Package 'stlnpp'

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Type Package

Title Spatio-temporal analysis of point patterns on linear networks

Version 0.3.5

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Description Statistical analysis of spatio-temporal point processes on linear networks. This pack-
ages provides tools to visualise and analyse spatio-temporal point patterns on linear networks us-
ing first- and second-order summary statistics.

Depends spatstat (>= 1.60-1.013), stats

Suggests plot3D, lattice, graphics

License GPL (>= 2)

Encoding UTF-8

LazyData true

RoxygenNote 7.0.2

R topics documented:

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as.stlpp   *Convert data to a space-time point pattern on a linear network*

Description

Convert data to a space-time point pattern on a linear network

Usage

```
as.stlpp(x,y,t,L)
```

Arguments

x,y,t   vectors of cartesian coordinates and time occurance. Alternatively, x can be of
                 classes data.frame, ppp and lpp.

L   linear network (object of class linnet) on which the points lie.

Details

This function converts data to an object of class stlpp.

Data can be of formats:

- x is of class class data.frame with three columns. Then columns are considered as cartesian
  coordinates (i.e. x,y,t) and they will be converted to a spatio-temporal point pattern on the
  linear network L.
- x is a planar point pattern (class ppp). Then x will be converted to a spatio-temporal point
  pattern on the linear network L and with coresponding time vector t.
- x is a linear point pattern (class lpp). Then x will be converted to a spatio-temporal point
  pattern on the linear network L and with coresponding time vector t.
- x,y,t are vectors of same length where x,y are living on the corresponding network L.

Value

A spatio-temporal point pattern on a linear network. An object of class stlpp.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

See Also

as.stlpp.lpp, runifpointOnLines, as.lpp

Examples

```
data(easynet)
x <- runifpointOnLines(40, easynet)
t1 <- sample(1:10,40,replace=TRUE)
Y <- as.stlpp(x,t=t1,L=easynet)

Z <- as.stlpp.lpp(Y)
t2 <- sample(1:10,40,replace=TRUE)
W <- as.stlpp(Z,t=t2)
```

---

as.stlpp.lpp   *Methods for space-time point patterns on a linear network.*

Description

This function projects an object of class `stlpp` to a linear network.

Usage

```
as.stlpp.lpp(x)
```

Arguments

x   an object of class `stlpp`

Details

This function projects the space-time point pattern x on linear network L into L, giving its corresponding spatial point pattern.

Value

An object of class `lpp`.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

See Also

`as.stlpp`, `lpp`, `as.lpp`

Examples

```
data(easynet)
x <- runifpointOnLines(40, easynet)
t1 <- sample(1:10,40,replace=TRUE)
Y <- as.stlpp(x,t=t1,L=easynet)
as.stlpp.lpp(Y)
```

---

as.stlpp.tpp   *Methods for space-time point patterns on a linear network.*

Description

This function converts an object of class stlpp to class tpp.

Usage

```
as.stlpp.tpp(X)
```

Arguments

X   an object of class stlpp

Details

This function projects the space-time point pattern X on L times T into the time interval T.

Value

An object of class tpp.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

See Also

as.stlpp, lpp, as.lpp

Examples

```
X <- rpoistlpp(10,1,2,easynet)
as.stlpp.tpp(X)
```

---

density.stlpp   *Kernel estimation of intensity of space-time point patterns on a linear network*

Description

Kernel density estimation of a spatio-temporal point pattern on a linear network.

Usage

```
## S3 method for class stlpp
density(X,lbw,tbw,at=c("points","pixels"),dimt=512,...)
```

Arguments

X	an object of class `stlpp`
lbw	netwrok smoothing bandwidth
tbw	time smoothing bandwidth
at	string specifying whether to compute the intensity values at a grid of pixel locations and time (at="pixels") or only at the points of x (at="points"). default is to estimate the intensity at pixels
dimt	the number of equally spaced points at which the temporal density is to be estimated. see density
...	arguments passed to `density.lpp`

Details

Kernel smoothing is applied to the spatio-temporal point pattern X using methods in Moradi et al (2019). If lbw and tbw are not given, then they will be selected using `bw.nrd0` and `bw.scott.iso` respectively.

Value

if at="points": a vector of intensity values at the data points of X.

if at="pixels": a list of images on linear network. Each image represents an estimated saptio-temporal intensity at a fixed time. check the attributes for more accommodated outputs.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

References

Moradi, M.M. and Mateu, J. (2019). First and second-order characteristics of spatio-temporal point processes on linear networks. Journal of Computational and Graphical Statistics. In press.

See Also

density, density.lpp, bw.nrd0, bw.scott.iso

Examples

```
X <- rpoistlpp(.2,a=0,b=5,L=easynet)
density(X)
```

---

density.tpp   *Kernel estimation of intensity of temporal point patterns*

Description

Kernel estimation of intensity of temporal point patterns.

Usage

```
## S3 method for class tpp
density(x,tbw,at=c("points","pixels"),...)
```

Arguments

x	a temporal point pattern (of class tpp)
tbw	time smoothing bandwidth
at	string specifying whether to compute the intensity values at a grid of pixel locations (at="pixels") or only at the points of x (at="points"). default is to estimate the intensity at pixels
...	arguments passed to density

Value

A vector of intensity values.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

References

Moradi, M.M. and Mateu, J. (2019). First and second-order characteristics of spatio-temporal point processes on linear networks. Journal of Computational and Graphical Statistics. In press.

See Also

density, bw.nrd0

Examples

```
X <- tpp(sample(c(1:24),200,replace = T))
plot(density(X))
```

Eastbourne	*Eastbourne traffic accident data*

Description

This dataset represents the spatio-temporal locations of traffic accidents in the down-town of East-bourne (UK) in the period of 2005-2010. The network was provided by "OS OpenData" at www.ordnancesurvey.co.uk and is usable under the terms of the OS OpenData license. The traffic locations were collected by the UK Department for Transport at www.data.gov.uk and obtained through kaggle at www.kaggle.com.

The dataset Eastbourne is an object of class stlpp.

Usage

```
data(Eastbourne)
```

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

Source

Usability: The network of Eastbourne was provided by OS OpenData and contains OS data © Crown copyright and database right (2018). The traffic accident locations in Eastbourne were collected by the UK Department for Transport and were provided by kaggle.

This data is a part of enitre data which is selected and converted to this format by Mehdi Moradi.

References

Moradi, M.M. and Mateu, J. (2019). First and second-order characteristics of spatio-temporal point processes on linear networks. Journal of Computational and Graphical Statistics. In press.

See Also

stlpp

Examples

```
data(Eastbourne)
plot(Eastbourne)
```

---

easynet   *A simple linear network*

Description

A simple and not real network.

Usage

    data(easynet)

Source

Created by Mehdi Moradi

Medellin   *Medellin traffic accident data*

Description

This dataset represents the spatio-temporal locations of traffic accidents in an area near the pontifical bolivarian university in Medell\'in (Colombia) during 2016. The entire data were published in the OpenData portal of Medell\'in Town Hall at https://www.medellin.gov.co/geomedellin/index.hyg.

The dataset Medellin is an object of class stlpp.

Usage

    data(Medellin)

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

Source

This data is a part of enitre data which is selected and converted to this format by Mehdi Moradi.

References

Moradi, M.M. and Mateu, J. (2019). First and second-order characteristics of spatio-temporal point processes on linear networks. Journal of Computational and Graphical Statistics. In press.

See Also

stlpp

Examples

    data(Medellin)
    plot(Medellin)

---

methods.stlpp | *Methods for space-time point patterns on a linear network*

Description

Methods for space-time point patterns on a linear network.

Usage

```
## S3 method for class stlpp
plot(X,...)
## S3 method for class stlppint
plot(X,...)
## S3 method for class sumstlpp
plot(X,style=c("level","contour","perspective"), theta = 35, phi = 10,
facets = FALSE, ticktype = "detailed", resfac = 5,
xlab="r = distance",ylab="t = time",...)
## S3 method for class stlpp
print(X)
## S3 method for class stlpp
print(X)
## S3 method for class stlpp
print(X)
```

Arguments

X	an object of classes stlpp, stlppint or sumstlpp
...	gracphical arguments passed to plot.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

---

methods.tpp | *Methods for temporal point patterns*

Description

Methods for temporal point patterns.

Usage

```
## S3 method for class tpp
plot(x,...)
## S3 method for class tppint
plot(x,...)
## S3 method for class tpp
print(x)
```

```
## S3 method for class tppint
print(x)
```

Arguments

x	an object of class tpp or tppint.
...	graphics parameters passed to plot function.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

Examples

```
X <- tpp(sample(c(1:24),200,replace = T))
plot(X)
plot(density(X))
```

---

rpoistlpp	*Simulating spatio-temporal poisson point processes on a linear net-work*

Description

simulating a realisation of a spatio-temporal poisson point process on a linear network.

Usage

```
rpoistlpp(lambda,a,b,L,check=FALSE,lmax=NULL,nsim=1)
```

Arguments

lambda	intensity of the point process. It can be either a number or a function of location and time.
a	lower bound of time period.
b	upper bound of time period.
L	a linear network.
check	Logical value indicating whether to check that all the (x,y) points lie inside the specified window. see ppp.
lmax	upper bound for the values of labmda. This is optinal.
nsim	number of simulated patterns to generate.

Details

This function generates realisations of a spatio-temporal poisson point process on a linear network based on an intensity function lambda and lower/upper bounds a and b.

Value

an object of class stlpp if nsim=1, otherwise a list of objects of class stlpp.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

References

Moradi, M.M. and Mateu, J. (2019). First and second-order characteristics of spatio-temporal point processes on linear networks. Journal of Computational and Graphical Statistics. In press.

See Also

density.stlpp

Examples

```
X <- rpoistlpp(.2,a=0,b=5,L=easynet)
X
```

---

rthin.stlpp   *Random thinning*

Description

Applies independent random thinning to a spatio-temporal point pattern on a linear network.

Usage

```
## S3 method for class stlpp
rthin(X, P = P, nsim = 1)
```

Arguments

X	a spatio-temporal point pattern of class stlpp
P	retention probability
nsim	number of simulated realisations to be generated

Details

See rthin.

Value

An object of the same kind as X if nsim=1, or a list of such objects if nsim > 1.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

See Also

stlpp, rthin

Examples

```
data(Medellin)
rthin(Medellin,P=.5)
```

| STLg | *Pair correlation function for spatio-temporal point processes on linear networks* |

Description

Pair correlation function for spatio-temporal point processes on linear networks.

Usage

```
STLg(X,r=NULL,t=NULL)
```

Arguments

X	a realisation of a spatio-temporal point processes on a linear networks.
r	values of argument r where pair correlation function will be evaluated. optional.
t	values of argument t where pair correlation function will be evaluated. optional.

Details

This function calculates the pair correlation function for a homogeneous spatio-temporal point processes on a linear network.

Value

An object of class `sumstlpp`.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

References

Moradi, M.M. and Mateu, J. (2019). First and second-order characteristics of spatio-temporal point processes on linear networks. Journal of Computational and Graphical Statistics. In press.

See Also

`pcf`, `STLK`

Examples

```
X <- rpoistlpp(.2,a=0,b=5,L=easynet)
STLg(X)
```

STLginhom   *Inhomogeneous pair correlation function for spatio-temporal point processes on linear networks*

Description

Inhomogeneous pair correlation function for spatio-temporal point processes on linear networks.

Usage

```
STLginhom(X,lambda,normalize=FALSE,r=NULL,t=NULL,nxy=10)
```

Arguments

X	a realisation of a spatio-temporal point processes on a linear networks.
lambda	values of estimated intensity at data points.
normalize	normalization factor to be considered.
r	values of argument r where pair correlation function will be evaluated. optional.
t	values of argument t where pair correlation function will be evaluated. optional.
nxy	pixel array dimensions. optional.

Details

This function calculates the inhomogeneous pair correlation function for a spatio-temporal point processes on a linear network.

Value

An object of class sumstlpp.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

References

Moradi, M.M. and Mateu, J. (2019). First and second-order characteristics of spatio-temporal point processes on linear networks. Journal of Computational and Graphical Statistics. In press.

See Also

STLg, STLK, STLKinhom

Examples

```
X <- rpoistlpp(.2,a=0,b=5,L=easynet)
d <- density(X,at="points")
STLginhom(X,lambda=d,normalize=TRUE)
```

STLK   *K-function for spatio-temporal point processes on linear networks*

Description

K-function for spatio-temporal point processes on linear networks.

Usage

```
STLK(X,r=NULL,t=NULL)
```

Arguments

X	a realisation of a spatio-temporal point processes on a linear networks.
r	values of argument r where pair correlation function will be evaluated. optional.
t	values of argument t where pair correlation function will be evaluated. optional.

Details

This function calculates the K-function for a homogeneous spatio-temporal point processes on a linear network.

Value

An object of class `sumstlpp`.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

References

Moradi, M.M. and Mateu, J. (2019). First and second-order characteristics of spatio-temporal point processes on linear networks. Journal of Computational and Graphical Statistics. In press.

See Also

`Kest`, `STLg`

Examples

```
X <- rpoistlpp(.2,a=0,b=5,L=easynet)
STLK(X)
```

STLKinhom	*Inhomogeneous K-function for spatio-temporal point processes on linear networks*

Description

Inhomogeneous K-function for spatio-temporal point processes on linear networks

Usage

```
STLKinhom(X,lambda=lambda,normalize=FALSE,r=NULL,t=NULL,nxy=10)
```

Arguments

X	a realisation of a spatio-temporal point processes on a linear networks.
lambda	values of estimated intensity.
normalize	normalization factor to be considered.
r	values of argument r where pair correlation function will be evaluated. optional.
t	values of argument t where pair correlation function will be evaluated. optional.
nxy	pixel array dimensions. optional.

Details

This function calculates the inhomogeneous K-function for a spatio-temporal point processes on a linear network.

Value

An object of class [sumstlpp](#).

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

References

Moradi, M.M. and Mateu, J. (2019). First and second-order characteristics of spatio-temporal point processes on linear networks. Journal of Computational and Graphical Statistics. In press.

See Also

[STLg](#), [STLK](#), [STLginhom](#)

Examples

```
X <- rpoistlpp(.2,a=0,b=5,L=easynet)
lambda <- density(X,at="points")
STLKinhom(X,lambda=lambda,normalize=TRUE)
```

---

stlpp   *Create spatio-temporal point pattern on linear network*

Description

Create spatio-temporal point pattern on linear network.

Usage

```
stlpp(X, L, T, ...)
```

Arguments

X	Locations of the points. A matrix or data frame of coordinates, or a point pattern object (of class "ppp") or other data acceptable to `as.ppp` or `lpp`
L	linear network (object of class "linnet")
T	time vector
...	ignored

Details

This function creates an object of class stlpp. For details about X see `lpp`. T represents the time occurrence of data points.

Value

an object of class stlpp.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

See Also

`as.stlpp`, `lpp`

---

tpp   *Create a temporal point pattern.*

Description

Create an object of class `tpp` that represents a temporal point pattern.

Usage

```
tpp(X)
```

Arguments

X	an object of class `numeric`, `integer` or `vector`

Details

Create a temporal point pattern.

Value

An object of class tpp.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

See Also

stlpp

Examples

```
tpp(runif(10))
```

---

unique.stlpp	*Extract unique points from a spatio-temporal point pattern on a linear network*

Usage

```
## S3 method for class stlpp
unique(X,...)
```

Arguments

X	a realisation of a spatio-temporal point processes on a linear networks.
...	arguments for unique.

Details

This function calculates the inhomogeneous pair correlation function for a spatio-temporal point processes on a linear network.

Value

A spatio-temporal point pattern on a linear network with no duplicated point.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

References

Moradi, M.M. and Mateu, J. (2019). First and second-order characteristics of spatio-temporal point processes on linear networks. Journal of Computational and Graphical Statistics. In press.

See Also

unique

Examples

```
X =  rpoistlpp(0.1,0,5,L=easynet)
df = as.data.frame(X)
df_dup = df[sample(nrow(df), 20,replace = T), ]
Y = as.stlpp(df_dup,L=easynet)
npoints(Y)
npoints(unique(Y))
```

Index