.profxi(z, xlow, xup, conf = 0.95, nint = 100)
```

**Arguments**

<code>z</code>	An object returned by <code>gpd.fit</code> . The object should represent a stationary model.
<code>m</code>	The return level (i.e. the profile likelihood is for the value that is exceeded with probability $1/m$ ).
<code>xlow, xup</code>	The least and greatest value at which to evaluate the profile likelihood.
<code>npy</code>	The number of observations per year.
<code>conf</code>	The confidence coefficient of the plotted profile confidence interval.
<code>nint</code>	The number of points at which the profile likelihood is evaluated.

**Value**

A plot of the profile likelihood is produced, with a horizontal line representing a profile confidence interval with confidence coefficient `conf`.

**See Also**

[gpd.fit](#), [gpd.diag](#)

**Examples**

```
data(rain)
rnfit <- gpd.fit(rain, 10)
## Not run: gpd.prof(rnfit, m = 10, 55, 75)
## Not run: gpd.profxi(rnfit, -0.02, 0.15)
```

---

gum.diag

*Diagnostic Plots for Gumbel Models*

---

**Description**

Produces diagnostic plots for Gumbel models using the output of the function `gum.fit`.

**Usage**

```
gum.diag(z)
```

**Arguments**

`z` An object returned by `gum.fit`.

**Value**

For stationary models four plots are produced; a probability plot, a quantile plot, a return level plot and a histogram of data with fitted density.

For non-stationary models two plots are produced; a residual probability plot and a residual quantile plot.

**See Also**

[gev.fit](#), [gum.fit](#)

**Examples**

```
data(portpirie)
ppfit <- gum.fit(portpirie[,2])
gum.diag(ppfit)
```

gum.fit

*Maximum-likelihood Fitting of the Gumbel Distribution***Description**

Maximum-likelihood fitting for the gumbel distribution, including generalized linear modelling of each parameter.

**Usage**

```
gum.fit(xdat, ydat = NULL, mul = NULL, sigl = NULL, mulink = identity,
        siglink = identity, muinit = NULL, siginit = NULL, show = TRUE,
        method = "Nelder-Mead", maxit = 10000, ...)
```

**Arguments**

xdat	A numeric vector of data to be fitted.
ydat	A matrix of covariates for generalized linear modelling of the parameters (or NULL (the default) for stationary fitting). The number of rows should be the same as the length of xdat.
mul, sigl	Numeric vectors of integers, giving the columns of ydat that contain covariates for generalized linear modelling of the location and scale parameters respectively (or NULL (the default) if the corresponding parameter is stationary).
mulink, siglink	Inverse link functions for generalized linear modelling of the location and scale parameters respectively.
muinit, siginit	numeric giving initial parameter estimates. See Details section for information about default values (NULL).
show	Logical; if TRUE (the default), print details of the fit.
method	The optimization method (see <a href="#">optim</a> for details).
maxit	The maximum number of iterations.
...	Other control parameters for the optimization. These are passed to components of the control argument of <a href="#">optim</a> .

**Details**

For non-stationary fitting it is recommended that the covariates within the generalized linear models are (at least approximately) centered and scaled (i.e. the columns of ydat should be approximately centered and scaled).

Let  $m = \text{mean}(xdat)$  and  $s = \sqrt{6 * \text{var}(xdat) / \pi}$ . Then, initial values assigned when 'muinit' is NULL are  $m - 0.57722 * s$  (stationary case). When 'siginit' is NULL, the initial value is taken to be  $s$ , and when 'shinit' is NULL. When covariates are introduced (non-stationary case), these same initial values are used by default for the constant term, and zeros for all other terms. For example, if a Gumbel( $\mu(t) = \mu_0 + \mu_1 * t$ ,  $\sigma$ ) is being fitted, then the initial value for  $\mu_0$  is  $m - 0.57722 * s$ , and 0 for  $\mu_1$ .

**Value**

A list containing the following components. A subset of these components are printed after the fit. If `show` is TRUE, then assuming that successful convergence is indicated, the components `nllh`, `mle` and `se` are always printed.

<code>trans</code>	An logical indicator for a non-stationary fit.
<code>model</code>	A list with components <code>mul</code> and <code>sigl</code> .
<code>link</code>	A character vector giving inverse link functions.
<code>conv</code>	The convergence code, taken from the list returned by <code>optim</code> . A zero indicates successful convergence.
<code>nllh</code>	The negative logarithm of the likelihood evaluated at the maximum likelihood estimates.
<code>data</code>	The data that has been fitted. For non-stationary models, the data is standardized.
<code>mle</code>	A vector containing the maximum likelihood estimates.
<code>cov</code>	The covariance matrix.
<code>se</code>	A vector containing the standard errors.
<code>vals</code>	A matrix with two columns containing the maximum likelihood estimates of the location and scale parameters at each data point.

**See Also**

[gum.diag](#), [optim](#), [gev.fit](#)

**Examples**

```
data(portpirie)
gum.fit(portpirie[,2])
```

---

 ismev

*ismev – The Extremes Toolkit: Weather and Climate Applications of Extreme-Value Statistics*

---

**Description**

**ismev** includes functions to support the computations carried out in ‘An Introduction to Statistical Modeling of Extreme Values’ by Stuart Coles. The functions may be divided into the following groups; maxima/minima, order statistics, peaks over thresholds and point processes. **ismev** is an R port of Stuart Coles’ S-Plus extreme value statistical routines.

Primary functions include: ‘`gev.fit`’, ‘`gev.diag`’, ‘`gpd.fit`’, ‘`gpd.diag`’, ‘`pp.fit`’ and ‘`pp.diag`’.

Original R port was carried out by Alec Stephenson, and the package is currently being maintained by Eric Gilleland.

---

mrl.plot	<i>Mean Residual Life Plot</i>
----------	--------------------------------

---

**Description**

An empirical mean residual life plot, including confidence intervals, is produced. The mean residual life plot aids the selection of a threshold for the GPD or point process models.

**Usage**

```
mrl.plot(data, umin = min(data), umax = max(data) - 0.1,  
         conf = 0.95, nint = 100)
```

**Arguments**

data	A numeric vector of data to be fitted.
umin, umax	The minimum and maximum thresholds at which the mean residual life function is calculated.
conf	The confidence coefficient for the confidence intervals depicted in the plot.
nint	The number of points at which the mean residual life function is calculated.

**See Also**

[gpd.fit](#), [gpd.fitrangle](#), [pp.fit](#)

**Examples**

```
data(rain)  
mrl.plot(rain)
```

---

portpirie	<i>Annual Maximum Sea Levels at Port Pirie, South Australia</i>
-----------	---

---

**Description**

The portpirie data frame has 65 rows and 2 columns. The second column gives annual maximum sea levels recorded at Port Pirie, South Australia, from 1923 to 1987. The first column gives the corresponding years.

**Usage**

```
data(portpirie)
```

**Format**

This data frame contains the following columns:

**Year** A numeric vector of years.

**SeaLevel** A numeric vector of annual sea level maxima.

**Source**

Coles, S. G. (2001) *An Introduction to Statistical Modelling of Extreme Values*. London: Springer.

---

pp.diag

*Diagnostic Plots for Point Process Models*

---

**Description**

Produces diagnostic plots for point process models using the output of the function `pp.fit`.

**Usage**

```
pp.diag(z)
```

**Arguments**

`z` An object returned by `pp.fit`.

**Value**

For stationary models two plots are produced; a probability plot and a quantile plot.

For non-stationary models two plots are produced; a residual probability plot and a residual quantile plot.

**See Also**

[pp.fit](#), [gpd.fit](#)

**Examples**

```
data(rain)
rnfit <- pp.fit(rain, 10)
pp.diag(rnfit)
```

pp.fit

*Maximum-likelihood Fitting for the Point Process Model***Description**

Maximum-likelihood fitting for the point process model, including generalized linear modelling of each parameter.

**Usage**

```
pp.fit(xdat, threshold, npy = 365, ydat = NULL, mul = NULL, sigl =
  NULL, shl = NULL, mulink = identity, siglink = identity, shlink =
  identity, munit = NULL, siginit = NULL, shinit = NULL, show = TRUE,
  method = "Nelder-Mead", maxit = 10000, ...)
```

**Arguments**

xdat	A numeric vector of data to be fitted.
threshold	The threshold; a single number or a numeric vector of the same length as xdat.
npy	The number of observations per year/block.
ydat	A matrix of covariates for generalized linear modelling of the parameters (or NULL (the default) for stationary fitting). The number of rows should be the same as the length of xdat.
mul, sigl, shl	Numeric vectors of integers, giving the columns of ydat that contain covariates for generalized linear modelling of the location, scale and shape parameters respectively (or NULL (the default) if the corresponding parameter is stationary).
mulink, siglink, shlink	Inverse link functions for generalized linear modelling of the location, scale and shape parameters respectively.
munit, siginit, shinit	numeric giving initial parameter estimates. See Details section for information on default (NULL) initial values.
show	Logical; if TRUE (the default), print details of the fit.
method	The optimization method (see <a href="#">optim</a> for details).
maxit	The maximum number of iterations.
...	Other control parameters for the optimization. These are passed to components of the control argument of <a href="#">optim</a> .

**Details**

For non-stationary fitting it is recommended that the covariates within the generalized linear models are (at least approximately) centered and scaled (i.e. the columns of ydat should be approximately centered and scaled). Otherwise, the numerics may become unstable.

As of version 1.32, a more accurate estimate of the exceedance rate, in the face of covariates, is used (at the expense of computational efficiency). In particular, when including covariates, parameter estimates may differ from those in Coles (2001).

Let  $m = \text{mean}(x_{\text{dat}})$  and  $s = \sqrt{6 \cdot \text{var}(x_{\text{dat}}) / \pi}$ . Then, initial values assigned when 'munit' is NULL are  $m - 0.57722 \cdot s$  (stationary case). When 'siginit' is NULL, the initial value is taken to be  $s$ , and when 'shinit' is NULL, the initial value is taken to be 0.1. When covariates are introduced (non-stationary case), these same initial values are used by default for the constant term, and zeros for all other terms. For example, if a GEV ( $\mu(t) = \mu_0 + \mu_1 \cdot t$ ,  $\sigma$ ,  $\xi$ ) is being fitted, then the initial value for  $\mu_0$  is  $m - 0.57722 \cdot s$ , and 0 for  $\mu_1$ .

### Value

A list containing the following components. A subset of these components are printed after the fit. If show is TRUE, then assuming that successful convergence is indicated, the components nexc, nllh, mle and se are always printed.

trans	An logical indicator for a non-stationary fit.
model	A list with components $\mu_1$ , $\sigma_1$ and $sh_1$ .
link	A character vector giving inverse link functions.
threshold	The threshold, or vector of thresholds.
npv	The number of observations per year/block.
nexc	The number of data points above the threshold.
data	The data that lie above the threshold. For non-stationary models, the data is standardized.
conv	The convergence code, taken from the list returned by <code>optim</code> . A zero indicates successful convergence.
nllh	The negative logarithm of the likelihood evaluated at the maximum likelihood estimates.
vals	A matrix with four columns containing the maximum likelihood estimates of the location, scale and shape parameters, and the threshold, at each data point.
gpd	A matrix with three rows containing the maximum likelihood estimates of corresponding GPD location, scale and shape parameters at each data point.
mle	A vector containing the maximum likelihood estimates.
cov	The covariance matrix.
se	A vector containing the standard errors.

### Warning

Different optimization methods may result in wildly different parameter estimates.

### Note

This code is adapted by Eric Gilleland from code originally written for S-Plus by Stuart Coles, and ported to R by Alec Stephenson. See details section above.

**References**

Beirlant J, Goegebeur Y, Segers J and Teugels J. (2004). *Statistics of Extremes*, Wiley, Chichester, England.

Coles, Stuart (2001). *An Introduction to Statistical Modeling of Extreme Values*. Springer-Verlag, London.

**See Also**

[pp.diag](#), [optim](#), [pp.fitrangle](#), [mrl.plot](#), [gpd.fit](#)

**Examples**

```
data(rain)
pp.fit(rain, 10)
```

---

pp.fitrangle

*Fitting the Point Process Model Over a Range of Thresholds*

---

**Description**

Maximum-likelihood fitting for a stationary point process model, over a range of thresholds. Graphs of parameter estimates which aid the selection of a threshold are produced.

**Usage**

```
pp.fitrangle(data, umin, umax, npy = 365, nint = 10, show = FALSE, ...)
```

**Arguments**

data	A numeric vector of data to be fitted.
umin, umax	The minimum and maximum thresholds at which the model is fitted.
npy	The number of observations per year/block.
nint	The number of fitted models.
show	Logical; if TRUE, print details of each fit.
...	Optional arguments to <code>pp.fit</code> .

**Value**

Three graphs showing maximum likelihood estimates and confidence intervals of the location, scale and shape parameters over a range of thresholds are produced. A list object is returned invisibly with components: 'threshold' numeric vector of length 'nint' giving the thresholds used, 'mle' an 'nint X 3' matrix giving the maximum likelihood parameter estimates (columns are location, scale and shape respectively), 'se' an 'nint X 3' matrix giving the estimated standard errors for the parameter estimates (columns are location, scale and shape, resp.), 'ci.low', 'ci.up' 'nint X 3' matrices giving the lower and upper 95 intervals, resp. (columns same as for 'mle' and 'se').

**See Also**

[pp.fit](#), [mrl.plot](#), [gpd.fit](#), [gpd.fitrangle](#)

**Examples**

```
## Not run: data(rain)
## Not run: pp.fitrangle(rain, 10, 40)
```

---

rain	<i>Daily Rainfall Accumulations in South-West England</i>
------	---

---

**Description**

A numeric vector containing daily rainfall accumulations at a location in south-west England over the period 1914 to 1962.

**Usage**

```
data(rain)
```

**Format**

A vector containing 17531 observations.

**Source**

Coles, S. G. and Tawn, J. A. (1996) Modelling extremes of the areal rainfall process. *Journal of the Royal Statistical Society, B* **53**, 329–347.

**References**

Coles, S. G. (2001) *An Introduction to Statistical Modelling of Extreme Values*. London: Springer.

---

rlarg.diag	<i>Diagnostic Plots for Order Statistics Models</i>
------------	---

---

**Description**

Produces diagnostic plots for order statistics models using the output of the function `rlarg.fit`.

**Usage**

```
rlarg.diag(z, n = z$r)
```

**Arguments**

- `z` An object returned by `rlarg.fit`.
- `n` Probability and quantile plots are produced for the largest `n` order statistics.

**Value**

For stationary models four plots are initially produced; a probability plot, a quantile plot, a return level plot and a histogram of data with fitted density. Then probability and quantile plots are produced for the largest `n` order statistics.

For non-stationary models residual probability plots and residual quantile plots are produced for the largest `n` order statistics.

**See Also**

[rlarg.fit](#)

**Examples**

```
## Not run: data(venice)
## Not run: venfit <- rlarg.fit(venice[,-1])
## Not run: rlarg.diag(venfit)
```

---

`rlarg.fit`

*Maximum-likelihood Fitting of Order Statistics Model*

---

**Description**

Maximum-likelihood fitting for the order statistic model, including generalized linear modelling of each parameter.

**Usage**

```
rlarg.fit(xdat, r = dim(xdat)[2], ydat = NULL, mu1 = NULL, sig1 = NULL,
  sh1 = NULL, mulink = identity, siglink = identity, shlink = identity,
  munit = NULL, siginit = NULL, shinit = NULL, show = TRUE,
  method = "Nelder-Mead", maxit = 10000, ...)
```

**Arguments**

- `xdat` A numeric matrix of data to be fitted. Each row should be a vector of decreasing order, containing the largest order statistics for each year (or time period). The first column therefore contains annual (or period) maxima. Only the first `r` columns are used for the fitted model. By default, all columns are used. If one year (or time period) contains fewer order statistics than another, missing values can be appended to the end of the corresponding row.
- `r` The largest `r` order statistics are used for the fitted model.

ydat	A matrix of covariates for generalized linear modelling of the parameters (or NULL (the default) for stationary fitting). The number of rows should be the same as the number of rows of xdat.
mul, sigl, shl	Numeric vectors of integers, giving the columns of ydat that contain covariates for generalized linear modelling of the location, scale and shape parameters respectively (or NULL (the default) if the corresponding parameter is stationary).
mulink, siglink, shlink	Inverse link functions for generalized linear modelling of the location, scale and shape parameters respectively.
muinit, siginit, shinit	numeric of length equal to total number of parameters used to model the location, scale or shape parameter(s), resp. See Details section for default (NULL) initial values.
show	Logical; if TRUE (the default), print details of the fit.
method	The optimization method (see <code>optim</code> for details).
maxit	The maximum number of iterations.
...	Other control parameters for the optimization. These are passed to components of the control argument of <code>optim</code> .

### Details

For non-stationary fitting it is recommended that the covariates within the generalized linear models are (at least approximately) centered and scaled (i.e. the columns of ydat should be approximately centered and scaled).

Let  $m = \text{mean}(xdat)$  and  $s = \sqrt{6 \cdot \text{var}(xdat)} / \pi$ . Then, initial values assigned when 'muinit' is NULL are  $m - 0.57722 \cdot s$  (stationary case). When 'siginit' is NULL, the initial value is taken to be  $s$ , and when 'shinit' is NULL, the initial value is taken to be 0.1. When covariates are introduced (non-stationary case), these same initial values are used by default for the constant term, and zeros for all other terms. For example, if a GEV(  $\mu(t) = \mu_0 + \mu_1 \cdot t$ ,  $\sigma$ ,  $\xi$ ) is being fitted, then the initial value for  $\mu_0$  is  $m - 0.57722 \cdot s$ , and 0 for  $\mu_1$ .

### Value

A list containing the following components. A subset of these components are printed after the fit. If show is TRUE, then assuming that successful convergence is indicated, the components nllh, mle and se are always printed.

trans	An logical indicator for a non-stationary fit.
model	A list with components mul, sigl and shl.
link	A character vector giving inverse link functions.
conv	The convergence code, taken from the list returned by <code>optim</code> . A zero indicates successful convergence.
nllh	The negative logarithm of the likelihood evaluated at the maximum likelihood estimates.
data	The data that has been fitted. For non-stationary models, the data is standardized.

mle	A vector containing the maximum likelihood estimates.
cov	The covariance matrix.
se	A vector containing the standard errors.
vals	A matrix with three columns containing the maximum likelihood estimates of the location, scale and shape parameters at each data point.
r	The number of order statistics used.

**See Also**

[rlarg.diag](#), [optim](#)

**Examples**

```
## Not run: data(venice)
## Not run: rlarg.fit(venice[, -1])
```

---

venice	<i>Venice Sea Levels</i>
--------	--------------------------

---

**Description**

The venice data frame has 51 rows and 11 columns. The final ten columns contain the 10 largest sea levels observed within the year given by the first column. The ten largest sea levels are given for every year in the period 1931 to 1981, excluding 1935 in which only the six largest measurements are available.

**Usage**

```
data(venice)
```

**Format**

This data frame contains the following columns:

**Year** A numeric vector of years.

**r1** Annual sea level maxima.

**r2** The second largest sea level.

**r3** The third largest sea level.

**r4** The fourth largest sea level.

**r5** The fifth largest sea level.

**r6** The sixth largest sea level.

**r7** The seventh largest sea level.

**r8** The eighth largest sea level.

**r9** The ninth largest sea level.

**r10** The tenth largest sea level.

**Source**

Smith, R. L. (1986) Extreme value theory based on the  $r$  largest annual events. *Journal of Hydrology* **86**, 27–43.

**References**

Coles, S. G. (2001) *An Introduction to Statistical Modelling of Extreme Values*. London: Springer.

---

wavesurge

*Wave and Surge Heights in South-West England*

---

**Description**

The wavesurge data frame has 2894 rows and 2 columns. The columns contain wave and surge heights (in metres) at a single location off south-west England.

**Usage**

```
data(wavesurge)
```

**Format**

This data frame contains the following columns:

**wave** A numeric vector of wave heights.

**surge** A numeric vector of surge heights.

**Source**

Coles, S. G. (2001) *An Introduction to Statistical Modelling of Extreme Values*. London: Springer.

---

wind

*Annual Maximum Wind Speeds at Albany and Hartford*

---

**Description**

The wind data frame has 40 rows and 3 columns. The second and third columns contain annual maximum wind speeds at Albany, New York and Hartford, Connecticut respectively, over the period 1944 to 1983. The first column gives the corresponding years.

**Usage**

```
data(wind)
```

**Format**

This data frame contains the following columns:

**Year** A numeric vector of years.

**Hartford** Annual maximum wind speeds at Hartford.

**Albany** Annual maximum wind speeds at Albany.

**Source**

Coles, S. G. (2001) *An Introduction to Statistical Modelling of Extreme Values*. London: Springer.

---

wooster

*Minimum Temperatures at Wooster, Ohio*

---

**Description**

A numeric vector containing daily minimum temperatures, in degrees Fahrenheit, at Wooster, Ohio, over the period 1983 to 1988.

**Usage**

```
data(wooster)
```

**Format**

A vector containing 1826 observations.

**Source**

Coles, S. G., Tawn, J. A. and Smith, R. L. (1994) A seasonal Markov model for extremely low temperatures. *Environmetrics* **5**, 221–239.

**References**

Coles, S. G. (2001) *An Introduction to Statistical Modelling of Extreme Values*. London: Springer.

Smith, R. L., Tawn, J. A. and Coles, S. G. (1997) Markov chain models for threshold exceedences. *Biometrika* **84**, 249–268.

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