Package 'GenOU'

May 7, 2026

Type Package

Title Sequential Change-Point Tests for Generalized Ornstein-Uhlenbeck Processes

Version 0.2.1

Description Sequential change-point tests, parameters estimation, and goodness-of-fit tests for generalized Ornstein-Uhlenbeck processes.

Depends R (>= 3.5.0), doParallel, parallel, foreach, stats

License GPL (>= 2)

Encoding UTF-8

RoxygenNote 7.3.2

NeedsCompilation no

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Repository CRAN

Date/Publication 2025-08-28 08:40:02 UTC

Contents

gof_stat — *Function to estimate quantiles for a goodness-of-fit test for generalized Ornstein-Uhlenbeck process*

Description

Function to calculate the quantiles of Cramer-von Mise and Kolmogorov-Smirnov statistics.

Usage

```
gof_stat(X, T1, N, p, q)
```

Arguments

X	observations
T1	last time of observation
N	number of observations on from on interval (0,T1]
p	number of cosine coefficients >=1
q	number of sine coefficients >=0

Value

out	List of statistics (cvm and ks), estimated parameters, and pseudo-observations

Examples

```
T1=20
N=500
data(X)
out = gof_stat(X,T1,N,2,0)
```

kappa — *Change-point statistics for GOU*

Description

Function to compute Sigma covariance matrix and kappas of change-point statistics

Usage

```
kappa(theta, theta_star, sigma)
```

Arguments

theta	list of parameters before change-point: cos coefficients (>=1), sine coefficients (>=0, and alpha
theta_star	list of parameters after change-point: cos coefficients (>=1), sine coefficients (>=0, and alpha
sigma	volatility parameter of the GOU process

Value

out	List containing Sigma and kappas for Q and G statistics

Examples

```
theta=list(cos=c(1,2),alpha=1)
theta_star=list(cos=c(2,4),alpha=2)
sigma=3
out = kappa(theta,theta_star, sigma)
```

SimBM *Simulation of multidimensional Brownian motion*

Description

This function is used to simulate multidimensional Brownian motion at points 0,1/n, ..., 1.

Usage

```
SimBM(n, d)
```

Arguments

n	Number of simulated
d	Dimension of BM

Value

W	Brownian motion

Examples

```
W =  SimBM(100,4)
```

SimGOUexact *Simulation of generalized Ornstein-Uhlenbeck (GOU) process*

Description

Function to simulate exact N+K+1 values with change point after N+K_star, with K_star = floor(N*t_star), for a GOU process. Starting point is 0.

Usage

```
SimGOUexact(T1, N, t_star = 0, K, theta, theta_star, sigma)
```

Arguments

T1	Last time of observation
N	Number of observations on from on interval (0,T1]
t_star	Time of change-point after T1
K	Number of observation after change-point
theta	list of parameters before change-point: cos coefficients (>=1), sine and sigma
theta_star	list of parameters after change-point: cos coefficients (>=1), sine and sigma
sigma	volatility parameter of the GOU process

Value

X	Simulated path evaluated at points k x T1/N, 0 <= k <= N+K

Examples

```
set.seed(3253)
T1=20
N=500
K=2*N
t_star=0
theta=list(cos=c(1,2),alpha=1) # d=3 parameters for the drift
theta_star=list(cos=c(2,5),alpha=1)
sigma=3
X=SimGOUexact(T1,N,t_star,K,theta,theta_star,sigma)
```

`SimQuantilesGoF` *Function to estimate quantiles for residuals of generalized Ornstein-Uhlenbeck (GOU) process*

Description

Computation of quantiles for Cramer-von Mises and Kolmogorov-Smirnov statistics for testing goodness-of-fit of GOU

Usage

```
SimQuantilesGoF(n, B = 50000, alpha = c(0.9, 0.95, 0.975, 0.99), n_cores = 2)
```

Arguments

`n`	number of points
`B`	number of bootstrap samples (default 50000)
`alpha`	vector of probabilities (default is (.90,.95,.975,.99))
`n_cores`	number of cores for parallel computing (default is 2)

Value

`q`	Data frame of simulated quantiles of weighted BM

`SimQuantilesWBM` *Function to estimate quantiles for weigthed Brownian Motion functional*

Description

Function to calculate the critical value for the Euclidean norm of d-dimensional BM divided by t^gamma

Usage

```
SimQuantilesWBM(
  n,
  d,
  gamma,
  B = 50000,
  alpha = c(0.9, 0.95, 0.975, 0.99),
  n_cores = 2
)
```

Arguments

n	number of points
d	dimension of Brownian motion
gamma	parameter between 0 and 0.5 (not included)
B	number of bootstrap samples (default 50000)
alpha	vector of probabilities (default is (.90,.95,.975,.99))
n_cores	number of cores for parallel computing (default is 2)

Value

qs	Simulated quantiles of weighted BM

StatGOU *Change-point tests for generalized Ornstein-Uhlenbec (GOU) process*

Description

Function to simulate exact N+K+1 values with change point after N+K_star, with K_star = floor(N*t_star), for a GOU process. Starting point is 0.

Usage

```
StatGOU(X, T1, N, p, q, gamma, c1, cd)
```

Arguments

X	observations
T1	last time of observation
N	number of observations on from on interval (0,T1]
p	number of cosine coefficients >=1
q	number of sine coefficients >=0
gamma	weight parameter >=0 and < 0.5
c1	critical value for Q stat (based on 1-dimensional weigthed BM)
cd	critical value for G stat (based on d-dimensional weigthed BM), where d = p+q+1 is the number of estimated parameters for the drift.

Value

out	List

References

Lyu, Nasri and Remillard (2025): Sequential Change-point Detection with Generalized Ornstein–Uhlenbeck Processes

Examples

```
T1=20
N=500
gamma = 0.1
p=2
q=0
c1 = 2.2838 # corresponding to gamma=0.1
c3 = 3.0502 # corresponding to gamma=0.1 and d=3 estimated parameters for the drift
data(X)
out=StatGOU(X,T1,N,p,q,gamma,c1,c3)
```

X *Simulated GOU process*

Description

Simulated GOU process with set.seed(3253), theta=list(cos=c(1,2),alpha=1) theta_star=list(cos=c(2,4),alpha=2), using X=SimGOUexact(20,500,0,1000,theta,theta_star,3)

Usage

```
data(X)
```

Format

Simulated GOU process (X)

Examples

```
data(X)
```

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