Package 'HydroPortailStats'

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Type Package

Title 'HydroPortail' Statistical Functions

Version 1.0.3

Description
Statistical functions used in the French 'HydroPortail' <https://hydro.eaufrance.fr/>. This includes functions to estimate distributions, quantile curves and uncertainties, along with various other utilities.
Technical details are available (in French) in Renard (2016) <https://hal.inrae.fr/hal-02605318>.

License GPL-3

Encoding UTF-8

LazyData true

Depends R (>= 3.5.0)

Imports stats, graphics, evd, mvtnorm, numDeriv

RoxygenNote 7.2.3

Suggests knitr, rmarkdown

NeedsCompilation no

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R topics documented:

`distInfo` *Information on available distributions*

Description

A named list containing information (parameters, contraints, notes, warnings, etc.) for all available univariate distributions.

Usage

```
distInfo
```

Format

A named list where each element is itself a list containing:

parName parameters short names

parLongName parameters long names

parSymbol parameters typical symbols

constraints constraints on parameters

url link to more information

note notes

warning warnings: read carefully since this highlights in particular differences with "standard" parameterizations found in e.g. Wikipedia or R.

`Generate` *Random numbers generator*

Description

Generate random realizations from a distribution

Usage

```
Generate(dist, par, n = 1)
```

Arguments

`dist`	character, distribution name
`par`	numeric vector, parameter vector
`n`	integer, number of values to generate

Value

The generated values as a numeric vector.

Examples

```
Generate('Normal',c(0,1),10)
Generate('GEV',c(100,25,-0.2),10)
Generate('GEV',c(100,25,0.2),10)
Generate('Poisson',0.75,10)
```

GetCdf *Cumulative Distribution Function (cdf)*

Description

Evaluates the cdf of a distribution

Usage

```
GetCdf(y, dist, par)
```

Arguments

y	numeric, value at which the cdf is evaluated
dist	character, distribution name
par	numeric vector, parameter vector

Value

The cdf as a numeric.

Examples

```
GetCdf(0,'Normal',c(0,1))
GetCdf(200,'GEV',c(100,25,-0.2))
GetCdf(200,'GEV',c(100,25,0.2))
GetCdf(3,'Poisson',0.75)
```

GetEmpFreq *Empirical nonexceedance frequency*

Description

Computes the empirical nonexceedance frequency of the ith sorted value amongst n

Usage

```
GetEmpFreq(i, n, formula = "Hazen")
```

Arguments

i	integer or integer vector, observation rank(s)
n	integer, number of observations
formula	character, formula, available: 'Hazen', 'Standard', 'MinusOne', 'Weibull', 'Benard', 'Cunnane', 'Beard', 'Blom', 'Gringorten', 'Landwehr', 'Tukey'.

Value

The nonexceedance frequency.

Examples

```
GetEmpFreq(i=1:10,n=10)
GetEmpFreq(i=1:10,n=10,formula='Standard')
GetEmpFreq(i=1:10,n=10,formula='MinusOne')
GetEmpFreq(i=1:10,n=10,formula='Cunnane')
```

GetEstimate_BAY *Bayesian estimation of a distribution*

Description

Returns MCMC samples from the posterior distribution.

Usage

```
GetEstimate_BAY(
  y,
  dist,
  prior,
  par0,
  mult = 0.1,
  eps = 0.1,
  batch.length = 100,
  batch.n = 100,
  moverate.min = 0.1,
  moverate.max = 0.5,
  mult.down = 0.9,
  mult.up = 1.1
)
```

Arguments

y	numeric vector, data
dist	character, distribution name
prior	list of lists, prior distributions. For each parameter to be estimated, the prior is a list of the form pr=list(dist=..., par=...). See example below.
par0	numeric vector, initial parameter guess. You may use GetEstimate_ROUGH().
mult	numeric, initial jump standard deviations are set to mult * abs(par0)
eps	numeric, where par0 is zero, initial jump standard deviations are set to eps (to avoid jumps of size zero)
batch.length	integer, MCMC parameter: length of each non-adaptive batch

batch.n	integer, MCMC parameter: number of batches (= adaptation period). Total number of simulations is nsim=batch.n*batch.length
moverate.min	numeric in (0;1), MCMC parameter: lower bound for the desired move rate interval
moverate.max	numeric in (0;1), MCMC parameter: upper bound for the desired move rate interval
mult.down	numeric in (0;1), MCMC parameter: multiplication factor used to decrease jump size when move rate is too low.
mult.up	numeric (>1, avoid 1/mult.down), MCMC parameter: multiplication factor used to increase jump size when move rate is too high.

Value

A list with the following components:

x	numeric matrix nsim*length(x0), MCMC simulations
fx	numeric vector, corresponding values f(x)

Examples

```
y=c(9.2,9.5,11.4,9.5,9.4,9.6,10.5,11.1,10.5,10.4)
prior1=list(dist='FlatPrior',par=NULL)
prior2=list(dist='LogNormal',par=c(1,1))
prior3=list(dist='Normal',par=c(0,0.25))
prior=list(prior1,prior2,prior3)
par0=GetEstimate_ROUGH(y,'GEV')$par
mcmc=GetEstimate_BAY(y,'GEV',prior,par0,batch.length=50,batch.n=50)
graphicalpar=par(mfrow=c(2,3))
plot(mcmc$x[,1],type='l'); plot(mcmc$x[,2],type='l'); plot(mcmc$x[,3],type='l')
hist(mcmc$x[,1]); hist(mcmc$x[,2]); hist(mcmc$x[,3])
par(graphicalpar)
```

GetEstimate_HYDRO2 *Hydro2 estimate of a distribution*

Description

Returns an estimate of a distribution as it was computed in the old HYDRO2 software. Only available for distributions 'Normal', 'LogNormal', and 'Gumbel'.

Usage

```
GetEstimate_HYDRO2(y, dist)
```

Arguments

y	numeric vector, data
dist	character, distribution name

Value

A list with the following components:

par	numeric vector, estimated parameter vector.
obj	numeric, objective fonction (NA for this estimate)
ok	logical, did computation succeed?
err	integer, error code (0 if ok)
message	error message

Examples

```
y=c(9.2,9.5,11.4,9.5,9.4,9.6,10.5,11.1,10.5,10.4)
GetEstimate_HYDRO2(y,'Normal')
GetEstimate_HYDRO2(y,'LogNormal')
GetEstimate_HYDRO2(y,'Gumbel')
GetEstimate_HYDRO2(y,'GEV')
GetEstimate_HYDRO2(y,'Poisson')
```

GetEstimate_LMOM *L-Moment estimate of a distribution*

Description

Returns an estimate of a distribution using the method of L-moments. Note that for some distributions, this is not strictly speaking the L-moment estimate: For LogNormal and LogPearsonIII, the L-moment estimate of log(data) is used.

Usage

```
GetEstimate_LMOM(y, dist)
```

Arguments

y	numeric vector, data
dist	character, distribution name

Value

A list with the following components:

par	numeric vector, estimated parameter vector.
obj	numeric, objective fonction (NA for this estimate)
ok	logical, did computation succeed?
err	integer, error code (0 if ok)
message	error message

Examples

```
y=c(9.2,9.5,11.4,9.5,9.4,9.6,10.5,11.1,10.5,10.4)
GetEstimate_LMOM(y,'Normal')
GetEstimate_LMOM(y,'LogNormal')
GetEstimate_LMOM(y,'Gumbel')
GetEstimate_LMOM(y,'GEV')
GetEstimate_LMOM(y,'Poisson')
```

`GetEstimate_ML` *Maximum-likelihood estimate of a distribution*

Description

Returns an estimate of a distribution using the method of maximum likelihood.

Usage

```
GetEstimate_ML(
  y,
  dist,
  par0 = NULL,
  method = optim_method_def,
  lower = -Inf,
  upper = Inf
)
```

Arguments

`y`	numeric vector, data
`dist`	character, distribution name
`par0`	numeric vector, initial parameter guess. You may use GetEstimate_ROUGH().
`method`	character, method used to maximize likelihood, see ?optim
`lower`	numeric vector, lower bounds, see ?optim
`upper`	numeric vector, upper bounds, see ?optim

Value

A list with the following components:

`par`	numeric vector, estimated parameter vector.
`obj`	numeric, objective fonction (maximum log-likelihood)
`ok`	logical, did computation succeed?
`err`	integer, error code (0 if ok)
`message`	error message

Examples

```
y=c(9.2,9.5,11.4,9.5,9.4,9.6,10.5,11.1,10.5,10.4)
GetEstimate_ML(y,'Normal')
GetEstimate_ML(y,'LogNormal')
GetEstimate_ML(y,'Gumbel')
GetEstimate_ML(y,'Gumbel',par0=GetEstimate_ROUGH(y,'Gumbel')$par)
GetEstimate_ML(y,'GEV',par0=GetEstimate_ROUGH(y,'GEV')$par)
GetEstimate_ML(y,'Poisson')
```

GetEstimate_MOM *Moment estimate of a distribution*

Description

Returns an estimate of a distribution using the method of moments. Note that for some distributions, this is not strictly speaking the moment estimate. For LogPearsonIII for instance, the moment estimate of log(data) is used. Also for GPD3, the threshold is estimated as min(data).

Usage

```
GetEstimate_MOM(y, dist)
```

Arguments

y	numeric vector, data
dist	character, distribution name

Value

A list with the following components:

par	numeric vector, estimated parameter vector.
obj	numeric, objective fonction (NA for this estimate)
ok	logical, did computation succeed?
err	integer, error code (0 if ok)
message	error message

Examples

```
y=c(9.2,9.5,11.4,9.5,9.4,9.6,10.5,11.1,10.5,10.4)
GetEstimate_MOM(y,'Normal')
GetEstimate_MOM(y,'LogNormal')
GetEstimate_MOM(y,'Gumbel')
GetEstimate_MOM(y,'GEV')
GetEstimate_MOM(y,'Poisson')
```

`GetEstimate_ROUGH` *Rough estimate of a distribution*

Description

Returns a rough first-guess estimate of a distribution. This estimate may be poor but it solely aims at being used as a starting point for more advanced estimation approaches (e.g. max-likelihood or Bayesian). It is therefore chosen as an easy-to-compute explicit formula, robust and error-proof.

Usage

```
GetEstimate_ROUGH(y, dist)
```

Arguments

`y`	numeric vector, data
`dist`	character, distribution name

Value

A list with the following components:

`par`	numeric vector, estimated parameter vector.
`obj`	numeric, objective fonction (NA for this estimate)
`ok`	logical, did computation succeed?
`err`	integer, error code (0 if ok)
`message`	error message

Examples

```
y=c(9.2,9.5,11.4,9.5,9.4,9.6,10.5,11.1,10.5,10.4)
GetEstimate_ROUGH(y,'Normal')
GetEstimate_ROUGH(y,'LogNormal')
GetEstimate_ROUGH(y,'Gumbel')
GetEstimate_ROUGH(y,'GEV')
GetEstimate_ROUGH(y,'Poisson')
```

GetParFeas *Parameter feasibility*

Description

Evaluates whether a parameter vector is feasible (for instance, are scale parameters >0 ?)

Usage

```
GetParFeas(dist, par)
```

Arguments

dist	character, distribution name
par	numeric vector, parameter vector

Value

A logical.

Examples

```
# Feasible
GetParFeas('Normal',c(0,1))
# Not feasible because second parameter (standard deviation) is negative
GetParFeas('Normal',c(0,-1))
```

GetParName *Parameter names.*

Description

Returns the names of the parameters of a distribution, in French (default) or English.

Usage

```
GetParName(dist, lang = "fr")
```

Arguments

dist	character, distribution name
lang	character, language ('en' or 'fr')

Value

A character vector.

Examples

```
GetParName('Normal')
GetParName('GEV')
GetParName('GEV',lang='en')
```

GetParNumber *Number of parameters.*

Description

Returns the number of parameters of a distribution.

Usage

```
GetParNumber(dist)
```

Arguments

dist	character, distribution name

Value

An integer.

Examples

```
GetParNumber('Normal')
GetParNumber('GEV')
```

GetPdf *Probability Density Function (pdf)*

Description

Evaluates the pdf of a distribution

Usage

```
GetPdf(y, dist, par, log = FALSE)
```

Arguments

y	numeric, value at which the pdf is evaluated
dist	character, distribution name
par	numeric vector, parameter vector
log	logical, returns log-pdf if TRUE

Value

The pdf or the log-pdf as a numeric.

Examples

```
GetPdf(0,'Normal',c(0,1))
GetPdf(200,'GEV',c(100,25,-0.2))
GetPdf(200,'GEV',c(100,25,0.2))
GetPdf(3,'Poisson',0.75)
```

GetQfromT *Get quantile from return period*

Description

Compute the T-quantile from the results of Hydro3_Estimation()

Usage

```
GetQfromT(RP, H3, options = options_def)
```

Arguments

RP	numeric, return period
H3	list, resulting from a call to Hydro3_Estimation()
options	list, see ?Hydro3_Estimation

Value

A list with the following components:

q	numeric, quantile
IC	numeric vector, uncertainty interval

Examples

```
y=stats::rnorm(50)
H3=Hydro3_Estimation(y,'Normal')
GetQfromT(100,H3)
```

GetQuantile *Quantile Function*

Description

Evaluates the quantiles of a distribution

Usage

```
GetQuantile(p, dist, par)
```

Arguments

p	numeric in (0;1), nonexceedance probability
dist	character, distribution name
par	numeric vector, parameter vector

Value

The p-quantile as a numeric.

Examples

```
GetQuantile(0.99,'Normal',c(0,1))
GetQuantile(0.99,'GEV',c(100,25,-0.2))
GetQuantile(0.99,'GEV',c(100,25,0.2))
GetQuantile(0.99,'Poisson',0.75)
```

GetReducedVariate *Reduced variate*

Description

Returns the 'reduced variate' that is used in some quantile plots (see e.g. quantile curve on Gumbel paper)

Usage

```
GetReducedVariate(p, dist)
```

Arguments

p	numeric in (0;1), nonexceedance probability
dist	character, distribution name

Value

The reduced variate with nonexceedance probability p.

Examples

```
GetReducedVariate(0.99,'Normal')
GetReducedVariate(0.99,'Gumbel')
GetReducedVariate(0.99,'GEV')
GetReducedVariate(0.99,'Poisson')
```

GetTfromQ *Get return period from value*

Description

Compute the return period associated with a value from the results of Hydro3_Estimation()

Usage

```
GetTfromQ(q, H3, options = options_def)
```

Arguments

q	numeric, value
H3	list, resulting from a call to Hydro3_Estimation()
options	list, see ?Hydro3_Estimation

Value

A list with the following components:

RP	numeric, return period
IC	numeric vector, uncertainty interval

Examples

```
y=stats::rnorm(50)
H3=Hydro3_Estimation(y,'Normal')
GetTfromQ(3,H3)
```

`GetUncertainty_ML` *Maximum-likelihood estimation of uncertainty*

Description

Returns an estimate of the uncertainty around the maximum-likelihood estimate, in the form of a covariance matrix and some simulations from the corresponding Gaussian distribution.

Usage

```
GetUncertainty_ML(y, dist, par, nsim = nsim_def)
```

Arguments

`y`	numeric vector, data
`dist`	character, distribution name
`par`	numeric vector, estimated parameter (using GetEstimate_ML()).
`nsim`	integer, number of simulated parameter replicates.

Value

A list with the following components:

`cov`	numeric matrix npar*npar, covariance matrix.
`sim`	numeric matrix nsim*npar, simulated parameter replicates.
`ok`	logical, did computation succeed?
`err`	integer, error code (0 if ok)
`message`	error message

Examples

```
y=c(9.2,9.5,11.4,9.5,9.4,9.6,10.5,11.1,10.5,10.4)
estim=GetEstimate_ML(y,'Gumbel',par0=GetEstimate_ROUGH(y,'Gumbel')$par)
GetUncertainty_ML(y,'Gumbel',par=estim$par)
```

`Hydro3_Estimation` *Hydro3 estimation*

Description

Main estimation function used in the HydroPortail. In short, this function estimates a distribution and the associated uncertainty, and returns all needed information to display and plot the results (parameter estimates, quantile curves, etc.)

Usage

```
Hydro3_Estimation(
  y,
  dist,
  Emeth = Emeth_def,
  Umeth = Umeth_def,
  options = options_def,
  mcmcoptions = mcmcoptions_def,
  prior = GetDefaultPrior(GetParNumber(dist)),
  do.KS = TRUE,
  do.MK = TRUE,
  do.Pettitt = TRUE
)
```

Arguments

`y`	numeric vector, data.
`dist`	character, distribution name. See dataset distInfo for a description of available distributions. In particular, type names(distInfo) for the list of available distributions, and distInfo[['GEV']] for more information on a particular distribution (here, GEV).
`Emeth`	character, estimation method. Default is 'LMOM' (L-Moments), available: 'MOM' (Moments), 'ML' (Maximum Likelihood), 'BAY' (Bayesian).
`Umeth`	character, uncertainty quantification method. Default is 'PBOOT' (Parametric bootstrap), available: 'BOOT' (Bootstrap, not recommended), 'NONE', 'ML' (only usable when Emeth='ML' as well), and 'BAY' (the only usable method when Emeth='BAY').
`options`	list, options, see details below.
`mcmcoptions`	list, MCMC options, see details below.
`prior`	list, prior distributions, only used when Emeth='BAY'. See ?GetEstimate_BAY for details.
`do.KS, do.MK, do.Pettitt`	logical, perform KS/MK/Pettitt tests?

Details

The argument 'options' allows controlling various properties of the analysis and results. It is a list with the following components:

- FreqFormula, character, formula for computing nonexceedance frequency, see ?GetEmpFreq.
- pgrid, numeric vector, probabilities defining the x values where pdf f(x) and cdf F(x) are computed. These x values are quantiles from the estimated distribution with probabilities pgrid.
- Tgrid, numeric vector, return periods where quantile function q(T) is computed.
- IClevel, numeric, level of uncertainty interval.
- p2T, numeric, conversion factor between nonexceedance probability p and return period T. p=1-1/(p2T*T). In general p2T=1 but for a peak-over-threshold approach leading to say 3 events per year on average, p2T=3.
- invertT, logical, when invertT=TRUE, LARGE return periods correspond to SMALL data values. This is typically used for low-flow statistics.
- splitZeros, logical, when splitZeros=TRUE zero and negative values are removed from the data y before estimating the distribution,and are used to estimate the probability of zeros p0. This is typically used for low-flow statistics to estimate the probability of zero streamflow.
- lang, chanracter, language ('fr' or 'en').
- nsim, integer, number of replicated parameters representing uncertainty.

The argument 'mcmcoptions' is only used when Emeth='BAY' and is a list controlling MCMC properties:

- mult, numeric, see ?Metropolis_OAAT_adaptive
- eps, numeric, see ?Metropolis_OAAT_adaptive
- batch.length, integer, see ?Metropolis_OAAT_adaptive
- batch.n, integer, see ?Metropolis_OAAT_adaptive
- moverate.min, numeric, see ?Metropolis_OAAT_adaptive
- moverate.max, numeric, see ?Metropolis_OAAT_adaptive
- mult.down, numeric, see ?Metropolis_OAAT_adaptive
- mult.up, numeric, see ?Metropolis_OAAT_adaptive
- burn, numeric, burn-in factor, e.g. if burn=0.2 the first 20 percents of MCMC samples are discarded
- slim, integer, sliming factor, e.g. if slim=5 only one MCMC sample every 5 is kept (after burn-in)

Value

A list with the following components:

`dist`	character, estimated distribution.
`ok`	logical, did estimation succeed?
`err`	integer, error code (0 if ok).

message	error message.
empirical	data frame, sorted data and empirical estimates (nonexceedance frequency, return period and reduced variate)
pcdf	data frame, estimated pdf and cdf
quantile	data frame, estimated quantiles and uncertainty intervals
par	data frame, estimated parameters and uncertainty intervals
KS	list, result of the Kolmogorov-Smirnov test, see ?KS
MK	list, result of the Mann-Kendall test, see ?MK
Pettitt	list, result of the Pettitt test, see ?Pettitt
u	list, parameter uncertainty in the form of a covariance matrix ($cov) and simulated parameter replicates ($sim). Also contains error-handling flags $ok, $err and $message.

Examples

```
y=stats::rnorm(50)
H3=Hydro3_Estimation(y,'Normal')
H3=Hydro3_Estimation(y,'GEV',Emeth='ML',Umeth='ML')
```

Hydro3_Plot *Hydro3 plot*

Description

Plot summarizing the results of Hydro3_Estimation()

Usage

```
Hydro3_Plot(
  H3,
  useU = FALSE,
  lwd = 2,
  cex.lab = 2,
  cex.axis = 1.3,
  pch = 19,
  col = "red"
)
```

Arguments

H3	list, resulting from a call to Hydro3_Estimation()
useU	logical, use reduced variate u rather than return period T in plots?
lwd, cex.lab, cex.axis, pch	numeric, graphical parameters, see ?graphics::par
col	character, graphical parameter (points color)

Value

nothing (just creates a plot)

Examples

```
y=stats::rnorm(50)
H3=Hydro3_Estimation(y,'Normal')
Hydro3_Plot(H3)
```

KS *Kolmogorov-Smirnov Test*

Description

Applies a one-sample Kolmogorov-Smirnov test (see ?stats::ks.test)

Usage

```
KS(y, dist, par)
```

Arguments

y	numeric vector, data
dist	character, distribution name
par	numeric vector, parameter vector

Value

A list with the following components:

pval	numeric, p-value of the test
stat	numeric, test statistics
xtra	numeric, xtra information: empty for this test

Examples

```
y=stats::rnorm(20)
KS(y,'Normal',c(0,1))
KS(y,'Normal',c(1,1))
KS(y,'Gumbel',c(0,1))
```

mcmcoptions_def *Default MCMC options*

Description

A named list containing the default MCMC options. See ?Hydro3_Estimation for more details.

Usage

```
mcmcoptions_def
```

Format

An object of class `list` of length 10.

Metropolis_OAAT *One-At-A-Time Metropolis sampler*

Description

Performs nsim iterations of the OAAT Metropolis sampler (simulated vector is updated one component at a time). a.k.a block Metropolis sampler with blocks of length one. Sometimes also called 'Metropolis-within-Gibbs'.

Usage

```
Metropolis_OAAT(f, x0, nsim, sdjump, ...)
```

Arguments

`f`	function, log-pdf of the target distribution
`x0`	numeric vector, starting point
`nsim`	integer, number of simulations
`sdjump`	numeric vector, standard deviation of the Gaussian jump for each component
`...`	other arguments passed to f

Value

A list with the following components:

`x`	numeric matrix nsim*length(x0), MCMC simulations
`fx`	numeric vector, corresponding values f(x)
`moverate`	numeric vector, move rate associated with each component

Examples

```
# Bivariate target distribution: beta(0.8,0.4) X exp(1)
f=function(x){stats::dbeta(x[1],0.8,0.4,log=TRUE)+stats::dexp(x[2],log=TRUE)}
x0=c(0.5,2)
sdjump=c(0.5,1)
mcmc=Metropolis_OAAT(f,x0,1000,sdjump)
graphicalpar=par(mfrow=c(1,3))
plot(mcmc$x);hist(mcmc$x[,1]); hist(mcmc$x[,2])
par(graphicalpar)
```

Metropolis_OAAT_adaptive

Adaptive One-At-A-Time Metropolis sampler

Description

Performs nsim iterations of the Adaptive version of the OAAT Metropolis sampler (see ?Metropolis_OAAT). Adaptation is performed by monitoring move rates every batch.length iterations, and increasing / decreasing the jump standard deviation if the move rate is not within specified bounds.

Usage

```
Metropolis_OAAT_adaptive(
  f,
  x0,
  sdjump,
  ...,
  batch.length = 100,
  batch.n = 100,
  moverate.min = 0.1,
  moverate.max = 0.5,
  mult.down = 0.9,
  mult.up = 1.1
)
```

Arguments

f	function, log-pdf of the target distribution
x0	numeric vector, starting point
sdjump	numeric vector, initial standard deviation of the Gaussian jump for each component
...	other arguments passed to f
batch.length	integer, length of each non-adaptive batch
batch.n	integer, number of batches (= adaptation period). Total number of simulations is nsim=batch.n*batch.length

moverate.min	numeric in (0;1), lower bound for the desired move rate interval
moverate.max	numeric in (0;1), upper bound for the desired move rate interval
mult.down	numeric in (0;1), multiplication factor used to decrease jump size when move rate is too low.
mult.up	numeric (>1, avoid 1/mult.down) multiplication factor used to increase jump size when move rate is too high.

Value

A list with the following components:

x	numeric matrix nsim*length(x0), MCMC simulations
fx	numeric vector, corresponding values f(x)

Examples

```
# Bivariate target distribution: beta(0.8,0.4) X exp(1)
f=function(x){stats::dbeta(x[1],0.8,0.4,log=TRUE)+stats::dexp(x[2],log=TRUE)}
x0=c(0.5,2)
sdjump=c(0.5,1)
mcmc=Metropolis_OAAT_adaptive(f,x0,sdjump)
graphicalpar=par(mfrow=c(1,3))
plot(mcmc$x);hist(mcmc$x[,1]); hist(mcmc$x[,2])
par(graphicalpar)
```

Metropolis_OAAT_jump *One-At-A-Time Metropolis sampler*

Description

Performs a single iteration of the OAAT Metropolis sampler (simulated vector is updated one component at a time). a.k.a block Metropolis sampler with blocks of length one. Sometimes also called 'Metropolis-within-Gibbs'.

Usage

```
Metropolis_OAAT_jump(f, x0, fx0, sdjump, ...)
```

Arguments

f	function, log-pdf of the target distribution
x0	numeric vector, starting point
fx0	numeric, f(x0)
sdjump	numeric vector, standard deviation of the Gaussian jump for each component
...	other arguments passed to f

Value

A list with the following components:

x	numeric vector, updated point after the iteration
fx	numeric, updated value f(x)
move	logical vector, TRUE for components of the vector x that changed

Examples

```
# Bivariate target distribution: beta(2,10) X exp(1)
f=function(x){stats::dbeta(x[1],2,10,log=TRUE)+stats::dexp(x[2],log=TRUE)}
x0=c(0.5,0.5)
fx0=f(x0)
sdjump=c(0.1,0.1)
Metropolis_OAAT_jump(f,x0,fx0,sdjump)
```

MK *Mann-Kemdall Test*

Description

Applies the Mann-Kendall trend test

Usage

```
MK(y)
```

Arguments

y	numeric vector, data

Value

A list with the following components:

pval	numeric, p-value of the test
stat	numeric, test statistics
xtra	numeric, xtra information: empty for this test

Examples

```
y=stats::rnorm(50)
MK(y)
y=y+0.1*(1:length(y))
MK(y)
```

options_def *Default estimation options*

Description

A named list containing the default estimation options. See ?Hydro3_Estimation for more details.

Usage

```
options_def
```

Format

An object of class `list` of length 9.

Pettitt *Pettitt Test*

Description

Applies the Pettitt step-change test

Usage

```
Pettitt(y)
```

Arguments

`y`	numeric vector, data

Value

A list with the following components:

`pval`	numeric, p-value of the test
`stat`	numeric, test statistics
`xtra`	numeric, xtra information: position of the step change

Examples

```
y=stats::rnorm(50)
Pettitt(y)
y[26:50]=y[26:50]+2
Pettitt(y)
```

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