Package 'stpphawkes'

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Type Package

Title Missing Data for Marked Hawkes Process

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Description Estimation of model parameters for marked Hawkes process.
Accounts for missing data in the estimation of the parameters.
Technical details found in (Tucker et al., 2019 <DOI:10.1016/j.spasta.2018.12.004>).

Imports interp, extraDistr, Rcpp

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Encoding UTF-8

SystemRequirements GNU GSL

NeedsCompilation yes

URL https://github.com/sandialabs/stpphawkes

BugReports https://github.com/sandialabs/stpphawkes/issues

LinkingTo Rcpp, RcppArmadillo, RcppProgress, RcppGSL

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`areapl` *Calculate area of polynomial*

Description

Calculate area of polynomial

Usage

```
areapl(poly)
```

Arguments

`poly`	- matrix describing polynomial

Value

W - area of polynomial

homog.STPP *Simulate a homogenous space-time Poisson process*

Description

This function simulates a homogenous space-time Poisson process on W, defined by polygon

Usage

```
homog.STPP(
  mu,
  poly,
  t.region,
  xfrac = 0.1,
  yfrac = 0.1,
  remove = FALSE,
  checkpoly = TRUE,
  showplot = FALSE
)
```

Arguments

mu	- background parameter
poly	- matrix defining polygon (N x 2)
t.region	- vector of two elements describing time span
xfrac	- x fractional increase of polygon to handle boundary effects (default = .1)
yfrac	- y fractional increase (default = .1)
remove	- remove points outside polygon (default = FALSE)
checkpoly	- check if polygon is proper (default = TRUE)
showplot	- plot points (default = FALSE)

Value

A DataFrame containing x,y,t

Examples

```
out = homog.STPP(0.5,matrix(c(0,0,1,1,0,1,1,0),ncol=2),c(0,10))
```

intensity_temporal *Calculate intensity function for temporal Hawkes*

Description

Calculate intensity function for temporal Hawkes

Usage

```
intensity_temporal(mu, alpha, beta, times, evalpt)
```

Arguments

mu	- background parameter
alpha	- alpha parameter
beta	- beta parameter
times	- history of previous times
evalpt	- point to evaluate

Value

lambda - intensity at evalpt

mcmc_stpp *Bayesian Estimation of Spatio-Temporal Hawkes Model Parameters*

Description

This function computes the posterior of a spatio-temporal exponential decay Hawkes model using Metropolis-with-in-Gibbs sampling.

Usage

```
mcmc_stpp(
  data,
  poly,
  t_max = max(data$t),
  t_mis = NULL,
  param_init = NULL,
  mcmc_param = NULL,
  branching = TRUE,
  print = TRUE,
  sp_clip = TRUE
)
```

Arguments

`data`	- A DataFrame containing x,y,t
`poly`	- matrix defining polygon (N x 2)
`t_max`	- maximum time value (default = max(times))
`t_mis`	- vector of two elements describing missing time range (default = 'NULL')
`param_init`	- list of parameters of initial guess (default = 'NULL', will start with MLE)
`mcmc_param`	- list of mcmc parameters
`branching`	- using branching structure in estimation (default = 'TRUE')
`print`	- print progress (default = 'TRUE')
`sp_clip`	- when simulating missing data spatial points, clip spatial region back to observed region (default = 'TRUE')

Details

The default is to estimate the branching structure. The model will also account to missing data if `t_mis` is provided.

Value

A List containing the mcmc samples (samps), branching structure ('y', if 'TRUE'), and missing data ('zsamps' if 't_mis' is not 'NULL') If 't_mis' is not 'NULL' the mcmc samples will contain 'n_missing', the number of missing points estimated

---

`mcmc_stpp_nonunif` *Bayesian Estimation of Spatio-Temporal Hawkes Model Parameters with non uniform spatial locations*

Description

This function computes the posterior of a spatio-temporal exponential decay Hawkes model using Metropolis-with-in-Gibbs sampling.

Usage

```
mcmc_stpp_nonunif(
  data,
  poly,
  t_max = max(data$t),
  t_mis = NULL,
  param_init = NULL,
  mcmc_param = NULL,
  branching = TRUE,
  print = TRUE,
  sp_clip = TRUE
)
```

Arguments

`data`	- A DataFrame containing x,y,t
`poly`	- matrix defining polygon (N x 2)
`t_max`	- maximum time value (default = max(times))
`t_mis`	- vector of two elements describing missing time range (default = 'NULL')
`param_init`	- list of parameters of initial guess (default = 'NULL', will start with MLE)
`mcmc_param`	- list of mcmc parameters
`branching`	- using branching structure in estimation (default = 'TRUE')
`print`	- print progress (default = 'TRUE')
`sp_clip`	- when simulating missing data spatial points, clip spatial region back to observed region (default = 'TRUE')

Details

The default is to estimate the branching structure. The model will also account to missing data if `t_mis` is provided.

Value

A List containing the mcmc samples (samps), branching structure ('y', if 'TRUE'), and missing data ('zsamps' if 't_mis' is not 'NULL') If 't_mis' is not 'NULL' the mcmc samples will contain 'n_missing', the number of missing points estimated

---

`mcmc_temporal` *Bayesian Estimation of Temporal Hawkes Model Parameters*

Description

This function computes the posterior of the parameters of a temporal exponential decay Hawkes model using Metropolis-with-in-Gibbs sampling.

Usage

```
mcmc_temporal(
  times,
  t_max = max(times),
  t_mis = NULL,
  param_init = NULL,
  mcmc_param = NULL,
  branching = TRUE,
  print = TRUE
)
```

Arguments

`times`	- vector of arrival times
`t_max`	- maximum time value (default = max(times))
`t_mis`	- Mx2 matrix, mth row contains two elements describing the mth missing time range (default = 'NULL')
`param_init`	- list of parameters of initial guess (default = 'NULL', will start with MLE)
`mcmc_param`	- list of mcmc parameters
`branching`	- using branching structure in estimation (default = 'TRUE')
`print`	- print progress (default = 'TRUE')

Details

The default is to estimate the branching structure which is much more computationally efficient. The model will also account to missing data if `t_mis` is provided.

Branching models specify gamma priors for mu, alpha and beta parameters.

Value

A List containing the mcmc samples (samps), branching structure ('y', if 'TRUE'), and missing data ('zsamps' if 't_mis' is not 'NULL') If 't_mis' is not 'NULL' the mcmc samples will contain 'n_missing', the number of missing points estimated

Examples

```
times = simulate_temporal(.5,.1,.5,c(0,10),numeric())
out = mcmc_temporal(times)
```

---

mcmc_temporal_catmark *Bayesian Estimation of Temporal Hawkes Model Parameters with Categorical Marks*

Description

This function computes the posterior of the parameters of a temporal exponential decay Hawkes model using Metropolis-with-in-Gibbs sampling.

Usage

```
mcmc_temporal_catmark(
  times,
  marks,
  t_max = max(times),
  t_mis = NULL,
  param_init = NULL,
```

```
  mcmc_param = NULL,
  branching = TRUE,
  print = TRUE
)
```

Arguments

`times`	- vector of arrival times
`marks`	- vector of marks
`t_max`	- maximum time value (default = max(times))
`t_mis`	- Mx2 matrix, mth row contains two elements describing the mth missing time range (default = 'NULL')
`param_init`	- list of parameters of initial guess (default = 'NULL, will start with MLE)
`mcmc_param`	- list of mcmc parameters
`branching`	- using branching structure in estimation (default = 'TRUE')
`print`	- print progress (default = 'TRUE')

Details

The default is to estimate the branching structure which is much more computationally efficient. The model will also account to missing data if `t_mis` is provided.

Value

A List containing the mcmc samples (samps), branching structure ('y', if 'TRUE'), and missing data ('zsamps' if 't_mis' is not 'NULL') If 't_mis' is not 'NULL' the mcmc samples will contain 'n_missing', the number of missing points estimated

---

`mcmc_temporal_contmark` *Bayesian Estimation of Temporal Hawkes Model Parameters with Categorical Marks*

Description

This function computes the posterior of the parameters of a temporal exponential decay Hawkes model using Metropolis-with-in-Gibbs sampling.

Usage

```
mcmc_temporal_contmark(
  times,
  marks,
  wshape,
  t_max = max(times),
```

```
  t_mis = NULL,
  param_init = NULL,
  mcmc_param = NULL,
  branching = TRUE,
  dist = "Weibull",
  print = TRUE
)
```

Arguments

`times`	- vector of arrival times
`marks`	- vector of continuous marks
`wshape`	- fixed weibull shape parameter
`t_max`	- maximum time value (default = max(times))
`t_mis`	- Mx2 matrix, mth row contains two elements describing the mth missing time range (default = 'NULL')
`param_init`	- list of parameters of initial guess (default = 'NULL', will start with MLE)
`mcmc_param`	- list of mcmc parameters
`branching`	- using branching structure in estimation (default = 'TRUE')
`dist`	- distribution for marks string (default = "Weibull")
`print`	- print progress (default = 'TRUE')

Details

The default is to estimate the branching structure which is much more computationally efficient. The model will also account to missing data if `t_mis` is provided.

Value

A List containing the mcmc samples (samps), branching structure ('y', if 'TRUE'), and missing data ('zsamps' if 't_mis' is not 'NULL') If 't_mis' is not 'NULL' the mcmc samples will contain 'n_missing', the number of missing points estimated

---

pip *Point in polygon*

Description

Determines if a point is in a polygon or on a polygon boundary

Usage

```
pip(x, y, poly)
```

Arguments

x	- vector of x positions
y	- vector of y positions
poly	- matrix defining polygon (N x 2)

Value

A list containing the x and y coordinates of the points inside the polygon @export

---

ptinpoly *Calculate if points are in the polynomial*

Description

Calculate if points are in the polynomial

Usage

```
ptinpoly(x, y, xp, yp, bb)
```

Arguments

x	- vector of x coordinates
y	- vector of y coordinates
xp	- vector of x coordinates of polynomial
yp	- vector of y coordinates of polynomial
bb	- matrix of bounding box of polynomial

Value

inout - vector of 1 if point is in polynomial and 0 if not

simulate_hawkes_stpp *Simulate homogenous spatio-temporal hawkes model*

Description

Simulate homogenous spatio-temporal hawkes model

Usage

```
simulate_hawkes_stpp(params, poly, t_region, d, history, seed = -1L)
```

Arguments

params	- list containing params (μ, a, b, σ)
poly	- matrix defining polygon (N x 2)
t_region	- vector of two elements describing time region (e.g., c(0,10))
d	- generate parents on larger polygon by expanded observed polygon by d (default = R::qnorm(.95, 0, sig, 1, 0))
history	- history of process (e.g., numeric())
seed	- set random number seed (default=-1)

Value

A DataFrame containing x,y,t

simulate_hawkes_stpp_nonunif *Simulate inhomogenous spatio-temporal hawkes model*

Description

Simulate inhomogenous spatio-temporal hawkes model

Usage

```
simulate_hawkes_stpp_nonunif(params, poly, t_region, d, history, seed = -1L)
```

Arguments

params	- list containing params (μ, a, b, σ,μx, μy, σx, σy)
poly	- matrix defining polygon (N x 2)
t_region	- vector of two elements describing time region (e.g., c(0,10))
d	- generate parents on larger polygon by expanded observed polygon by d (default = R::qnorm(.95, 0, sig, 1, 0))
history	- history of process (e.g., numeric())
seed	- set random number seed (default=-1)

Value

A DataFrame containing x,y,t

`simulate_temporal` *Simulates a temporal Hawkes process with an exponential correlation function*

Description

Simulates a temporal Hawkes process with an exponential correlation function

Usage

```
simulate_temporal(mu, alpha, beta, tt, times, seed = -1L)
```

Arguments

`mu`	- background parameter
`alpha`	- α parameter
`beta`	- β parameter
`tt`	- vector of two elements defining time span (e.g., c(0,10))
`times`	- history of previous times (e.g., numeric())
`seed`	- value to seed random number generation (default = -1)

Value

arrivals - vector of arrival times

Examples

```
times = simulate_temporal(.5,.1,.5,c(0,10),numeric())
```

`stpp.mle` *MLE Estimation of Spatio-Temporal Hawkes Model Parameters*

Description

Maximum likelihood estimation of the parameters of a spatio-temporal exponential decay Hawkes model.

Usage

```
stpp.mle(data, poly, t_max = max(data$t), initval = NA, print = TRUE)
```

Arguments

data	- A DataFrame containing x,y, and t
poly	- a matrix defining the polygon
t_max	- maximum time value (default = max(times))
initval	- vector of two elements describing missing time range (default = NA)
print	- print progress (default = TRUE)

Value

A list containing the parameter values and likelihood value

---

stpp.mle.nonunif *MLE Estimation of Nonuniform Spatio-Temporal Hawkes Model Parameters*

Description

Maximum likelihood estimation of the parameters of a spatio-temporal exponential decay Hawkes model.

Usage

```
stpp.mle.nonunif(data, poly, t_max = max(data$t), initval = NA, print = TRUE)
```

Arguments

data	- A DataFrame containing x,y, and t
poly	- a matrix defining the polygon
t_max	- maximum time value (default = max(times))
initval	- vector of two elements describing missing time range (default = NA)
print	- print progress (default = TRUE)

Value

A list containing the parameter values and likelihood value

stpphawkes *Marked Hawkes Process with Missing Data*

Description

A library for estimation of spatio-temporal Hawkes process parameters with missing data support

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References

J. D. Tucker, L. Shand, and J. R. Lewis, "Handling Missing Data in Self-Exciting Point Process Models," Spatial Statistics, vol. 29. pp. 160-176, 2019.

See Also

Useful links:

- https://github.com/sandialabs/stpphawkes
- Report bugs at https://github.com/sandialabs/stpphawkes/issues

temporal.catmark.mle *MLE Estimation of Temporal Hawkes Model Parameters with Categorical Marks*

Description

Maximum likelihood estimation of the parameters of a temporal exponential decay Hawkes model

Usage

```
temporal.catmark.mle(t, marks, t_max = max(t), initval = NA, print = TRUE)
```

Arguments

t	- vector of arrival times
marks	- vector of marks
t_max	- maximum time value (default = max(times))
initval	- initial parameter values for likelihood optimization
print	- print progress (default = TRUE)

Value

A list containing the parameter values and likelihood value

---

temporal.mle *MLE Estimation of Temporal Hawkes Model Parameters*

Description

Maximum likelihood estimation of the parameters of a temporal exponential decay Hawkes model

Usage

```
temporal.mle(t, t_max = max(t), initval = NA, print = TRUE)
```

Arguments

t	- vector of arrival times
t_max	- maximum time value (default = max(times))
initval	- vector of two elements describing missing time range (default = NA)
print	- print progress (default = TRUE)

Value

A list containing the parameter values and likelihood value

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