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Title Bayesian Analysis in Extreme Value Theory

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Description Provides functions for the Bayesian analysis of extreme value models, using Markov chain Monte Carlo methods. Allows the construction of both uninformative and informed prior distributions for common statistical models applied to extreme event data, including the generalized extreme value distribution.

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Contents

Accept Rate	2
dinfo	3
lh	4
mc.quant	5
mposterior	6
posterior	7
prior	8
rainfall	9
rl.pred	10
rl.pst	11

Index	12
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Accept Rate

*Compute Suited Proposal Standard Deviations***Description**

Compute suited proposal standard deviations for the MCMC algorithm.

Usage

```
ar.choice(init, prior, lh = c("none", "gev", "gpd", "pp", "os"), ..., psd,
ar = rep(.4, npar), n = 1000, tol = rep(.05, npar))
```

Arguments

<code>init</code>	a numeric vector for the starting value of the MCMC algorithm.
<code>prior</code>	A prior model. See function <code>prior.prob</code> , <code>prior.quant</code> , <code>prior.norm</code> and <code>prior.loglognorm</code> .
<code>lh</code>	The likelihood function. Should be one of “none”, “gev”, “gpd”, “pp” and “os”.
<code>...</code>	Optional arguments to be passed to the <code>posterior</code> function.
<code>psd</code>	The initials proposal standard deviations.
<code>ar</code>	Optional. The objective accept rates - default is <code>rep(.4, npar)</code> .
<code>n</code>	Optional. The length of the simulated Markov Chains.
<code>tol</code>	Optional. The tolerance for the convergence test.

Details

The suited proposal standard deviations (`psd`) are computed through trial and error processes. Proposal standard deviations are fundamental to ensure good mixing properties for the Markov Chains.

For this purpose, there exists a thumb rule: *“In small dimensions, aim at an average acceptance rate of 50. In large dimensions, at an average acceptance rate of 25. (Gelman et al., 1995)”*.

For numerical conveniences, the trial and error process is more accurate with small initial starting `psd`.

Value

Return a list with two arguments. “`psd`”: the suited proposal standard deviations and “`ar`”: the accept rates related to these proposal standard deviations.

Author(s)

Mathieu Ribatet

References

Gelman, A. and Roberts, G. and Gilks, W. (1995) *Efficient Metropolis Jumping Rules*. Oxford University Press.

Examples

```
data(rainfall)
prrain <- prior.quant(shape = c(38.9, 7.1, 47), scale = c(1.5, 6.3,
  2.6))
n <- 10000; t0 <- c(43.2, 7.64, 0.32);
s <- ar.choice(init = t0, prior = prrain, lh = "pp", data = rainfall,
  thresh = 40, noy = 54, psd = rep(0.01, 3))
```

dinfo

Information for Beta and Gamma Distributions

Description

Show means, variances and modes for beta and gamma distributions.

Usage

```
ibeta(mean, var, shape1, shape2)
igamma(mean, var, shape, scale)
```

Arguments

mean, var Numeric vectors giving means and variances.
shape1, shape2 Numeric vectors. See [dbeta](#).
shape, scale Numeric vectors. See [dgamma](#).

Details

For `ibeta`, either both of `mean` and `var` or both of `shape1` and `shape2` must be specified. For `igamma`, either both of `mean` and `var` or both of `shape` and `scale` must be specified. The pair of vectors that are passed to each function define a set of beta/gamma distributions. If one vector is shorter than the other, the shorter vector is replicated.

Value

A matrix with five columns and n rows, where n is the length of the longest argument. If $n = 1$ the dimension is dropped (i.e. a vector of length five is returned). The columns contain the means, variances, modes, and the shape/scale parameters of the specified distributions. If a mode is NA, it does not exist, or it is not unique, or it does not occur in the interior of the support. If an entire row is NA, the corresponding arguments do not lead to a valid distribution.

See Also

[dbeta](#), [dgamma](#)

Examples

```

ibeta(shape1 = 5, shape2 = 4)
ibeta(mean = seq(0.1,0.9,0.2), var = 0.03)
igamma(shape=c(38.9,7.1,47), scale=c(1.5,6.3,2.6))

```

lh

*Calculate Log-likelihoods***Description**

Calculate log-likelihoods for the gev, order statistics or point process models.

Usage

```

pplik(par, data, thresh, noy, trend, exact = FALSE)
gevlik(par, data, trend)
gpdlik(par, data, trend)
oslik(par, data, trend)

```

Arguments

par	If trend is missing, should be a numeric vector of length three, containing the location, scale and shape parameters. If trend is not missing, should be a numeric vector of length four, containing the location intercept, scale, shape and location trend parameters, in that order.
data	For pplik, gevlik and gpdlik; a non-empty numeric vector containing the data at which the likelihood is evaluated, possibly containing missing values. For oslik; a numeric matrix (see the user's guide).
thresh	Threshold. Typically a single number or a vector of the same length as data.
noy	Number of years/periods of observations, excluding any missing values.
trend	Trend vector (optional). If given, should be the same length as data for pplik and gevlik. For oslik, should contain one value for each row of data.
exact	In general, the point process likelihood includes an approximation to an integral. If exact is TRUE, every value in trend and thresh is used for the approximation.

Details

See the user's guide.

Value

A numeric vector.

Note

These functions are essentially internal, and need not be called by the user. They are documented only because their arguments (excluding par) can be passed to [posterior](#).

See Also

[posterior](#), [prior.prob](#)

mc.quant

Compute GEV Quantiles from Markov Chains

Description

Compute gev quantiles from samples stored within a Markov chain, corresponding to specified probabilities in the upper tail.

Usage

```
mc.quant(post, p, lh = c("gev", "gpd"))
```

Arguments

post	A Markov chain generated using <code>posterior</code> , containing samples of gev parameters.
p	A numeric vector of upper tail probabilities.
lh	Specify “gev” or “gpd” likelihood.

Details

See the user’s guide.

Value

A matrix with n rows and m columns, where n is the number of samples stored within the chain, and m is the length of the vector p . If $m = 1$ the dimension is dropped (i.e. a vector of length n is returned). The (i, j) th entry contains the gev quantile corresponding to the upper tail probability $p[j]$, evaluated at the parameters within sample i .

If a linear trend on the location has been implemented, the quantiles correspond to the distribution obtained when the trend parameter is zero.

See Also

[posterior](#)

mposterior

Maximizing Posterior Distributions

Description

Maximizing prior and posterior distributions for the location (with optional trend), scale and shape parameters under the gev, order statistics or point process models.

Usage

```
mposterior(init, prior, lh = c("none", "gev", "gpd", "pp", "os"),
  method = c("Nelder-Mead", "BFGS", "CG", "L-BFGS-B", "SANN"),
  lower = -Inf, upper = Inf, control = list(), hessian = FALSE, ...)
```

Arguments

init	Numeric vector of length three/four, giving the initial values for the optimization.
prior	An object of class "evprior", constructed using prior.prob, prior.quant or prior.norm.
lh	A character string specifying the likelihood; either "gev" for gev, "gpd" for gpd, "os" for order statistics, "pp" for Poisson process or "none" for none (the default). The latter can be used to maximize the prior distribution.
method	The method to be used. See optim .
lower, upper	Bounds on the variables for the "L-BFGS-B" method. See optim .
control	A list of control parameters. See optim .
hessian	Logical. See optim .
...	Arguments to the likelihood. Should include data unless lh is "none". Should also include thresh and noy if lh is "pp". Should include the vector trend if a linear trend on the location is implemented. See pplik for details.

Value

A list. See [optim](#).

See Also

[pplik](#), [posterior](#), [prior.prob](#)

Description

Constructing MCMC samples of prior and posterior distributions for the location (with optional trend), scale and shape parameters under the gev, order statistics or point process models.

Usage

```
posterior(n, init, prior, lh = c("none", "gev", "gpd", "pp", "os"), ..., psd,
          burn = 0, thin = 1)
```

Arguments

n	The run-length; the number of sampled vectors (excluding <code>init</code>).
init	Numeric vector of length three/four, giving the initial values for the chain, taken to be iteration zero.
prior	An object of class "evprior", constructed using <code>prior.prob</code> , <code>prior.quant</code> or <code>prior.norm</code> .
lh	A character string specifying the likelihood; either "gev" for gev, "gpd" for gpd, "os" for order statistics, "pp" for Poisson process or "none" for none (the default). The latter can be used to sample from the prior distribution.
...	Arguments to the likelihood. Should include data unless lh is "none". Should also include <code>thresh</code> and <code>noy</code> if lh is "pp". Should include the vector <code>trend</code> if a linear trend on the location is implemented. See pplik for details.
psd	A vector of length three/four containing standard deviations for proposal distributions.
burn	The burn-in period (an integer); the first burn iterations (including <code>init</code>) are excluded from the chain.
thin	The thinning interval (an integer); iteration k is stored only if $k \bmod \text{thin}$ is zero (and if k greater than or equal to burn).

Details

See the user's guide.

Value

A matrix with $1 + \text{floor}(n/\text{thin}) - \text{burn}$ rows. Row labels give the iteration numbers. Column labels give parameter names.

An attribute `ar` is also returned. This is a matrix containing acceptance rates in the first row (the number of proposals accepted divided by the number of iterations) and "external rates" in the second (the number of proposals that resulted in a zero likelihood, divided by the number of iterations).

See Also

[pplik](#), [prior.prob](#)

Examples

```
data(rainfall)
prrain <- prior.quant(shape = c(38.9, 7.1, 47), scale = c(1.5, 6.3, 2.6))

n <- 100 ; t0 <- c(50.8, 1.18, 0.65) ; s <- c(25, .35, .07) ; b <- 20
rn.prior <- posterior(n, t0, prrain, "none", psd = s, burn = b)

t0 <- c(43.2, 7.64, 0.32) ; s <- c(2, .2, .07)
rn.post <- posterior(n, t0, prrain, "pp", data = rainfall, thresh = 40,
  noy = 54, psd = s, burn = b)
```

prior

Construction of Prior Distributions

Description

Constructing prior distributions for the location, scale and shape parameters using normal, beta or gamma distributions. A linear trend for the location can also be specified, using a prior normal distribution centered at zero for the trend parameter.

Usage

```
prior.prob(quant, alpha, trendsd = 0)
prior.quant(prob = 10^-(1:3), shape, scale, trendsd = 0)
prior.norm(mean, cov, trendsd = 0)
prior.loglognorm(mean, cov, trendsd = 0)
```

Arguments

quant, alpha	Numeric vectors of length three and four respectively. Beta prior distributions are placed on probability ratios corresponding to the quantiles given in quant.
prob, shape, scale	Numeric vectors of length three. Gamma prior distributions, with parameters shape and scale, are placed on quantile differences corresponding to the probabilities given in prob.
mean, cov	The prior distribution for the location, log(scale) and shape is taken to be trivariate normal, with mean mean (a numeric vector of length three) and covariance matrix cov (a symmetric positive definite three by three matrix).
trendsd	The standard deviation for the marginal normal prior distribution (with mean zero) placed on the linear trend parameter for the location. If this is zero (the default) a linear trend is not implemented.

Details

See the user's guide.

Value

Returns an object of class "evprior", which is essentially just a list of the arguments passed.

See Also

[posterior](#), [pplik](#)

Examples

```
mat <- diag(c(10000, 10000, 100))
prior.norm(mean = c(0,0,0), cov = mat, trendsd = 10)
prior.quant(shape = c(38.9,7.1,47), scale = c(1.5,6.3,2.6))
prior.prob(quant = c(85,88,95), alpha = c(4,2.5,2.25,0.25))
```

rainfall

Daily Aggregate Rainfall

Description

A numeric vector of length 20820 containing daily aggregate rainfall observations, in millimetres, recorded at a rain gauge in England over a 57 year period, beginning on a leap year. Three of these years contain only missing values.

Usage

```
data(rainfall)
```

Format

A vector containing 20820 observations.

Source

Unknown.

 rl.pred

Return Level Plots for GEV Predictive Distributions

Description

Produce return level plots depicting prior and posterior predictive gev distributions.

Usage

```
rl.pred(post, qlim, npy, lh = c("gev", "gpd"), period = 1, lty = 1, col = 1,
        xlab = "return period", ylab = "return level", ...)
```

Arguments

post	A Markov chain generated using posterior, containing samples from the corresponding prior/posterior distribution.
qlim	A vector of length two, giving the limits for the quantiles at which the predictive probabilities are calculated.
npy	The Number of observation Per Year (in average). If “gev” likelihood, “npy” is supposed to be equal to 1 i.e. annual maxima.
lh	The likelihood.
period	A vector of integers. One curve is plotted for each element of period. The <i>i</i> th curve depicts the probabilities that that quantiles will be exceeded over the next period[<i>i</i>] periods.
lty	Passed to <code>matplot</code> .
col	Passed to <code>matplot</code> .
xlab, ylab	Labels for the x and y axes.
...	Other arguments passed to <code>matplot</code> .

Details

See the user’s guide.

Value

The first two arguments to `matplot` are returned invisibly as a list.

If a linear trend on the location has been implemented, the plot corresponds to the distribution obtained when the trend parameter is zero.

See Also

[matplot](#), [posterior](#)

Description

Produce return level plots depicting prior and posterior distributions of gev quantiles.

Usage

```
rl.pst(post, npy, lh = c("gev", "gpd"), ci = 0.9, lty = c(2,1), col = c(2,1),
       xlab = "return period", ylab = "return level", ...)
```

Arguments

post	A Markov chain generated using posterior, containing samples from the corresponding prior/posterior distribution.
npy	The Number of observation Per Year (in average). If “gev” likelihood, “npy” is supposed to be equal to 1 i.e. annual maxima.
lh	The likelihood.
ci	The confidence coefficient for the plotted prior/posterior probability interval.
lty	Passed to <code>matplot</code> . The first and second values specify the line type of the probability interval and the median line respectively.
col	Passed to <code>matplot</code> . The first and second values specify the colour of the probability interval and the median line respectively.
xlab, ylab	Labels for the x and y axes.
...	Other arguments passed to <code>matplot</code> .

Details

See the user’s guide.

Value

The first two arguments to `matplot` are returned invisibly as a list.

If a linear trend on the location has been implemented, the plot corresponds to the distribution obtained when the trend parameter is zero.

See Also

[matplot](#), [posterior](#)

Index

- * **datasets**
 - rainfall, 9
- * **distribution**
 - dinfo, 3
- * **hplot**
 - rl.pred, 10
 - rl.pst, 11
- * **htest**
 - Accept Rate, 2
- * **manip**
 - mc.quant, 5
- * **models**
 - lh, 4
 - posterior, 7
 - prior, 8
- * **optimize**
 - mposterior, 6

Accept Rate, 2
ar.choice (Accept Rate), 2

dbeta, 3
dgamma, 3
dinfo, 3

gevlik(lh), 4
gpdlik(lh), 4

ibeta(dinfo), 3
igamma(dinfo), 3

lh, 4

matplotlib, 10, 11
mc.quant, 5
mposterior, 6

optim, 6
oslik(lh), 4

posterior, 2, 4–6, 7, 9–11

pplik, 6–9
pplik(lh), 4
prior, 8
prior.loglognorm, 2
prior.norm, 2
prior.prob, 2, 5, 6, 8
prior.quant, 2

rainfall, 9
rl.pred, 10
rl.pst, 11