Package ‘hawkes’

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Title Hawkes process simulation and calibration toolkit

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Description The package allows to simulate Hawkes process both in univariate and multivariate settings. It gives functions to compute different moments of the number of jumps of the process on a given interval, such as mean, variance or autocorrelation of process jumps on time intervals separated by a lag.

License GPL (>= 2)

Depends R (>= 3.0.2)

Imports Rcpp (>= 0.11.1)

LinkingTo Rcpp, RcppArmadillo (>= 0.4.100.2.1)

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jumpAutocorrelation — *Autocorrelation of Hawkes process jumps on nonoverlapping time intervals with lag.*

Description

The function returns the theoretical autocorrelation of the number of jumps of a Hawkes process on nonoverlapping time intervals with lag

Usage

```
jumpAutocorrelation(lambda0, alpha, beta, tau,lag)
```

Arguments

`lambda0`	Vector of initial intensity, a scalar in the monovariate case.
`alpha`	Matrix of excitation, a scalar in the monovariate case. Excitation values are all positive.
`beta`	Vector of betas, a scalar in the monovariate case.
`tau`	Time interval length.
`lag`	Time lag.

Details

Notice that in the scalar case, one must have beta>alpha for the process to be stable, and in the multivariate case, the matrix (diag(beta)-alpha) must have eigen values with strictly positive real parts for the process to be stable.

Value

Returns a matrix containing the autocorrelation of the number of jumps of process components.

References

Jose Da Fonseca and Riadh Zaatour Hawkes Process : Fast Calibration, Application to Trade Clustering and Diffusive Limit. *Journal of Futures Markets*, Volume 34, Issue 6, pages 497-606, June 2014.

Jose Da Fonseca and Riadh Zaatour Clustering and Mean Reversion in Hawkes Microstructure Models.

Examples

```
#One dimensional Hawkes process
lambda0<-0.02
alpha<-0.05
beta<-0.06
tau<-60#one minute
lag<-0#adjacent non overlappingintervals
h<-jumpAutocorrelation(lambda0,alpha,beta,tau,lag)

#Multivariate Hawkes process
lambda0<-c(0.02,0.02)
alpha<-matrix(c(0.05,0,0,0.05),byrow=TRUE,nrow=2)
beta<-c(0.06,0.06)
tau<-60#one minute
lag<-0#adjacent non overlappingintervals
h<-jumpAutocorrelation(lambda0,alpha,beta,tau,lag)
```

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jumpMean — *Mean of Hawkes process jumps.*

Description

The function returns the theoretical mean of the number of jumps of a Hawkes process on a time interval of length tau.

Usage

```
jumpMean(lambda0, alpha, beta, tau)
```

Arguments

`lambda0`	Vector of initial intensity, a scalar in the monovariate case.
`alpha`	Matrix of excitation, a scalar in the monovariate case. Excitation values are all positive.
`beta`	Vector of betas, a scalar in the monovariate case.
`tau`	Time interval length.

Details

Notice that in the scalar case, one must have beta>alpha for the process to be stable, and in the multivariate case, the matrix (diag(beta)-alpha) must have eigen values with strictly positive real parts for the process to be stable.

Value

Returns a vector containing the mean number of jumps of every process component.

References

Jose Da Fonseca and Riadh Zaatour Hawkes Process : Fast Calibration, Application to Trade Clustering and Diffusive Limit. *Journal of Futures Markets*, Volume 34, Issue 6, pages 497-606, June 2014.

Jose Da Fonseca and Riadh Zaatour Clustering and Mean Reversion in Hawkes Microstructure Models.

Examples

```
#One dimensional Hawkes process
lambda0<-0.02
alpha<-0.05
beta<-0.06
tau<-60#one minute
h<-jumpMean(lambda0,alpha,beta,tau)

#Multivariate Hawkes process
lambda0<-c(0.02,0.02)
alpha<-matrix(c(0.05,0,0,0.05),byrow=TRUE,nrow=2)
beta<-c(0.06,0.06)
tau<-60#one minute
h<-jumpMean(lambda0,alpha,beta,tau)
```

`jumpVariance` *Variance of Hawkes process jumps.*

Description

The function returns the theoretical variance matrix of the number of jumps of a Hawkes process on a time interval of length tau.

Usage

```
jumpVariance(lambda0, alpha, beta, tau)
```

Arguments

`lambda0`	Vector of initial intensity, a scalar in the monovariate case.
`alpha`	Matrix of excitation, a scalar in the monovariate case. Excitation values are all positive.
`beta`	Vector of betas, a scalar in the monovariate case.
`tau`	Time interval length.

Details

Notice that in the scalar case, one must have beta>alpha for the process to be stable, and in the multivariate case, the matrix (diag(beta)-alpha) must have eigen values with strictly positive real parts for the process to be stable.

Value

Returns a matrix containing the variance of the number of jumps of every process component.

References

Jose Da Fonseca and Riadh Zaatour Hawkes Process : Fast Calibration, Application to Trade Clustering and Diffusive Limit. *Journal of Futures Markets*, Volume 34, Issue 6, pages 497-606, June 2014.

Jose Da Fonseca and Riadh Zaatour Clustering and Mean Reversion in Hawkes Microstructure Models.

Examples

```
#One dimensional Hawkes process
lambda0<-0.02
alpha<-0.05
beta<-0.06
tau<-60#one minute
h<-jumpVariance(lambda0,alpha,beta,tau)

#Multivariate Hawkes process
lambda0<-c(0.02,0.02)
alpha<-matrix(c(0.05,0,0,0.05),byrow=TRUE,nrow=2)
beta<-c(0.06,0.06)
tau<-60#one minute
h<-jumpVariance(lambda0,alpha,beta,tau)
```

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likelihoodHawkes — *Compute the likelihood function of a hawkes process*

Description

Compute the likelihood function of a hawkes process for the given parameter and given the jump times vector (or list of vectors in the multivariate case), and until a time horizon.

Usage

```
likelihoodHawkes(lambda0, alpha, beta, history)
```

Arguments

`lambda0`	Vector of initial intensity, a scalar in the monovariate case.
`alpha`	Matrix of excitation, a scalar in the monovariate case. Excitation values are all positive.
`beta`	Vector of betas, a scalar in the monovariate case.
`history`	Jump times vector (or list of vectors in the multivariate case).

Value

Returns the opposite of the likelihood.

References

Y. Ogata. (1981) On Lewis simulation method for point processes. *IEEE Transactions on Information Theory*, **31**

Examples

```
#One dimensional Hawkes process
lambda0<-0.2
alpha<-0.5
beta<-0.7
history<-simulateHawkes(lambda0,alpha,beta,3600)
l<-likelihoodHawkes(lambda0,alpha,beta,history[[1]])

#Multivariate Hawkes process
lambda0<-c(0.2,0.2)
alpha<-matrix(c(0.5,0,0,0.5),byrow=TRUE,nrow=2)
beta<-c(0.7,0.7)
history<-simulateHawkes(lambda0,alpha,beta,3600)
l<-likelihoodHawkes(lambda0,alpha,beta,history)
```

`simulateHawkes` *Hawkes process simulation Function*

Description

The function simulates a Hawkes process for the given parameter, and until a time horizon.

Usage

```
simulateHawkes(lambda0, alpha, beta, horizon)
```

Arguments

`lambda0`	Vector of initial intensity, a scalar in the monovariate case.
`alpha`	Matrix of excitation, a scalar in the monovariate case. Excitation values are all positive.
`beta`	Vector of betas, a scalar in the monovariate case.
`horizon`	Time horizon until which the simulation is to be conducted.

Details

Notice that in the scalar case, one must have beta>alpha for the process to be stable, and in the multivariate case, the matrix (diag(beta)-alpha) must have eigen values with strictly positive real parts for the process to be stable.

Value

Returns a vector of jump times in the monovariate case, and a list of such vectors for every component in the multivariate case.

References

Y. Ogata. (1981) On Lewis simulation method for point processes. *IEEE Transactions on Information Theory*, **31**

Examples

```
#One dimensional Hawkes process
lambda0<-0.2
alpha<-0.5
beta<-0.7
horizon<-3600#one hour
h<-simulateHawkes(lambda0,alpha,beta,horizon)

#Multivariate Hawkes process
lambda0<-c(0.2,0.2)
alpha<-matrix(c(0.5,0,0,0.5),byrow=TRUE,nrow=2)
beta<-c(0.7,0.7)
horizon<-3600#one hour
h<-simulateHawkes(lambda0,alpha,beta,horizon)
```

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