

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](https://doi.org/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

RoxygenNote 7.3.2

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areapl	<i>Calculate area of polynomial</i>
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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 ($N \times 2$)
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	<i>Calculate intensity function for temporal Hawkes</i>
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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	<i>Bayesian Estimation of Spatio-Temporal Hawkes Model Parameters</i>
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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

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

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

<code>mcmc_stpp_nonunif</code>	<i>Bayesian Estimation of Spatio-Temporal Hawkes Model Parameters with non uniform spatial locations</i>
--------------------------------	--

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 ($N \times 2$)
t_max	- maximum time value (default = $\max(\text{times})$)
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	- $M \times 2$ 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	- $M \times 2$ 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	- $M \times 2$ 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 ($N \times 2$)

Value

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

ptinpoly	<i>Calculate if points are in the polynomial</i>
----------	--

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 ($N \times 2$)
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 ($\mu, a, b, \sigma, \mu x, \mu y, \sigma x, \sigma y$)
poly	- matrix defining polygon ($N \times 2$)
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	<i>Simulates a temporal Hawkes process with an exponential correlation function</i>
-------------------	---

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	<i>MLE Estimation of Spatio-Temporal Hawkes Model Parameters</i>
----------	--

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	<i>MLE Estimation of Nonuniform Spatio-Temporal Hawkes Model Parameters</i>
------------------	---

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

 stpshawkes

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/stpshawkes>
- Report bugs at <https://github.com/sandialabs/stpshawkes/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

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

Value

A list containing the parameter values and likelihood value

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