# Package ‘HKprocess’

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**Type** Package

**Title** Hurst-Kolmogorov Process

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**Imports** MCMCpack (>= 1.3-3), gtools(>= 3.5.0)

**Depends** R (>= 3.2.3)

**Suggests** ltsa (>= 1.4.6), FGN (>= 2.0-12)

**Description** Methods to make inference about the Hurst-Kolmogorov and the AR(1) process.

**License** GPL-3

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**NeedsCompilation** yes

**Repository** CRAN

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## R topics documented:

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`acfHKp` *Autocorrelation of HKp.*

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## Description

The Hurst-Kolmogorov stochastic process (HKp) is a persistent process. The term HKp is an alternative of the term Fractional Gaussian Noise (FGN, see Koutsoyiannis 2010). Its autocorrelation function (ACF) is given by eq.16 (Koutsoyiannis 2002).

## Usage

```
acfHKp(H,maxlag)
```

## Arguments

| | |
|---|---|
| `H` | Hurst parameter |
| `maxlag` | ACF computed at lags 0,1,...,maxlag |

## Value

Vector of autocorrelations at lags 0,1,...,maxlag.

## Note

The parameter H should be in (0,1), see Koutsoyiannis (2002)

## Author(s)

Hristos Tyralis

## References

Koutsoyiannis, D. (2002) The Hurst phenomenon and fractional Gaussian noise made easy, *Hydrological Sciences Journal* **47(4)**, 573–595. `http://dx.doi.org/10.1080/02626660209492961`.

Koutsoyiannis, D. (2010) A random walk on water, *Hydrology and Earth System Sciences* **14**, 585–601. `http://dx.doi.org/10.5194/hess-14-585-2010`.

## Examples

```
# Compute the ACF at lags 0,1,...,10 when H = 0.8.

acfHKp(0.8,10)
```

---

`inferf` *Posterior distribution of the $\phi$ parameter of the AR(1) process, using an Accept-Reject algorithm.*

---

## Description

The function inferf is used to create a sample from the posterior distribution of $\phi$. The function uses the eq.10 (Tyralis and Koutsoyiannis 2014) to make inference on $\phi$ and an Accept-Reject algorithm (see Robert and Casella 2004, Algorithm A.4).

## Usage

```
inferf(data,n,add = 0.001,minu = -0.999,maxu = 0.999)
```

## Arguments

| | |
|---|---|
| `data` | time series data |
| `n` | The size of the simulated sample |
| `add` | A number added to the maximum value of the natural logarithm of eq.10, to avoid bugs of the Accept-Reject algorithm due to computation errors |
| `minu` | A lower bound to the parameter $\phi$ |
| `maxu` | An upper bound to the parameter $\phi$ |

## Value

Vector with the simulated sample.

## Author(s)

Hristos Tyralis

## References

Robert C.P., Casella G. (2004) *Monte Carlo Statistical Methods*, New York: Springer.

Tyralis H., Koutsoyiannis, D. (2014) A Bayesian statistical model for deriving the predictive distribution of hydroclimatic variables, *Climate Dynamics* **42(11-12)**, 2867–2883. http://dx.doi.org/10.1007/s00382-013-1804-y.

## Examples

```
# Posterior distribution of the phi parameter of the AR(1) process for the Nile
# time series.

set.seed(12345)

samp.sim <- inferf(Nile,500)
```

```
hist(samp.sim,breaks = 20,main = expression(paste("Histogram of ",phi)),
xlab = expression(phi))
```

---

inferfmetrop — *Posterior distribution of the $\phi$ parameter of the AR(1) process, using a Metropolis algorithm.*

---

## Description

The function inferfmetrop is used to create a sample from the posterior distribution of $\phi$. The function uses the eq.10 in Tyralis and Koutsoyiannis (2014) and a Metropolis algorithm to make inference on $\phi$.

## Usage

```
inferfmetrop(data,theta.init = 0.7,burnin = 500,mcmc = 20000,thin = 1,tune = 1,
verbose = 0,seed = NA)
```

## Arguments

| | |
|---|---|
| `data` | time series data |
| `theta.init` | Starting values for the sampling. Must be of the appropriate dimension. It must also be the case that `fun(theta.init, ...)` is greater than `-Inf`. |
| `burnin` | The number of burn-in iterations for the sampler. |
| `mcmc` | The number of MCMC iterations after burnin. |
| `thin` | The thinning interval used in the simulation. The number of MCMC iterations must be divisible by this value. |
| `tune` | The tuning parameter for the Metropolis sampling. Can be either a positive scalar or a $k$-vector, where $k$ is the length of $\theta$. |
| `verbose` | A switch which determines whether or not the progress of the sampler is printed to the screen. If `verbose` is greater than 0 the iteration number, the $\theta$ vector, the function value, and the Metropolis acceptance rate are sent to the screen every `verbose`th iteration. |
| `seed` | The seed for the random number generator. If NA, the Mersenne Twister generator is used with default seed 12345; if an integer is passed it is used to seed the Mersenne twister. The user can also pass a list of length two to use the L'Ecuyer random number generator, which is suitable for parallel computation. The first element of the list is the L'Ecuyer seed, which is a vector of length six or NA (if NA a default seed of `rep(12345,6)` is used). The second element of list is a positive substream number. See the MCMCpack specification for more details. |

## Value

An mcmc object that contains the posterior sample. This object can be summarized by functions provided by the coda package.

## Note

The Metropolis algorithm uses the function MCMCmetrop1R from the package MCMCpack (Martin et al. 2011).

## Author(s)

Hristos Tyralis

## References

Martin A.D., Quinn K.M., Park J.H. (2011) MCMCpack: Markov chain Monte Carlo in R, *Journal of Statistical Software* **42(9)**, 1–21. http://www.jstatsoft.org/v42/i09.

Tyralis H., Koutsoyiannis, D. (2014) A Bayesian statistical model for deriving the predictive distribution of hydroclimatic variables, *Climate Dynamics* **42(11-12)**, 2867–2883. http://dx.doi.org/10.1007/s00382-013-1804-y.

## Examples

```
# Posterior distribution of the phi parameter of the AR(1) process for the Nile
# time series.

samp.sim <- inferfmetrop(Nile,theta.init = 0.7,burnin = 500,mcmc = 500,thin = 1,
tune = 1,seed = 12345)

hist(samp.sim,breaks = 20,main = expression(paste("Histogram of ",phi)),
xlab = expression(phi))
```

---

# inferH — *Posterior distribution of the H parameter of the HKp using an Accept-Reject algorithm.*

---

## Description

The function inferH is used to create a sample from the posterior distribution of H. The function uses the eq.10 (Tyralis and Koutsoyiannis 2014) to make inference on H and an Accept-Reject algorithm (see Robert and Casella 2004, Algorithm A.4).

## Usage

```
inferH(data,n,add = 0.001,minu = 0.001,maxu = 0.999)
```

## Arguments

| | |
|---|---|
| `data` | time series data |
| `n` | The size of the simulated sample |
| `add` | A number added to the maximum value of the natural logarithm of eq.10, to avoid bugs of the Accept-Reject algorithm due to computation errors |

| | |
|---|---|
| minu | A lower bound to the parameter H |
| maxu | An upper bound to the parameter H |

## Value

Vector with the simulated sample.

## Author(s)

Hristos Tyralis

## References

Robert C.P., Casella G. (2004) *Monte Carlo Statistical Methods*, New York: Springer.

Tyralis H., Koutsoyiannis, D. (2014) A Bayesian statistical model for deriving the predictive distribution of hydroclimatic variables, *Climate Dynamics* **42(11-12)**, 2867–2883. http://dx.doi.org/10.1007/s00382-013-1804-y.

## Examples

```
# Posterior distribution of the H parameter of the HKp for the Nile time series.

set.seed(12345)

samp.sim <- inferH(Nile,500)

hist(samp.sim,breaks = 20,main = "Histogram of H",xlab = "H")
```

---

# inferHmetrop *Posterior distribution of the H parameter of the HKp, using a Metropolis algorithm.*

---

## Description

The function inferfmetrop is used to create a sample from the posterior distribution of H. The function uses the eq.10 in Tyralis and Koutsoyiannis (2014) and a Metropolis algorithm to make inference on H.

## Usage

```
inferHmetrop(data, theta.init=0.7, burnin = 500, mcmc = 20000, thin = 1,
tune = 1,verbose = 0,seed = NA)
```

## Arguments

| | |
|---|---|
| `data` | time series data |
| `theta.init` | Starting values for the sampling. Must be of the appropriate dimension. It must also be the case that `fun(theta.init, ...)` is greater than `-Inf`. |
| `burnin` | The number of burn-in iterations for the sampler. |
| `mcmc` | The number of MCMC iterations after burnin. |
| `thin` | The thinning interval used in the simulation. The number of MCMC iterations must be divisible by this value. |
| `tune` | The tuning parameter for the Metropolis sampling. Can be either a positive scalar or a $k$-vector, where $k$ is the length of $\theta$. |
| `verbose` | A switch which determines whether or not the progress of the sampler is printed to the screen. If `verbose` is greater than 0 the iteration number, the $\theta$ vector, the function value, and the Metropolis acceptance rate are sent to the screen every `verbose`th iteration. |
| `seed` | The seed for the random number generator. If NA, the Mersenne Twister generator is used with default seed 12345; if an integer is passed it is used to seed the Mersenne twister. The user can also pass a list of length two to use the L'Ecuyer random number generator, which is suitable for parallel computation. The first element of the list is the L'Ecuyer seed, which is a vector of length six or NA (if NA a default seed of `rep(12345,6)` is used). The second element of list is a positive substream number. See the MCMCpack specification for more details. |

## Value

An mcmc object that contains the posterior sample. This object can be summarized by functions provided by the coda package.

## Note

The Metropolis algorithm uses the function MCMCmetrop1R from the package MCMCpack (Martin et al. 2011).

## Author(s)

Hristos Tyralis

## References

Martin A.D., Quinn K.M., Park J.H. (2011) MCMCpack: Markov chain Monte Carlo in R, *Journal of Statistical Software* **42(9)**, 1–21. http://www.jstatsoft.org/v42/i09.

Tyralis H., Koutsoyiannis, D. (2014) A Bayesian statistical model for deriving the predictive distribution of hydroclimatic variables, *Climate Dynamics* **42(11-12)**, 2867–2883. http://dx.doi.org/10.1007/s00382-013-1804-y.

### Examples

```
# Posterior distribution of the H parameter of the HKp for the Nile time series.

samp.sim <- inferHmetrop(Nile,theta.init = 0.7,burnin = 500,mcmc = 500,thin = 1,
tune = 1,seed = 12345)

hist(samp.sim,breaks = 20,main = "Histogram of H",xlab = "H")
```

---

## infermsfmetrop — *Bayesian inference for $\mu$ and $\sigma$^2 for the AR(1) process.*

---

### Description

The function infermsmetrop is used to create a sample from the posterior distribution of $\mu$ and $\sigma$^2, using eqs. 8,9 in Tyralis and Koutsoyiannis (2014) for the AR(1) process.

### Usage

```
infermsfmetrop(fbayes,data)
```

### Arguments

| | |
|---|---|
| `data` | time series data |
| `fbayes` | phi parameter simulation sample, should be a vector |

### Value

A matrix with two columns, the first corresponding to the sample of $\mu$ and the second corresponding to the sample of $\sigma$^2.

### Author(s)

Hristos Tyralis

### References

Tyralis H., Koutsoyiannis, D. (2014) A Bayesian statistical model for deriving the predictive distribution of hydroclimatic variables, *Climate Dynamics* **42(11-12)**, 2867–2883. http://dx.doi.org/10.1007/s00382-013-1804-y.

### Examples

```
# Posterior distribution of the mu and sigma parameters of the AR(1) process for
# the Nile time series.

set.seed(12345)

samp.sim1 <- inferf(Nile,500)
```

```
samp.sim2 <- infermsfmetrop(samp.sim1,Nile)

hist(samp.sim2[,1],breaks = 20,main = expression(paste("Histogram of ",mu)),
xlab = expression(paste(mu)))

hist(sqrt(samp.sim2[,2]),breaks = 20,
main = expression(paste("Histogram of ",sigma)),xlab = expression(paste(sigma)))
```

---

`infermsmetrop` *Bayesian inference for $\mu$ and $\sigma$^2 for the HKp.*

---

## Description

The function infermsmetrop is used to create a sample from the posterior distribution of $\mu$ and $\sigma$^2, using eqs. 8,9 in Tyralis and Koutsoyiannis (2014) for the HKp.

## Usage

```
infermsmetrop(Hbayes,data)
```

## Arguments

| | |
|---|---|
| `data` | time series data |
| `Hbayes` | Hurst parameter simulation sample, should be a vector |

## Value

A matrix with two columns, the first corresponding to the sample of $\mu$ and the second corresponding to the sample of $\sigma$^2.

## Author(s)

Hristos Tyralis

## References

Tyralis H., Koutsoyiannis, D. (2014) A Bayesian statistical model for deriving the predictive distribution of hydroclimatic variables, *Climate Dynamics* **42(11-12)**, 2867–2883. http://dx.doi.org/10.1007/s00382-013-1804-y.

## Examples

```
# Posterior distributions of the mu and sigma parameters of the HKp for the Nile
# time series.

set.seed(12345)

samp.sim1 <- inferH(Nile,500)
```

```
samp.sim2 <- infermsmetrop(samp.sim1,Nile)

hist(samp.sim2[,1],breaks = 20,main = expression(paste("Histogram of ",mu)),
xlab = expression(paste(mu)))

hist(sqrt(samp.sim2[,2]),breaks = 20,
main = expression(paste("Histogram of ",sigma)),xlab = expression(paste(sigma)))
```

---

lssd *LSSD estimation for the HKp parameters.*

---

## Description

The function lssd is used to estimate the $\sigma$ and H parameters of the HKp, using the LSSD (Least Squares based on Standard Deviation) method as described in Koutsoyiannis (2003) and Tyralis and Koutsoyiannis (2011,Section 2.3).

## Usage

```
lssd(data,k1,p = 2,q = 0,interval = c(0.001,0.999))
```

## Arguments

| | |
|---|---|
| `data` | time series data |
| `k1` | maximum aggregation scale |
| `p` | Parameter used to determine the weights |
| `q` | Parameter used to determine the penalty factor |
| `interval` | H interval estimation |

## Value

Vector of LSSD estimates of $\sigma$ and H.

## Author(s)

Hristos Tyralis

## References

Koutsoyiannis, D. (2003) Climate change, the Hurst phenomenon, and hydrological statistics, *Hydrological Sciences Journal* **48(1)**, 3–24. http://dx.doi.org/10.1623/hysj.48.1.3.43481.

Tyralis H., Koutsoyiannis, D. (2011) Simultaneous estimation of the parameters of the Hurst-Kolmogorov stochastic process, *Stochastic Environmental Research & Risk Assessment* **25(1)**, 21–33. http://dx.doi.org/10.1007/s00477-010-0408-x.

## Examples

```
# Estimate the parameters for the Nile time series.

lssd(data = Nile,k1 = floor(length(Nile)/10),p = 2)
```

---

`lsv` *LSV estimation for the HKp parameters.*

---

## Description

The function lsv is used to estimate the $\sigma$ and H parameters of the HKp, using the LSV (Least Squares based on Variance) method as described in Tyralis and Koutsoyiannis (2011,Section 2.4).

## Usage

```
lsv(data,k1,p = 6,q = 0,interval = c(0.001,0.999))
```

## Arguments

| | |
|---|---|
| `data` | time series data |
| `k1` | maximum aggregation scale |
| `p` | Parameter used to determine the weights |
| `q` | Parameter used to determine the penalty factor |
| `interval` | H interval estimation |

## Value

Vector of LSV estimates of $\sigma$ and H.

## Author(s)

Hristos Tyralis

## References

Tyralis H., Koutsoyiannis, D. (2011) Simultaneous estimation of the parameters of the Hurst-Kolmogorov stochastic process, *Stochastic Environmental Research & Risk Assessment* **25(1)**, 21–33. http://dx.doi.org/10.1007/s00477-010-0408-x.

## Examples

```
# Estimate the parameters for the Nile time series.

lsv(data = Nile,k1 = floor(length(Nile)/10),p = 6,q = 50)
```

ltza *Value of quadratic forms for the inverse of a symmetric positive definite autocorrelation matrix.*

## Description

The function ltza is used to calculate the value of quadratic forms for the inverse of a symmetric positive definite autocorrelation matrix, using the Levinson algorithm (Golub and Van Loan 1996, Algorithm 4.7.2).

## Usage

```
ltza(r,x)
```

## Arguments

| | |
|---|---|
| r | autocorelation vector |
| x | time series data |

## Value

Vector with values t(x) * solve(R) * x, t(en) * solve(R) * x, t(en) * solve(R) * en and the natural logarithm of the determinant of R. t(.) denotes the transpose of a vector, en = (1,1,...,1) and R is the autocorrelation matrix.

## Author(s)

Hristos Tyralis

## References

Golub G.H., Van Loan C.F. (1996) *Matrix Computations*, Baltimore: John Hopkins University Press.

## Examples

```
# Estimate the parameters for the Nile time series.

r <- acfHKp(H = 0.8,maxlag = length(Nile)-1)

examp <- ltza(r,Nile)

# Comparison of the algorithm with typical approaches

examp[1] - as.numeric(t(Nile) %*% solve(toeplitz(r)) %*% Nile)

examp[2] - as.numeric(t(rep(1,length(r))) %*% solve(toeplitz(r)) %*% Nile)

examp[3] - as.numeric(t(rep(1,length(r))) %*% solve(toeplitz(r)) %*%
```

```
rep(1,length(r)))

examp[4] - log(det(toeplitz(r)))
```

---

`ltzb` *Value of quadratic forms for the inverse of a symmetric positive definite autocorrelation matrix.*

---

### Description

The function ltzb is used to calculate the value of quadratic forms for the inverse of a symmetric positive definite autocorrelation matrix, using the Levinson algorithm (Golub and Van Loan 1996, Algorithm 4.7.2).

### Usage

```
ltzb(r,x)
```

### Arguments

| | |
|---|---|
| `r` | autocorelation vector |
| `x` | time series data |

### Value

Vector with values t(en) * solve(R) * x and t(en) * solve(R) * en. t(.) denotes the transpose of a vector, en = (1,1,...,1) and R is the autocorrelation matrix.

### Author(s)

Hristos Tyralis

### References

Golub G.H., Van Loan C.F. (1996) *Matrix Computations*, Baltimore: John Hopkins University Press.

### Examples

```
# Estimate the parameters for the Nile time series.

r <- acfHKp(H = 0.8,maxlag = length(Nile)-1)

examp <- ltzb(r,Nile)
# Comparison of the algorithm with typical approaches

examp[1] - as.numeric(t(rep(1,length(r))) %*% solve(toeplitz(r)) %*% Nile)

examp[2] - as.numeric(t(rep(1,length(r))) %*% solve(toeplitz(r)) %*%
rep(1,length(r)))
```

## ltzc — *Value of quadratic forms for the inverse of a symmetric positive definite autocorrelation matrix.*

### Description

The function ltzc is used to calculate the value of quadratic forms for the inverse of a symmetric positive definite autocorrelation matrix, using the Levinson algorithm (Golub and Van Loan 1996, Algorithm 4.7.2).

### Usage

```
ltzc(r,x)
```

### Arguments

| | |
|---|---|
| `r` | autocorelation vector |
| `x` | time series data |

### Value

Vector with values t(x) * solve(R) * x and the natural logarithm of the determinant of R. t(.) denotes the transpose of a vector and R is the autocorrelation matrix.

### Author(s)

Hristos Tyralis

### References

Golub G.H., Van Loan C.F. (1996) *Matrix Computations*, Baltimore: John Hopkins University Press.

### Examples

```
# Estimate the parameters for the Nile time series.

r <- acfHKp(H = 0.8,maxlag = length(Nile)-1)

examp <- ltzc(r,Nile)

# Comparison of the algorithm with typical approaches

examp[1] - as.numeric(t(Nile) %*% solve(toeplitz(r)) %*% Nile)

examp[2] - log(det(toeplitz(r)))
```

ltzd — *Value of quadratic forms for the inverse of a symmetric positive definite autocorrelation matrix.*

## Description

The function ltzd is used to calculate the value of quadratic forms for the inverse of a symmetric positive definite autocorrelation matrix, using the Levinson algorithm (Golub and Van Loan 1996, Algorithm 4.7.2).

## Usage

```
ltzd(r,x)
```

## Arguments

| | |
|---|---|
| `r` | autocorelation vector |
| `x` | time series data |

## Value

A numeric value t(x) * solve(R) * x. t(.) denotes the transpose of a vector and R is the autocorrelation matrix.

## Author(s)

Hristos Tyralis

## References

Golub G.H., Van Loan C.F. (1996) *Matrix Computations*, Baltimore: John Hopkins University Press.

## Examples

```
# Estimate the parameters for the Nile time series.

r <- acfHKp(H = 0.8,maxlag = length(Nile)-1)

examp <- ltzd(r,Nile)

# Comparison of the algorithm with typical approaches

examp - as.numeric(t(Nile) %*% solve(toeplitz(r)) %*% Nile)
```

`MannKendallLTP` *Mann-Kendall trend test under the scaling hypothesis.*

## Description

The function MannKendallLTP applies the Mann-Kendall test under the scaling hypothesis for the data (Hamed 2008).

## Usage

```
MannKendallLTP(data)
```

## Arguments

| | |
|---|---|
| `data` | time series data |

## Value

A list with three components.

| | |
|---|---|
| `Mann_Kendall` | Kendall's tau statistic, score, variance of score, Sen's slope, denominator D where tau=S/D and p-value for the Mann-Kendall test |
| `Significance_of_H` | H estimate (eq.21, Hamed 2008) of the modified variables and p-value |
| `Mann_Kendall_LTP` | Variance of score (p.356, Hamed 2008) and p-value for the Mann-Kendall test under the scaling hypothesis |

## Note

The functions score.c, score0.c and VstarSfunction.c are called from the C library of the package. The estimator of H for the stochastic process in eq(18) (Hamed 2008) is the ML estimator in Tyralis and Koutsoyiannis (2011). The denominator for the Mann-Kendall test is calculated according to eq(23.3.4) in Hipel and McLeod (1994). The Mann-Kendall and modified Mann-Kendall test's hypotheses are Ho: no trend vs H1: trend is present. The H test's hypotheses are H0: H is not significant vs H1: H is significant.

## Author(s)

Hristos Tyralis

## References

Hamed K.H. (2008) Trend detection in hydrologic data: The Mann-Kendall trend test under the scaling hypothesis, *Journal of Hydrology* **349(3–4)**, 350–363. `http://dx.doi.org/10.1016/j.jhydrol.2007.11.009`.

Hipel K.W., McLeod AI (1994) *Time series modelling of water resources and environmental systems*, Amsterdam: Elsevier.

Tyralis H., Koutsoyiannis, D. (2011) Simultaneous estimation of the parameters of the Hurst-Kolmogorov stochastic process, *Stochastic Environmental Research & Risk Assessment* **25(1)**, 21–33. http://dx.doi.org/10.1007/s00477-010-0408-x.

## Examples

```
# Modified Mann-Kendall test for the Nile time series.

MannKendallLTP(Nile)
```

---

`mlear1` *Maximum likelihood estimation for the AR(1) parameters.*

---

## Description

The function mlear1 is used to estimate the $\mu$, $\sigma$ and $\phi$ parameters of the AR(1) process as defined in Tyralis and Koutsoyiannis (2014). The method for their estimation is described in eqs.8-9 (Tyralis and Koutsoyiannis 2011).

## Usage

```
mlear1(data,interval = c(-0.9999,0.9999),tol = .Machine$double.eps^0.25)
```

## Arguments

| | |
|---|---|
| `data` | time series data |
| `interval` | $\phi$ interval estimation |
| `tol` | estimation error tolerance |

## Value

A vector whose values are the maximum likelihood estimates of $\mu$, $\sigma$ and $\phi$.

## Note

The function likelihoodfunction.c is called from the C library of the package. Ideas for creating this function came from McLeod et al. (2007).

## Author(s)

Hristos Tyralis

## References

McLeod A.I., Yu H., Krougly Z.L. (2007) Algorithms for linear time series analysis: With R package, *Journal of Statistical Software* **23(5)**, 1–26. http://www.jstatsoft.org/v23/i05.

Tyralis H., Koutsoyiannis, D. (2011) Simultaneous estimation of the parameters of the Hurst-Kolmogorov stochastic process, *Stochastic Environmental Research & Risk Assessment* **25(1)**, 21–33. http://dx.doi.org/10.1007/s00477-010-0408-x.

Tyralis H., Koutsoyiannis, D. (2014) A Bayesian statistical model for deriving the predictive distribution of hydroclimatic variables, *Climate Dynamics* **42(11-12)**, 2867–2883. http://dx.doi.org/10.1007/s00382-013-1804-y.

## Examples

```
# Estimate the parameters for the Nile time series.

mlear1(Nile)
```

---

`mleHK` *Maximum likelihood estimation for the HKp parameters.*

---

## Description

The function mleHK is used to estimate the $\mu$, $\sigma$ and H parameters of the HKp. The method for their estimation is described in eqs.8-9 (Tyralis and Koutsoyiannis 2011).

## Usage

```
mleHK(data,interval = c(0.0001,0.9999),tol = .Machine$double.eps^0.25)
```

## Arguments

| | |
|---|---|
| `data` | time series data |
| `interval` | H interval estimation |
| `tol` | estimation error tolerance |

## Value

Vector of maximum likelihood estimates of $\mu$, $\sigma$ and H.

## Note

The function likelihoodfunction.c is called from the C library of the package. Ideas for creating this function came from McLeod et al. (2007).

## Author(s)

Hristos Tyralis

## References

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## Examples

```
# Estimate the parameters for the Nile time series.

mleHK(Nile)
```

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