Package 'splancs'

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Title Spatial and Space-Time Point Pattern Analysis

Depends R (>= 2.10.0), sp (>= 0.9)

Imports stats, graphics, grDevices, methods

Description The Splancs package was written as an enhancement to S-Plus for display and analysis of spatial point pattern data; it has been ported to R and is in ``maintenance mode".

License GPL (>= 2)

URL https://www.maths.lancs.ac.uk/~rowlings/Splancs/, https://rsbivand.github.io/splancs/, https://github.com/rsbivand/splancs

BugReports https://github.com/rsbivand/splancs/issues

NeedsCompilation yes

Author Roger Bivand [cre], Barry Rowlingson [aut], Peter Diggle [aut], Giovanni Petris [ctb], Stephen Eglen [ctb]

Maintainer Roger Bivand <Roger.Bivand@nhh.no>

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Contents

`addpoints` *Add points interactively to a point data set*

Description

Add points interactively to a point data set.

Usage

```
addpoints(pts,plot=FALSE,quiet=FALSE)
```

Arguments

`pts`	A points data set.
`plot`	if true, plot the `pts` data, using `pointmap`. If false, or if `pts` is missing, don't plot the data.
`quiet`	if true, don't print a prompt to enter points.

Details

The points entered are displayed on the current graphics device.

Value

A points data set consisting of `pts` and the points entered on the current graphics device.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

delpoints

---

amacrines *Amacrines on/off data set*

Description

Two two-column matrices of points marked on and off

Usage

```
data(amacrines)
```

Format

Two two-column matrices of points marked on and off

Source

https://www.maths.lancs.ac.uk/~diggle/pointpatterns/Datasets/, Peter J. Diggle, Department of Mathematics and Statistics, Lancaster University, Lancaster LA1 4YF, UK: public-domain spatial point pattern data-sets.

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areapl *Calculate area of polygon*

Description

Calculate area of polygon. If the polygon is self-intersecting, the area will not be correct.

Usage

```
areapl(poly)
```

Arguments

poly	a polygon data set

Value

The area of the polygon is returned

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

Examples

```
x <- c(1,0,0,1,1,1,1,3,3,1)
y <- c(0,0,1,1,0,0,-1,-1,0,0)
m <- cbind(x, y)
plot(m, type="b")
areapl(m)
areapl(m[1:5,])
areapl(m[6:10,])
```

---

as.points *Creates data in spatial point format*

Description

Creates data in spatial point format.

Usage

```
as.points(...)
```

Arguments

...	any object(s), such as x and y vectors of the same length, or a list or data frame containing x and y vectors. Valid options for ... are: a points object ; returns it unaltered; a list with x and y elements of the same length — returns a points object with the x and y elements as the coordinates of the points; two vectors of equal length ; returns a points object with the first vector as the x coordinates, the second vector as the y-coordinates.

Value

as.points tries to return the argument(s) as a points object.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

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bboxx *Generate a non-closed bounding polygon*

Description

Generate a non-closed bounding polygon from the bounding box of an object

Usage

```
bboxx(obj)
```

Arguments

obj	A matrix with two rows and two columns reporting the bounding box of an object

Details

The object used by bboxx may easily be created by using the **sp** bbox method on an object of interest, such as a points data set.

Value

A points data set of four points giving the non-closed coordinates of the bounding box

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

sbox, bbox

bodmin *Bodmin Moors granite tors*

Description

Locations of 35 granite tors on Bodmin Moor, taken from Infomap data set (northings multiplied by -1 to correspond to Figure 3.2, p. 82, Bailey and Gatrell.

Usage

```
data(bodmin)
```

Format

A list corresponding to a Venables and Ripley point object with 35 observations

x	numeric	grid eastings
y	numeric	grid northings
area	list	bounding box with xl, xu, yl, yu
poly	array	polygon boundary with columns x and y

Source

Pinder and Witherick, 1977 - Bailey and Gatrell 1995, ch. 3.

References

Bailey, T. C. and Gatrell, A. C. 1995, Interactive spatial data analysis. Longman, Harlow.

burkitt *Burkitt's lymphoma in Uganda*

Description

Locations of cases of Burkitt's lymphoma in the Western Nile district of Uganda 1960-1975. The time variable is recorded as the number of days starting from an origin of 1 Jan 1960. The examples given below show how the `chron()` function and derived time structures may be used to analyse the data in the time dimension.

Usage

```
data(burkitt)
```

Format

The data is provided as a data table:

x	numeric	grid eastings
y	numeric	grid northings
t	numeric	day number starting at 1/1/1960 of onset
age	numeric	age of child patient
dates	factor	day as string yy-mm-dd

as a points object `burpts` of `burkitt$x` and `burkitt$y`; and a point object of the area boundary `burbdy`.

Source

Williams, E. H. et al. 1978, - Bailey and Gatrell 1995, ch. 3.

References

Bailey, T. C. and Gatrell, A. C. 1995, Interactive spatial data analysis. Longman, Harlow.

Examples

```
data(burkitt)
burDates <- as.Date(as.character(burkitt$dates), "%y-%m-%d")
res <- aggregate(rep(1, length(burDates)), list(quarters(burDates), format(burDates, "%y")), sum)
plot(as.numeric(as.character(res$Group.2)) +
 0.25*(as.numeric(substr(as.character(res$Group.1), 2, 2))-1),
 res$x, type="h", lwd=3, col=ifelse(as.character(res$Group.1)=="Q3",
 "grey","red"), xlab="year", ylab="count", xaxt="n")
axis(1, at=seq(61,75,4), labels=format(seq.Date(as.Date("1961/1/1"),
 as.Date("1975/1/1"), "4 years")))
title("Plot of Burkitt's lymphoma in West Nile district,\nQ3 grey shaded")
op <- par(mfrow=c(3,5))
for (i in unique(format(burDates, "%y"))) {
polymap(burbdy)
pointmap(burpts[which(format(burDates, "%y") == i),], add=TRUE, pch=19)
title(main=paste("19", i, sep=""))
}
par(op)
op <- par(mfrow=c(2,2))
for (i in c("Q1", "Q2", "Q3", "Q4")) {
polymap(burbdy)
pointmap(burpts[which(unclass(quarters(burDates)) == i),], add=TRUE,
pch=19)
title(main=i)
}
par(op)
op <- par(mfrow=c(3,4))
for (i in months(seq(as.Date("70-01-01", "%y-%m-%d"), len=12, by="1 month"))) {
polymap(burbdy)
```

```
pointmap(burpts[which(unclass(months(burDates)) == i),], add=TRUE, pch=19)
title(main=i)
}
par(op)
```

`cardiff` *Locations of homes of juvenile offenders*

Description

Locations of homes of 168 juvenile offenders on a Cardiff housing estate

Usage

```
data(cardiff)
```

Format

A list corresponding to a Venables and Ripley point object with 168 observations

x	numeric	grid eastings
y	numeric	grid northings
area	list	bounding box with xl, xu, yl, yu
poly	array	polygon boundary with columns x and y

Source

Herbert, 1980, - Bailey and Gatrell 1995, ch. 3.

References

Bailey, T. C. and Gatrell, A. C. 1995, Interactive spatial data analysis. Longman, Harlow.

`csr` *Generate completely spatially random points on a polygon*

Description

Generate completely spatially random points on a polygon.

Usage

```
csr(poly,npoints)
```

Arguments

poly	A polygon data set.
npoints	The number of points to generate.

Details

csr generates points randomly in the bounding box of poly, then uses pip to extract those in the polygon. If the number of points remaining is less than that required, csr generates some more points in the bounding box until at least npoints remain inside the polygon. If too many points are generated then the list of points is truncated.

Uses runif() to generate random numbers and so updates .Random.seed, the standard S random number generator seed.

Value

A point data set consisting of npoints points distributed randomly, i.e. as an independent random sample from the uniform distribution in the polygon defined by poly.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

Examples

```
data(cardiff)
nsim <- 29
emp.Ghat <- Ghat(as.points(cardiff), seq(0,30,1))
av.Ghat <- numeric(length(emp.Ghat))
U.Ghat <- numeric(length(emp.Ghat))
L.Ghat <- numeric(length(emp.Ghat))
U.Ghat <- -99999
L.Ghat <- 99999
for(i in 1:nsim) {
S.Ghat <- Ghat(csr(cardiff$poly, length(cardiff$x)), seq(0,30,1))
av.Ghat <- av.Ghat + S.Ghat
L.Ghat <- pmin(S.Ghat, L.Ghat)
U.Ghat <- pmax(S.Ghat, U.Ghat)
}
av.Ghat <- av.Ghat/nsim
plot(av.Ghat, emp.Ghat, type="l", xlim=c(0,1), ylim=c(0,1),
xlab="Simulated average G", ylab="Empirical G")
lines(c(0,1),c(0,1),lty=2)
lines(U.Ghat,emp.Ghat,lty=3)
lines(L.Ghat,emp.Ghat,lty=3)
```

delpoints *Select points to delete from a points data set*

Description

Select points to delete from a points data set.

Usage

```
delpoints(pts,add=FALSE)
```

Arguments

pts	a points data set
add	if false, plot the points using pointmap.

Details

Using the mouse, the user selects points on the current graphics device. These points are marked on the plot as they are selected. The function returns the remaining points as a points object. If add is false the points are plotted on the current plot device.

Value

A points object containing the undeleted points.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

dsquare *Distance-squared from a number of points to a number of sources*

Description

Computes the distance-squared from a number of points to a number of sources.

Usage

```
dsquare(pts, srcs, namepref="d")
```

Arguments

pts	A number of points representing the locations of cases and controls.
srcs	A number of points representing source locations
namepref	A prefix given to the name of the results.

Value

A data frame with the same number of columns as srcs. The column names will be the value of namepref prefixing the numbers from 1 to the number of sources.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

tribble, triblik

Fhat *F nearest neighbour distribution function*

Description

Calculates an estimate of the F nearest neighbour distribution function

Usage

```
Fhat(pts1,pts2,s)
```

Arguments

pts1	A points data set
pts2	A points data set
s	A vector of distances at which to evaluate Fhat

Details

The function Fhat(pts1,pts2,s) is defined as the proportion of members of a point set pts2 for which the distance to the nearest member of another points set pts1 is less than or equal to s.

Value

A vector of the same length as s, containing the value of Fhat at the distances in s.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

nndistF,Fzero

Examples

```
data(uganda)
plot(seq(20, 500, 20), Fhat(as.points(uganda),
as.points(csr(uganda$poly, length(uganda$x))), seq(20, 500, 20)),
type="l", xlab="distance", ylab="Estimated F")
plot(Ghat(as.points(uganda), seq(20, 500, 20)), Fhat(as.points(uganda),
as.points(csr(uganda$poly, length(uganda$x))), seq(20, 500, 20)),
type="l", xlab="Estimated G", ylab="Estimated F")
lines(c(0,1),c(0,1),lty=2)
```

Fzero *Theoretical nearest neighbour distribution function*

Description

Calculate the theoretical nearest neighbour distribution function.

Usage

```
Fzero(density,s)
```

Arguments

density	The density of the point pattern, i.e. the number of points per unit area.
s	A vector of distances at which to evaluate Fzero

Details

Fzero returns the nearest neighbour distribution for a homogeneous planar Poisson process. In fortran notation, Fzero(s) is `FZERO = 1-EXP(-PI*DENSITY*(S**2))`.

Value

A vector of the same length as s, containing the value of Fzero at the distances in s.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

Fhat,Ghat,pdense

Examples

```
data(uganda)
plot(Ghat(as.points(uganda), seq(20, 500, 20)), Fzero(pdense(as.points(uganda),
uganda$poly), seq(20, 500, 20)), type="l", ylab="Theoretical G",
xlab="Estimated G")
lines(c(0,1),c(0,1),lty=2)
```

---

gen *generate points in polygon*

Description

generates random points within a defined polygon, trying to reach npoints points - used in csr.

Usage

```
gen(poly, npoints)
```

Arguments

poly	A polygon data set
npoints	The number of points to generate

Value

returns a point object.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

csr

---

getpoly *Draw a polygon on the current graphics device*

Description

Draw a polygon on the current graphics device

Usage

```
getpoly(quiet=FALSE)
```

Arguments

quiet	if TRUE, don't prompt for input of a polygon.

Details

The system prompts the user to enter points on the current graphics device using the mouse or other pointing device. The points are joined on the screen with the current line symbol. A polygon of the points entered is drawn on the current graphics device.

Value

A polygon data set consisting of the points entered. The current coordinate system is used.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

Ghat *G nearest neighbour distribution function*

Description

Calculates an estimate of the G nearest neighbour distribution function.

Usage

```
Ghat(pts,s)
```

Arguments

pts	A points data set
s	A vector of distances at which to evaluate the G function

Details

The function `Ghat(pts,s)` is defined as the proportion of members of a point set for which the distance to the nearest other member of the set is less than or equal to `s`.

Value

A vector of the same length as `s`, containing the estimate of G at the distances in `s`.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

Fhat, nndistG

Examples

```
data(uganda)
plot(seq(20, 500, 20), Ghat(as.points(uganda), seq(20, 500, 20)),
type="l", xlab="distance", ylab="Estimated G")
```

gridpts *Generate a grid of points*

Description

Generate a grid of points

Usage

```
gridpts(poly,npts,xs,ys)
```

Arguments

poly	polygon in which to generate the points
npts	approximate number of points to generate
xs, ys	grid spacing in x and y Either npts or xs and ys must be specified. If all three are given then xs and ys are ignored.

Value

A points object containing a grid of points inside the polygon. If npts is specified, then a grid spacing xs and ys will be calculated to give approximately npts in the polygon. If xs and ys are given then these will be used to generate a number of points in the polygon.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

inout *Test points for inclusion in a polygon*

Description

Test points for inclusion in a polygon.

Usage

```
inout(pts,poly,bound=NULL,quiet=TRUE)
```

Arguments

pts	A points data set
poly	A polygon data set
bound	If points fall exactly on polygon boundaries, the default NULL gives arbitrary assignments. If TRUE, then all points "on" boundaries are set as within the polygon, if FALSE, outside.
quiet	Do not report which points are on boundary for non-NULL bound

Value

A vector of logical values. TRUE means the point was inside the polygon, FALSE means the point was outside. Note that "inside" is an arbitrary concept for points "on" the polygon boundary.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

inpip,pip

Examples

```
data(uganda)
suganda <- sbox(uganda$poly)
ruganda <- csr(suganda, 1000)
polymap(suganda)
polymap(uganda$poly, add=TRUE)
def <- inout(ruganda, uganda$poly, bound=NULL)
pointmap(as.points(ruganda[def,1], ruganda[def,2]), add=TRUE, col="black")
pointmap(as.points(ruganda[!def,1], ruganda[!def,2]), add=TRUE, col="red")
tru <- inout(ruganda, uganda$poly, bound=TRUE, quiet=FALSE)
which(tru & !def)
ds1 <- as.points(expand.grid(x=seq(-1.5,1.5,0.5), y=seq(-1.5,1.5,0.5)))
ds1.poly <- ds1[chull(ds1),]
ds2 <- as.points(rnorm(300),rnorm(300))
plot(ds2, type="n", asp=1)
polymap(ds1.poly, add=TRUE, border="lightblue", col="lightblue", lwd=1)
points(ds2[inout(ds2,ds1.poly),],  col="green",  pch=20)
points(ds2[!inout(ds2,ds1.poly),], col="orange", pch=20)
points(ds1[inout(ds1,ds1.poly),],  col="black",  pch=20)
points(ds1[!inout(ds1,ds1.poly),], col="red",    pch=20)
plot(ds2, type="n", asp=1)
polymap(ds1.poly, add=TRUE, border="lightblue", col="lightblue", lwd=1)
points(ds2[inout(ds2,ds1.poly,bound=TRUE),],  col="green",  pch=20)
points(ds2[!inout(ds2,ds1.poly,bound=TRUE),], col="orange", pch=20)
```

```
points(ds1[inout(ds1,ds1.poly,bound=TRUE),],  col="black",  pch=20)
points(ds1[!inout(ds1,ds1.poly,bound=TRUE),], col="red",    pch=20)
plot(ds2, type="n", asp=1)
polymap(ds1.poly, add=TRUE, border="lightblue", col="lightblue", lwd=1)
points(ds2[inout(ds2,ds1.poly,bound=FALSE),],  col="green",  pch=20)
points(ds2[!inout(ds2,ds1.poly,bound=FALSE),], col="orange", pch=20)
points(ds1[inout(ds1,ds1.poly,bound=FALSE),],  col="black",  pch=20)
points(ds1[!inout(ds1,ds1.poly,bound=FALSE),], col="red",    pch=20)
```

`inpip` *Select points inside a polygon*

Description

Select points inside a polygon

Usage

```
inpip(pts,poly,bound=NULL,quiet=TRUE)
```

Arguments

`pts`	A points data set
`poly`	A polygon data set
`bound`	If points fall exactly on polygon boundaries, the default NULL gives arbitrary assignments. If TRUE, then all points "on" boundaries are set as within the polygon, if FALSE, outside.
`quiet`	Do not report which points are on boundary for non-NULL bound

Value

`inpip` returns a vector of indices of the points in `pts` that are located in the polygon. Note that "in" is an arbitrary concept for points "on" the polygon boundary.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

`pip`

is.points *Point Objects*

Description

Tests for data in spatial point format.

Usage

```
is.points(p)
```

Arguments

p	any object.

Value

is.points returns TRUE if p is a points object, FALSE otherwise.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

k12hat *Bivariate K-function*

Description

Calculates an estimate of the bivariate K-function

Usage

```
k12hat(pts1,pts2,poly,s)
```

Arguments

pts1, pts2	Two points data sets
poly	A polygon containing the points
s	A vector of distances at which to estimate the K12 function

Details

The bivariate K function is defined as the expected number of points of pattern 1 within a distance s of an arbitrary point of pattern 2, divided by the overall density of the points in pattern 1. To estimate this function, the approximately unbiased estimator given by Lotwick and Silverman (1982) is used.

Value

A vector like `s` containing the value of K12hat at the points in `s`.

References

Lotwick, H.W. and Silverman B.W. (1982) Methods for Analysing Spatial Processes of Several types of Points. *J. R. Statist Soc* B44 406-13; Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

Examples

```
data(okwhite)
data(okblack)
okpoly <- list(x=c(okwhite$x, okblack$x), y=c(okwhite$y, okblack$y))
plot(seq(5,80,5), sqrt(k12hat(as.points(okwhite), as.points(okblack),
bboxx(bbox(as.points(okpoly))), seq(5,80,5))/pi) - seq(5,80,5), xlab="distance",
ylab=expression(hat(L)[12]), ylim=c(-20,20), type="l")
```

`Kenv.csr` *Envelope of Khat from simulations of complete spatial randomness*

Description

Compute envelope of Khat from simulations of complete spatial randomness.

Usage

```
Kenv.csr(nptg,poly,nsim,s,quiet=FALSE)
```

Arguments

`nptg`	Number of points to generate in each simulation.
`poly`	Polygon in which to generate the points.
`nsim`	Number of simulations to do.
`s`	Vector of distances at which to calculate the envelope.
`quiet`	If FALSE, print a message after every simulation for progress monitoring. If TRUE, print no messages.

Value

A list with two components, called `$upper` and `$lower`. Each component is a vector like `s`. The two components contain the upper and lower bound of the Khat envelope.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

csr, khat

Examples

```
data(cardiff)
UL.khat <- Kenv.csr(length(cardiff$x), cardiff$poly, nsim=29, seq(2,30,2))
plot(seq(2,30,2), sqrt(khat(as.points(cardiff), cardiff$poly,
seq(2,30,2))/pi)-seq(2,30,2), type="l", xlab="Splancs - polygon boundary",
ylab="Estimated L", ylim=c(-1,1.5))
lines(seq(2,30,2), sqrt(UL.khat$upper/pi)-seq(2,30,2), lty=2)
lines(seq(2,30,2), sqrt(UL.khat$lower/pi)-seq(2,30,2), lty=2)
```

Kenv.label *Envelope of K1hat-K2hat from random labelling of two point patterns*

Description

Compute envelope of K1hat-K2hat from random labelling of two point patterns

Usage

```
Kenv.label(pts1,pts2,poly,nsim,s,quiet=FALSE)
```

Arguments

`pts1`	First point data set.
`pts2`	Second point data set.
`poly`	Polygon containing the points.
`nsim`	Number of random labellings to do.
`s`	Vector of distances at which to calculate the envelope.
`quiet`	If FALSE, print a message after every simulation for progress monitoring. If TRUE, print no messages.

Details

The two point data sets are randomly labelled using `rLabel`, then `Khat` is called to estimate the K-function for each resulting set at the distances in `s`. The difference between these two estimates is then calculated. The maximum and minimum values of this difference at each distance,over the `nlab` labellings is returned.

Value

A list with two components, called `$upper` and `$lower`. Each component is a vector like `s`.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

rLabel,ikhat

Examples

```
data(okwhite)
data(okblack)
okpoly <- list(x=c(okwhite$x, okblack$x), y=c(okwhite$y, okblack$y))
K1.hat <- khat(as.points(okwhite), bboxx(bbox(as.points(okpoly))), seq(5,80,5))
K2.hat <- khat(as.points(okblack), bboxx(bbox(as.points(okpoly))), seq(5,80,5))
K.diff <- K1.hat-K2.hat
plot(seq(5,80,5), K.diff, xlab="distance", ylab=expression(hat(K)[1]-hat(K)[2]),
ylim=c(-11000,7000), type="l", main="Simulation envelopes, random labelling")
env.lab <- Kenv.label(as.points(okwhite), as.points(okblack),
bboxx(bbox(as.points(okpoly))), nsim=29, s=seq(5,80,5))
lines(seq(5,80,5), env.lab$upper, lty=2)
lines(seq(5,80,5), env.lab$lower, lty=2)
```

Kenv.pcp *Calculate simulation envelope for a Poisson Cluster Process*

Description

This function computes the envelope of Khat from simulations of a Poisson Cluster Process for a given polygon

Usage

```
Kenv.pcp(rho, m, s2, region.poly, larger.region=NULL, nsim, r, vectorise.loop=TRUE)
```

Arguments

rho	intensity of the parent process
m	average number of offsprings per parent
s2	variance of location of offsprings relative to their parent
region.poly	a polygon defining the region in which the process is to be generated
larger.region	a rectangle containing the region of interest given in the form (xl,xu,yl,yu), defaults to sbox() around region.poly
nsim	number of simulations required
r	vector of distances at which the K function has to be estimated
vectorise.loop	if TRUE, use new vectorised code, if FALSE, use loop as before

Value

ave	mean of simulations
upper	upper bound of envelope
lower	lower bound of envelope

Author(s)

Giovanni Petris <GPetris@uark.edu>, Roger.Bivand@nhh.no

References

Diggle, P. J. (1983) *Statistical analysis of spatial point patterns*, London: Academic Press, pp. 55-57 and 78-81; Bailey, T. C. and Gatrell, A. C. (1995) *Interactive spatial data analysis*, Harlow: Longman, pp. 106-109.

See Also

pcp, pcp.sim, khat

Examples

```
data(cardiff)
polymap(cardiff$poly)
pointmap(as.points(cardiff), add=TRUE)
title("Locations of homes of 168 juvenile offenders")
pcp.fit <- pcp(as.points(cardiff), cardiff$poly, h0=30, n.int=30)
pcp.fit
m <- npts(as.points(cardiff))/(areapl(cardiff$poly)*pcp.fit$par[2])
r <- seq(2,30,by=2)
K.env <- Kenv.pcp(pcp.fit$par[2], m, pcp.fit$par[1], cardiff$poly,
          nsim=20, r=r)
L.env <- lapply(K.env, FUN=function(x) sqrt(x/pi)-r)
limits <- range(unlist(L.env))
plot(r, sqrt(khat(as.points(cardiff),cardiff$poly,r)/pi)-r, ylim=limits,
     main="L function with simulation envelopes and average", type="l",
```

```
     xlab="distance", ylab="")
lines(r, L.env$lower, lty=5)
lines(r, L.env$upper, lty=5)
lines(r, L.env$ave, lty=6)
abline(h=0)
```

Kenv.tor *Envelope of K12hat from random toroidal shifts of two point patterns*

Description

Compute envelope of K12hat from random toroidal shifts of two point patterns.

Usage

```
Kenv.tor(pts1,pts2,poly,nsim,s,quiet=FALSE)
```

Arguments

pts1	First point data set.
pts2	Second point data set.
poly	Polygon containing the points.
nsim	Number of random toroidal shifts to do.
s	Vector of distances at which to calculate the envelope.
quiet	If FALSE, print a message after every simulation for progress monitoring. If true, print no messages.

Details

The second point data set is randomly shifted using rtor.shift in the rectangle defined by poly. Then k12hat is called to compute K12hat for the two patterns. The upper and lower values of K12hat over the ntor toroidal shifts are returned.

Value

A list with two components, called $upper and $lower. Each component is a vector like s.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

rtor.shift,k12hat

Examples

```
data(okwhite)
data(okblack)
okpoly <- list(x=c(okwhite$x, okblack$x), y=c(okwhite$y, okblack$y))
plot(seq(5,80,5), sqrt(k12hat(as.points(okwhite), as.points(okblack),
bboxx(bbox(as.points(okpoly))), seq(5,80,5))/pi) - seq(5,80,5), xlab="distance",
ylab=expression(hat(L)[12]), ylim=c(-35,35), type="l",
main="Simulation envelopes, random toroidal shifts")
env.ok <- Kenv.tor(as.points(okwhite), as.points(okblack),
bboxx(bbox(as.points(okpoly))), nsim=29, s=seq(5,80,5))
lines(seq(5,80,5), sqrt(env.ok$upper/pi)-seq(5,80,5), lty=2)
lines(seq(5,80,5), sqrt(env.ok$lower/pi)-seq(5,80,5), lty=2)
```

`Kenv.tor1` *Modified envelope of K12hat from random toroidal shifts of two point patterns*

Description

Modification of `Kenv.tor()` to allow the assignment of a p value to the goodness of fit, following the method outlined in Peter Diggle's 1986 paper (J Neurosci methods 18:115-125) and in his 2002 book.

Usage

```
Kenv.tor1(pts1, pts2, poly, nsim, s, quiet = FALSE)
```

Arguments

`pts1`	First point data set
`pts2`	Second point data set
`poly`	Polygon containing the points
`nsim`	Number of random toroidal shifts to do
`s`	Vector of distances at which to calculate the envelope
`quiet`	If FALSE, print a message after every simulation for progress monitoring. If TRUE, print no messages

Value

A list with components: `$upper`, `$lower`, `real`, `u`, `ksim`, and `rank`. The first three components are vectors like `s`, the next two contain results passed back from the simulations, and the final is a one-element vector with the rank of the observed data set.

Author(s)

Stephen Eglen <stephen@inf.ed.ac.uk>

See Also

Kenv.tor

Examples

```
data(amacrines)
ama.a <- rbind(amacrines.on, amacrines.off)
ama.bb <- bboxx(bbox(as.points(ama.a)))
ama.t <- seq(from = 0.002, to=.250, by=0.002)
nsim=999
plot(amacrines.on, asp=1, pch=19,
 main="Data set, match figure 1.4 of Diggle(2002)?")
points(amacrines.off, pch=1)
#
k12 <- k12hat(amacrines.on, amacrines.off, ama.bb, ama.t)
#
k11 <- khat(amacrines.on, ama.bb, ama.t)
k22 <- khat(amacrines.off, ama.bb, ama.t)
k00 <- khat(ama.a, ama.bb, ama.t)
theor <- pi * (ama.t^2)
#
plot(ama.t, k12-theor, ylim=c(min( c(k12, k11, k22, k00) - theor),
 max( c(k12, k11, k22, k00) - theor)),
 main="2nd order properties, match figure 4.8 of Diggle (2002)", type="l")
lines(ama.t, -theor)
lines(ama.t, k11-theor, lty=2)
lines(ama.t, k22-theor, lty=3)
lines(ama.t, k00-theor, lty=5)
#
k12.tor <- Kenv.tor(amacrines.on, amacrines.off, ama.bb,
 nsim, ama.t, quiet=TRUE)
plot(ama.t, k12-theor, type="l", main="Output from Kenv.tor")
lines(ama.t, k12.tor$upper-theor, type="l", col="red")
lines(ama.t, k12.tor$lower-theor, type="l", col="red")
#
k12.sims <- Kenv.tor1(amacrines.on, amacrines.off, ama.bb,
 nsim, ama.t, quiet=TRUE)
plot(ama.t, sqrt(k12.sims$real/pi), type="l", asp=1, bty="n",
 main=paste("K12 versus toroidal sims; rank ", k12.sims$rank, "of",
 length(k12.sims$u)))
lines(ama.t, sqrt(k12.sims$upper/pi), col="red")
lines(ama.t, sqrt(k12.sims$lower/pi), col="red")
```

---

kernel2d *Kernel smoothing of a point pattern*

Description

Perform kernel smoothing of a point pattern

Usage

```
kernel2d(pts,poly,h0,nx=20,ny=20,kernel='quartic',quiet=FALSE)
spkernel2d(pts, poly, h0, grd, kernel = "quartic")
```

Arguments

pts	A points data set, or in function spkernel2d an object with a coordinates method from the sp package
poly	A splancs polygon data set
h0	The kernel width parameter
nx	Number of points along the x-axis of the returned grid.
ny	Number of points along the y-axis of the returned grid.
kernel	Type of kernel function to use. Currently only the quartic kernel is implemented.
quiet	If TRUE, no debugging output is printed.
grd	a GridTopology object from the sp package

Details

The kernel estimate, with a correction for edge effects, is computed for a grid of points that span the input polygon. The kernel function for points in the grid that are outside the polygon are returned as NA's. The output list is in a format that can be read into `image()` directly, for display and superposition onto other plots.

Value

kernel2d returns a list with the following components:

x	List of x-coordinates at which the kernel function has been evaluated.
y	List of y-coordinates at which the kernel function has been evaluated.
z	A matrix of dimension nx by ny containing the value of the kernel function.
h0, kernel	containing the values input to kernel2d

spkernel2d returns a numeric vector with the value of the kernel function stored in the order required by sp package SpatialGridDataFrame objects

References

Berman M. and Diggle P.J. (1989) Estimating Weighted Integrals of the Second-Order Intensity of Spatial Point Patterns. *J. R. Statist Soc* B51 81-92; Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655, (Barry Rowlingson); the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

Examples

```
data(bodmin)
plot(bodmin$poly, asp=1, type="n")
image(kernel2d(as.points(bodmin), bodmin$poly, h0=2, nx=100, ny=100),
add=TRUE, col=terrain.colors(20))
pointmap(as.points(bodmin), add=TRUE)
polymap(bodmin$poly, add=TRUE)
bodmin.xy <- coordinates(bodmin[1:2])
apply(bodmin$poly, 2, range)
grd1 <- GridTopology(cellcentre.offset=c(-5.2, -11.5), cellsize=c(0.2, 0.2), cells.dim=c(75,100))
k100 <- spkernel2d(bodmin.xy, bodmin$poly, h0=1, grd1)
k150 <- spkernel2d(bodmin.xy, bodmin$poly, h0=1.5, grd1)
k200 <- spkernel2d(bodmin.xy, bodmin$poly, h0=2, grd1)
k250 <- spkernel2d(bodmin.xy, bodmin$poly, h0=2.5, grd1)
df <- data.frame(k100=k100, k150=k150, k200=k200, k250=k250)
kernels <- SpatialGridDataFrame(grd1, data=df)
spplot(kernels, checkEmptyRC=FALSE, col.regions=terrain.colors(16), cuts=15)
```

---

kernel3d *Space-time kernel*

Description

Compute the space-time kernel

Usage

```
kernel3d(pts, times, xgr, ygr, zgr, hxy, hz)
```

Arguments

pts	A matrix of event coodinates x,y.
times	A vector of event times, t.
xgr	The values of x at which to compute the kernel function.
ygr	The values of y at which to compute the kernel function.
zgr	The values of time at which to compute the kernel function.
hxy	The quartic kernel width in the x and y direction.
hz	The quartic kernel width in the temporal direction.

Value

A list is returned. Most of the components are just copies of the input parameters, except for the `$v` parameter. This is a three dimensional array containing the kernel-smoothed values. Its dimension is `[length(xgr),length(ygr),length(tgr)]`.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

kerview

Examples

```
data(burkitt)
b3d <- kernel3d(burpts, burkitt$t, seq(250,350,10), seq(250, 400, 10),
  seq(365,5800,365), 30, 200)
brks <- quantile(b3d$v, seq(0,1,0.05))
cols <- heat.colors(length(brks)-1)
oldpar <- par(mfrow=c(3,5))
for (i in 1:15) image(seq(250,350,10), seq(250, 400, 10), b3d$v[,,i],
  asp=1, xlab="", ylab="", main=1960+i, breaks=brks, col=cols)
par(oldpar)
```

---

kernrat *Ratio of two kernel smoothings*

Description

Return the ratio of two kernel smoothings

Usage

```
kernrat(pts1,pts2,poly,h1,h2,nx=20,ny=20,kernel='quartic')
```

Arguments

pts1, pts2	Point data sets
poly	A polygon data set
h1, h2	The kernel width parameters, h1 for pts1, and h2 for pts2
nx	Number of points along the x-axis of the returned grid.
ny	Number of points along the y-axis of the returned grid.
kernel	Type of kernel function to use. Currently only the quartic kernel is implemented.

Value

A list with the following components:

x	List of x-coordinates at which the kernel function has been evaluated.
y	List of y-coordinates at which the kernel function has been evaluated.
z	A matrix of dimension nx by ny containing the ratio of the kernel functions.
h	A vector of length 2 containing h1 and h2
kernel	a character string containing the kernel name.

References

Berman M. and Diggle P.J. (1989) Estimating Weighted Integrals of the Second-Order Intensity of Spatial Point Patterns. *J. R. Statist Soc* B51 81-92; Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

kernel2d, mse2d

Examples

```
data(okwhite)
data(okblack)
okpoly <- list(x=c(okwhite$x, okblack$x), y=c(okwhite$y, okblack$y))
kr <- kernrat(as.points(okwhite), as.points(okblack), bboxx(bbox(as.points(okpoly))),
 h1=50, h2=50)
image(kr, asp=1)
brks <- quantile(c(kr$z), seq(0,1,1/10), na.rm=TRUE)
lbrks <- formatC(brks, 3, 6, "g", " ")
cols <- heat.colors(length(brks)-1)
def.par <- par(no.readonly = TRUE)
layout(matrix(c(1,0,1,2), 2, 2, byrow = TRUE), c(2.5,1.5), c(1,3), TRUE)
image(kr, breaks=brks, col=cols, asp=1)
plot.new()
legend(c(0,1), c(0,1), legend=paste(lbrks[-length(lbrks)], lbrks[-1], sep=":"), fill=cols, bty="n")
par(def.par)
```

---

kerview *A linked-window system for browsing space-time data*

Description

A linked-window system for browsing space-time data.

Usage

```
kerview(pts, times, k3, map=TRUE, addimg=TRUE, ncol=1)
```

Arguments

pts	A matrix of event x,y coordinates.
times	A vector of event times.
k3	An object returned from kernel3d, the space-time kernel smoothing function
map	If false, don't plot the map display.
addimg	If true, overwrite successive images in the image display, else make a fresh image plot each time.
ncol	Number of columns and rows for multiple images and maps.

Details

This function displays three linked views of the data. In the current graphics window a temporal slice from the kernel smoothing is displayed. Another graphics device is started to display a map of the data that contributed to that time-slice. A third graphics device shows a histogram of the times of the events. Clicking with the mouse in this window with button 1 sets the time for the other displays to the time on the x-axis of the histogram at the clicked point.

In this way the 3-dimensional kernel smoothed function can be browsed, and the corresponding map of the data compared.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

kernel3d

---

khat *K-function*

Description

Calculates an estimate of the K-function

Usage

```
khat(pts,poly,s,newstyle=FALSE,checkpoly=TRUE)
## S3 method for class 'khat'
print(x, ...)
## S3 method for class 'khat'
plot(x, ...)
```

Arguments

pts	A points data set
poly	A polygon containing the points - must be a perimeter ring of points
s	A vector of distances at which to calculate the K function
newstyle	if TRUE, the function returns a khat object
checkpoly	if TRUE compare polygon area and polygon bounding box and convex hull areas to see whether the polygon object is malformed; may be set to FALSE if the polygon is known to be a ring of points
x	a khat object
...	other arguments passed to plot and print functions

Details

The K function is defined as the expected number of further points within a distance s of an arbitrary point, divided by the overall density of the points. In practice an edge-correction is required to avoid biasing the estimation due to non-recording of points outside the polygon.

The newstyle argument and khat object were introduced in collaboration with Thomas de Cornulier to permit the mapping of counts or khats for chosen distance values, as in http://pbil.univ-lyon1.fr/R/pdf/Thema81.pdf, p.18.

Value

If newstyle is FALSE, a vector like s containing the value of K at the points in s. else a khat object list with:

khat	the value of K at the points in s
counts	integer matrix of counts of points within the vector of distances s for each point
khats	matrix of values of K within the vector of distances s for each point
s	s

References

Ripley, B.D. 1976 The second-order analysis of stationary point processes, *J. Appl. Prob, 13* 255-266; Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

Kenv.csr

Examples

```
data(cardiff)
s <- seq(2,30,2)
plot(s, sqrt(khat(as.points(cardiff), cardiff$poly, s)/pi) - s,
 type="l", xlab="Splancs - polygon boundary", ylab="Estimated L",
 ylim=c(-1,1.5))
newstyle <- khat(as.points(cardiff), cardiff$poly, s, newstyle=TRUE)
str(newstyle)
newstyle
apply(newstyle$khats, 2, sum)
plot(newstyle)
```

---

khvc *Covariance matrix for the difference between two K-functions*

Description

Calculate the covariance matrix for the difference between two K-functions. Also return the contribution to the variance for each of the two point patterns,

Usage

```
khvc(pts1, pts2, poly, s)
```

Arguments

pts1	An object containing the case locations.
pts2	An object containing the control locations.
poly	A polygon enclosing the locations in pts1 and pts2
s	A vector of distances at which the calculation is to be made.

Value

A list with four components:

varmat	The upper triangle of the covariance matrix.
k11	The variance of Khat for the cases
k22	The variance of Khat for the controls
k12	The covariance of Khat for the cases and Khat for controls.

Note

Note that the diagonal of the covariance matrix is $k11 - 2 * $k12 + $k22

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

khat, khvmat, secal

---

khvmat *Covariance matrix for the difference between two K-functions*

Description

Calculate the covariance matrix for the difference between two K-functions under random labelling of the corresponding two sets of points.

Usage

```
khvmat(pts1, pts2, poly, s)
```

Arguments

pts1	An object containing the case locations.
pts2	An object containing the control locations.
poly	Polygon enclosing the points in pts1 and pts2.
s	A vector of distances at which the calculation is to be made.

Value

A matrix containing the covariances, with the variances on the diagonal.

References

Diggle P.J and Chetwynd A.C (1991) Second order analysis of spatial clustering Biometrics 47 1155-63; Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

secal

`mpoint` *Overlay a number of point patterns*

Description

Overlay a number of point patterns.

Usage

```
mpoint(...,cpch,add=FALSE,type="p")
```

Arguments

`...`	At least one argument consisting of a points data set must be specified.
`cpch`	A vector of characters for plotting symbols
`add`	if `add` is `TRUE` then overlay on an existing plot
`type`	plot data as points if `type="p"`, lines if `type="l"`

Details

`mpoint` enables several point or polygon datasets to be overlayed. The plot region is calculated so that all the specified datasets fit in the region. The parameter `cpch` specifies the characters to use for each set of points. The default `cpch` consists of the numbers 1 to 9 followed by the uppercase letters A to Z. If `cpch` is shorter than the number of point sets to plot, then it is repeated.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

`pointmap`

mse2d *Mean Square Error for a Kernel Smoothing*

Description

Estimate the Mean Square Error for a Kernel Smoothing.

Usage

```
mse2d(pts,poly,nsmse, range)
```

Arguments

pts	A set of points.
poly	A polygon containng the points.
nsmse	Number of steps of h at which to calculate the mean square error.
range	Maximum value of h for calculating the mean square error.

Value

A list with two components, $h and $mse. These vectors store corresponding values of the mean square error at values of the kernel smoothing parameter, h. The value of h corresponding to the minimum value of $mse can be passed to kernel2d as the optimum smoothing parameter.

References

Berman M. & Diggle P.J. (1989) Estimating Weighted Integrals of the Second-Order Intensity of a Spatial Point Pattern. *J. R. Statist Soc* B 51 81–92; Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

kernel2d

Examples

```
data(bodmin)
Mse2d <- mse2d(as.points(bodmin), bodmin$poly, nsmse=50, range=8)
plot(Mse2d$h[5:50],Mse2d$mse[5:50], type="l")
```

`n2dist` *Nearest neighbours for two point patterns*

Description

Calculate nearest neighbours for two point patterns

Usage

```
n2dist(pts1,pts2)
```

Arguments

`pts1`, `pts2`	Point data sets

Value

Returns a list with components `$dists` and `$neighs`. `$dists[i]` is the distance of the nearest neighbour of point `pts2[i,]` in `pts1` and `$neighs[i]` is the index in `pts1` of the point nearest to `pts2[i,]`. Documentation and example by Alun Pope, 2007-08-23.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

`nndistF`, `Fhat`, `Ghat`, `Fzero`

Examples

```
(test1 <- matrix(c(151.1791, -33.86056, 151.1599, -33.88729, 151.1528,
-33.90685, 151.1811, -33.85937),nrow=4,byrow=TRUE))
(test2 <- as.points(151.15, -33.9))
n2dist(test1,test2)
n2dist(test2,test1)
```

nndistF *Nearest neighbour distances as used by Fhat()*

Description

Calculate nearest neighbour distances as used by `Fhat()`

Usage

```
nndistF(pts1,pts2)
```

Arguments

`pts1`	A points data set
`pts2`	A points data set

Value

The set of distances from each of the points in `pts2` to the nearest point in `pts1` is returned as a vector.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

`nndistG`, `Fhat`, `Ghat`, `Fzero`

Examples

```
data(uganda)
boxplot(nndistF(as.points(uganda), as.points(csr(uganda$poly, length(uganda$x)))))
plot(ecdf(nndistF(as.points(uganda),
as.points(csr(uganda$poly, length(uganda$x))))),
main="Fhat ecdf Uganda volcano data")
```

nndistG *Nearest neighbour distances as used by Ghat()*

Description

Calculate nearest neighbour distances as used by `Ghat()`.

Usage

```
nndistG(pts)
```

Arguments

`pts`	A points data set

Value

Returns a list with components `$dists` and `$neighs`. `$dists[i]` is the distance to the nearest neighbour of point `i` in `pts`, and `$neighs[i]` is the index of the neighbour of point `i`.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

`nndistF`, `Fhat`, `Ghat`, `Fzero`

Examples

```
data(uganda)
boxplot(nndistG(as.points(uganda))$dists)
plot(ecdf(nndistG(as.points(uganda))$dists))
```

npts *Number of points in data set*

Description

return number of points in data set

Usage

```
npts(pts)
```

Arguments

pts	A points data set

Value

The number of points in the data set.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

okblack *Oklahoma black offenders*

Description

Locations of theft from property offences committed by black offenders in Oklahoma City

Usage

```
data(okblack)
```

Format

A list corresponding to a Venables and Ripley point object with 147 observations

x	numeric	grid eastings
y	numeric	grid northings
area	list	bounding box with xl, xu, yl, yu

Source

Carter and Hill, 1979, - Bailey and Gatrell 1995, ch. 3.

References

Bailey, T. C. and Gatrell, A. C. 1995, Interactive spatial data analysis. Longman, Harlow.

`okwhite` *Oklahoma white offenders*

Description

Locations of theft from property offences committed by white offenders in Oklahoma City

Usage

```
data(okwhite)
```

Format

A list corresponding to a Venables and Ripley point object with 104 observations

x	numeric	grid eastings
y	numeric	grid northings
area	list	bounding box with xl, xu, yl, yu

Source

Carter and Hill, 1979, - Bailey and Gatrell 1995, ch. 3.

References

Bailey, T. C. and Gatrell, A. C. 1995, Interactive spatial data analysis. Longman, Harlow.

pcp *Fit a Poisson cluster process*

Description

The function fits a Poisson cluster process to point data for a given enclosing polygon and fit parameters

Usage

```
pcp(point.data, poly.data, h0=NULL, expo=0.25, n.int=20)
```

Arguments

point.data	a points object
poly.data	a polygon enclosing the study region
h0	upper bound of integration in the criterion function
expo	exponent in the criterion function
n.int	number of intervals used to approximate the integral in the criterion function with a sum

Value

The function returns an object as returned by optim, including:

par	The best set of parameters s2 and rho found
value	The value of the fit corresponding to 'par'
convergence	'0' indicates successful convergence

Author(s)

Giovanni Petris <GPetris@uark.edu>, Roger.Bivand@nhh.no

References

Diggle, P. J. (1983) *Statistical analysis of spatial point patterns*, London: Academic Press, pp. 55-57 and 78-81; Bailey, T. C. and Gatrell, A. C. (1995) *Interactive spatial data analysis*, Harlow: Longman, pp. 106-109.

See Also

optim, pcp.sim, Kenv.pcp, khat

Examples

```
data(cardiff)
polymap(cardiff$poly)
pointmap(as.points(cardiff), add=TRUE)
title("Locations of homes of 168 juvenile offenders")
pcp.fit <- pcp(as.points(cardiff), cardiff$poly, h0=30, n.int=30)
pcp.fit
```

`pcp.sim` *Generate a Poisson Cluster Process*

Description

The function generates a Poisson cluster process for a given polygon within a larger bounding region and given process parameters

Usage

```
pcp.sim(rho, m, s2, region.poly, larger.region=NULL, vectorise.loop=TRUE)
```

Arguments

`rho`	intensity of the parent process
`m`	average number of offsprings per parent
`s2`	variance of location of offsprings relative to their parent
`region.poly`	a polygon defining the region in which the process is to be generated
`larger.region`	a rectangle containing the region of interest given in the form (xl,xu,yl,yu), defaults to `sbox()` around region.poly
`vectorise.loop`	if TRUE, use new vectorised code, if FALSE, use loop as before

Details

The function generates the parents in the larger bounding region, generates their children also in the larger bounding region, and then returns those inside the given polygon.

Value

A point object with the simulated pattern

Author(s)

Giovanni Petris <GPetris@uark.edu>, Roger.Bivand@nhh.no

References

Diggle, P. J. (1983) *Statistical analysis of spatial point patterns*, London: Academic Press, pp. 55-57 and 78-81; Bailey, T. C. and Gatrell, A. C. (1995) *Interactive spatial data analysis*, Harlow: Longman, pp. 106-109.

See Also

pcp, Kenv.pcp, khat

Examples

```
data(cardiff)
polymap(cardiff$poly)
pointmap(as.points(cardiff), add=TRUE)
title("Locations of homes of 168 juvenile offenders")
pcp.fit <- pcp(as.points(cardiff), cardiff$poly, h0=30, n.int=30)
pcp.fit
m <- npts(as.points(cardiff))/(areapl(cardiff$poly)*pcp.fit$par[2])
sims <- pcp.sim(pcp.fit$par[2], m, pcp.fit$par[1], cardiff$poly)
pointmap(as.points(sims), add=TRUE, col="red")
```

---

pdense *Overall density for a point pattern*

Description

Calculate overall density for a point pattern.

Usage

```
pdense(pts,poly)
```

Arguments

pts	A points data set
poly	A polygon data set

Value

The density of the points in the polygon. i.e. the number of points per unit area.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

Fzero

pip *Points inside or outside a polygon*

Description

Return points inside or outside a polygon.

Usage

```
pip(pts,poly,out=FALSE,bound=NULL,quiet=TRUE)
```

Arguments

pts	A points data set
poly	A polygon data set
out	If out=TRUE, return the points outside the polygon, else the points inside.
bound	If points fall exactly on polygon boundaries, the default NULL gives arbitrary assignments. If TRUE, then all points "on" boundaries are set as within the polygon, if FALSE, outside.
quiet	Do not report which points are on boundary for non-NULL bound

Details

pip calls inout, then selects the appropriate sub-set of points.

Value

pip returns the points of pts that lie inside (or outside with out=TRUE) the polygon poly. Compare this with inpip, which returns the indices of the points in the polygon, and inout which returns a logical vector indicating whether points are inside or outside.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

inpip, inout

plt *bins nearest neighbour distances*

Description

bins nearest neighbour distances

Usage

```
plt(data, value)
```

Arguments

data	nearest neighbour distances
value	breaks for binning distances

Value

binned values

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

Fhat, Ghat

pointmap *Graphics*

Description

Plots point and polygon data sets on the current graphics device.

Usage

```
pointmap(pts,add=FALSE,axes=TRUE,xlab="",ylab="", asp,...)
```

Arguments

pts	a points data set.
add	if FALSE, start a new plot. If TRUE, superimpose on current plot.
axes	if true, display axes with labelling. If false, do not display any axes on the plot.
xlab, ylab	Label strings for x and y axes.
asp	aspect parameter for plot
...	Graphical arguments may be entered, and these are passed to the standard S points and polygon routines.

Details

The specified data set is plotted on the current graphics device, either as points or polygons. For polymap, the last point in the data set is drawn connected to the first point. pointmap and polymap preserve the aspect ratio in the data by using the asp=1 plot argument. Graphical parameters can also be supplied to these routines, and are passed through to plot. Some useful parameters include pch to change the plotting character for points, lty to change the line type for polygons, and type="n" to set up axes for the plot without plotting anything.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

mpoint

Examples

```
data(bodmin)
plot(bodmin$poly, asp=1, type="n")
pointmap(as.points(bodmin), add=TRUE)
polymap(bodmin$poly, add=TRUE)
```

---

polymap *Graphics*

Description

Plots point and polygon data sets on the current graphics device.

Usage

```
polymap(poly,add=FALSE,xlab="",ylab="",axes=TRUE, asp,...)
```

Arguments

poly	a polygon.
add	if FALSE, start a new plot. If TRUE, superimpose on current plot.
xlab, ylab	Label strings for x and y axes.
axes	if true, display axes with labelling. If false, do not display any axes on the plot.
asp	aspect parameter for plot
...	Graphical arguments may be entered, and these are passed to the standard S points and polygon routines.

Details

The specified data set is plotted on the current graphics device, either as points or polygons. For polymap, the last point in the data set is drawn connected to the first point. pointmap and polymap preserve the aspect ratio in the data by using the asp=1 plot argument. Graphical parameters can also be supplied to these routines, and are passed through to plot. Some useful parameters include pch to change the plotting character for points, lty to change the line type for polygons, and type="n" to just set up axes for the plot without plotting anything.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

par, mpoint

Examples

```
data(bodmin)
plot(bodmin$poly, asp=1, type="n")
pointmap(as.points(bodmin), add=TRUE)
polymap(bodmin$poly, add=TRUE)
```

---

print.ribfit *Display the fit from tribble()*

Description

Display the fit from tribble

Usage

```
## S3 method for class 'ribfit'
print(x, ...)
```

Arguments

x	An object returned from tribble
...	optional arguments to pass through to print()

Details

The parameter estimates and log-likelihood for the raised incidence model are displayed. The likelihood ratio, D = 2*(L-Lo), is also given. This function is called whenever print operates on an object with class ribfit.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

tribble

---

ranpts *adjust number of random points in polygon*

Description

adjust number of random points in polygon

Usage

```
ranpts(pts, poly, nprq)
```

Arguments

pts	points object
poly	polygon object
nprq	required number of points

Value

points object with required number of random points

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

csr

`rLabel` *Randomly label two or more point sets*

Description

Randomly label two or more point sets. (function name changed from rlabel to rLabel to avoid collision with spatstat)

Usage

```
rLabel(...)
```

Arguments

...	Any number of points data sets

Details

The output data sets are a random labelling of the input data sets, i.e. all the points in the input data sets are randomly assigned to the output sets. The number of points in each output set is the same as its corresponding input set.

Value

A list of points data sets. There are as many elements in the list as arguments.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

`rtor.shift` *Random toroidal shift on a point data set*

Description

Perform a random toroidal shift on a point data set

Usage

```
rtor.shift(pts,rect)
```

Arguments

`pts`	The point data set to shift
`rect`	A rectangle defining the region for the toroidal map. If not given, the bounding box of `pts` is used.

Details

The planar region defined by `rect` is assumed connected at its top and bottom edges, and at its left and right sides. A random shift is applied to the points and the resulting set of points returned.

Value

A point data set like `pts`, but after application of a random toroidal shift along the x and y axes.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

`Shift`

sbox *Generate a box surrounding a point object*

Description

Generate a box surrounding a point object

Usage

```
sbox(pts, xfrac = .1, yfrac = .1)
```

Arguments

pts	A points data set
xfrac	The fraction of the width of the point pattern by which the box will surround the point pattern to the left and right.
yfrac	The fraction of the height of the point pattern by which the box will surround the point pattern to the top and bottom.

Value

A points data set of four points giving the coordinates of the surrounding box

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

bboxx

secal *Standard errors for the difference between two K-functions*

Description

Calculate standard errors for the difference between two K-functions under random labelling of the corresponding two sets of points.

Usage

```
secal(pts1,pts2,poly,s)
```

Arguments

`pts1`, `pts2`	Two point data sets
`poly`	Polygon enclosing the points in `pts1` and `pts2`
`s`	A vector of distances at which to calculate the standard error.

Details

To compare two point patterns, one can calculate the difference between their K-functions. The function `secal` gives the pointwise standard errors for the estimated differences, under the random labelling hypothesis.

Value

A vector like `s` containing the value of the standard error at each of the distances in `s`

References

Diggle P.J. and Chetwynd A.G. (1991) Second-order analysis of spatial clustering *Biometrics 47* 1155–63; Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

`khat`

`Shift` *Shift a point data set*

Description

Shift a point data set (function name changed from shift to Shift to avoid collision with spatstat)

Usage

```
Shift(pts,xsh=0.0,ysh=0.0)
```

Arguments

`pts`	The point data set to shift
`xsh`	Amount to shift along the x-axis
`ysh`	Amount to shift along the y-axis

Value

A point data set like `pts`, but with `xsh` added to its x-coordinates, and `ysh` added to its y-coordinates.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

`tor.shift`

---

southlancs *Cancer cases in Chorley-Ribble*

Description

Locations of cases of cancer of lung and larynx in Chorley-Ribble, Lancashire. The data set is split into a points object `southlancs.pts` and a case/control 0/1 vector `southlancs.cc`. There are 917 controls and 57 cases in this data set - these numbers differ from 978 and 58 in Diggle (1990) and Diggle and Rowlingson (1994). The data set also includes the approximate location of an old incinerator `old.incinerator`, as well as `southlancs.bdy`, the study area boundary.

Usage

```
data(southlancs)
```

Format

A data frame with 974 observations

[,1]	x	numeric	grid eastings (metres)
[,2]	y	numeric	grid northings (metres)
[,3]	cc	numeric	case/control, lung=0, larynx=1

Source

Diggle, Gatrell and Lovett, 1990, - Bailey and Gatrell 1995, ch. 3.

References

Bailey and Gatrell 1995, ch. 3; Diggle, P. (1990) A point process modelling approach to raised incidence of a rare phenomenon in the viscinity of a prespecified point. Journal of the Royal Statistical Society, A, 153, 349-362; Diggle, P. and Rowlingson, B. (1994) A conditional approach to point process modelling of elevated risk. Journal of the Royal Statistical Society, A, 157, 433-440.

Examples

```
data(southlancs)
op <- par(mfrow=c(2,1))
pointmap(southlancs.pts[southlancs.cc == 0,])
pointmap(old.incinerator, add=TRUE, col="red", pch=19)
title("Lung cancer controls")
pointmap(southlancs.pts[southlancs.cc == 1,])
pointmap(old.incinerator, add=TRUE, col="red", pch=19)
title("Larynx cancer cases")
par(op)
polymap(southlancs.bdy,border="grey")
contour(kernel2d(southlancs.pts[southlancs.cc == 0,],
southlancs.bdy, h=500, nx=100, ny=100), nlevels=20,
add=TRUE,drawlabels=FALSE)
pointmap(southlancs.pts[southlancs.cc == 1,], add=TRUE, pch=19,
 col="green")
pointmap(old.incinerator, add=TRUE, pch=19, col="red")
title(xlab="h=500, quartic kernel")
title("Density map of control, green case points, red old incinerator")
```

---

splancs *Return version number and author information*

Description

Return version number and author information

Usage

```
splancs()
```

Value

The version string is returned. This is a number of the format x.yy, where x is the major version number and yy is the minor version number.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

spoints *Point Objects*

Description

Creates and tests for data in spatial point format.

Usage

```
spoints(data,npoints)
```

Arguments

data	vector containing the data values for the points in order (x1,y1),(x2,y2),...
npoints	number of points to generate, if missing, set to length(data)/2.

Value

spoints returns an object suitable for use as a point data object. If npoints is given, the vector data is either truncated or repeated until sufficient data values are generated. The returned object is a two-column matrix, where the first column stores the x-coordinate, and the second column stores the y-coordinate.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

npts

stdiagn *Summary plots for clustering analysis*

Description

Produces some summary plots for clustering analysis

Usage

```
stdiagn(pts, stkh, stse, stmc=0,Dzero=FALSE)
```

Arguments

pts	A set of points, as used in Splancs
stkh	An object returned from stkhat
stse	An object returned from stsecal
stmc	An object returned from stmctest
Dzero	FALSE - default D plot, TRUE Dzero plot

Details

Four plots are produced on the current graphics device. The first plot is simply a map of the data. The second is a perspective plot of the difference between space-time K-function and the product of spatial and temporal K-functions. The third plot is of the standardised residuals against the product of spatial and temporal K-functions. If the Monte-Carlo data is given the fourth plot is a a histogram of the test statistics, with the value for the data indicated with a vertical line. See Diggle, Chetwynd, Haggkvist, and Morris (1995) for details.

References

Diggle, P., Chetwynd, A., Haggkvist, R. and Morris, S. 1995 Second-order analysis of space-time clustering. Statistical Methods in Medical Research, 4, 124-136;Bailey, T. C. and Gatrell, A. C. 1995, Interactive spatial data analysis. Longman, Harlow, pp. 122-125; Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

stkhat, stsecal, stvmat, stmctest

Examples

```
example(stkhat)
example(stsecal)
example(stmctest)
stdiagn(burpts, bur1, bur1se, bur1mc)
```

---

stkhat *Space-time K-functions*

Description

Compute the space-time K-functions

Usage

```
stkhat(pts, times, poly, tlimits, s, tm)
```

Arguments

pts	A set of points as defined in Splancs
times	A vector of times, the same length as the number of points in pts
poly	A polygon enclosing the points
tlimits	A vector of length 2 specifying the upper and lower temporal domain.
s	A vector of spatial distances for the analysis.
tm	A vector of times for the analysis

Value

A list with the following components is returned:

s, t	The spatial and temporal scales
ks	The spatial K-function
kt	The temporal K-function
kst	The space-time K-function

For details see Diggle, Chetwynd, Haggkvist, and Morris (1995)

References

Diggle, P., Chetwynd, A., Haggkvist, R. and Morris, S. 1995 Second-order analysis of space-time clustering. Statistical Methods in Medical Research, 4, 124-136;Bailey, T. C. and Gatrell, A. C. 1995, Interactive spatial data analysis. Longman, Harlow, pp. 122-125; Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

stsecal, stvmat, stmctest, stdiagn

Examples

```
data(burkitt)
bur1 <- stkhat(burpts, burkitt$t, burbdy, c(400, 5800),
  seq(1,40,2), seq(100, 1500, 100))
oldpar <- par(mfrow=c(2,1))
plot(bur1$s, bur1$ks, type="l", xlab="distance", ylab="Estimated K",
  main="spatial K function")
plot(bur1$t, bur1$kt, type="l", xlab="time", ylab="Estimated K",
  main="temporal K function")
par(oldpar)
```

`stmctest` *Monte-Carlo test of space-time clustering*

Description

Perform a Monte-Carlo test of space-time clustering.

Usage

```
stmctest(pts, times, poly, tlimits, s, tt, nsim, quiet=FALSE, returnSims=FALSE)
```

Arguments

`pts`	A set of points as used by Splancs.
`times`	A vector of times, the same length as the number of points in `pts`.
`poly`	A polygon enclosing the points.
`tlimits`	A vector of length 2, specifying the upper and lower temporal domain.
`s`	A vector of spatial distances for the analysis.
`tt`	A vector of times for the analysis.
`nsim`	The number of simulations to do.
`quiet`	If `quiet=TRUE` then no output is produced, otherwise the function prints the number of simulations completed so far, and also how the test statistic for the data ranks with the simulations.
`returnSims`	default FALSE, if TRUE, return the `stkhat` output for the observed data and each simulation as attributes `obs` and `sims`

Details

The function uses a sum of residuals as a test statistic, randomly permutes the times of the set of points and recomputes the test statistic for a number of simulations. See Diggle, Chetwynd, Haggkvist and Morris (1995) for details.

Value

A list with components:

`t0`	The observed value of the statistic
`t`	A single column matrix with `nsim` values each of which is a simulated value of the statistic

Note

The example of using returned simulated values is included only to show how the values might be used, not to indicate that this constitutes a way of examining which observed values of the space-time measure are exceptional.

References

Diggle, P., Chetwynd, A., Haggkvist, R. and Morris, S. 1995 Second-order analysis of space-time clustering. Statistical Methods in Medical Research, 4, 124-136;Bailey, T. C. and Gatrell, A. C. 1995, Interactive spatial data analysis. Longman, Harlow, pp. 122-125; Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

stkhat, stsecal, stvmat, stdiagn

Examples

```
example(stkhat)
bur1mc <- stmctest(burpts, burkitt$t, burbdy, c(400, 5800),
  seq(1,40,2), seq(100, 1500, 100), nsim=49, quiet=TRUE, returnSims=TRUE)
plot(density(bur1mc$t), xlim=range(c(bur1mc$t0, bur1mc$t)))
abline(v=bur1mc$t0)
r0 <- attr(bur1mc, "obs")$kst-outer(attr(bur1mc, "obs")$ks, attr(bur1mc, "obs")$kt)
rsimlist <- lapply(attr(bur1mc, "sims"), function(x) x$kst - outer(x$ks, x$kt))
rarray <- array(do.call("cbind", rsimlist), dim=c(20, 15, 49))
rmin <- apply(rarray, c(1,2), min)
rmax <- apply(rarray, c(1,2), max)
r0 < rmin
r0 > rmax
```

---

stsecal *Standard error for space-time clustering*

Description

Computes the standard error for space-time clustering.

Usage

```
stsecal(pts, times, poly, tlim, s, tm)
```

Arguments

pts	A set of points, as defined in Splancs.
times	A vector of times, the same length as the number of points in pts
poly	A polygon enclosing the points
tlim	A vector of length 2 specifying the upper and lower temporal domain.
s	A vector of spatial distances for the analysis
tm	A vector of times for the analysis

Value

A matrix of dimension `[length(s),length(t)]` is returned. Element `[i,j]` is the standard error at `s[i],t[j]`. See Diggle Chetwynd Haggkvist and Morris (1995) for details.

References

Diggle, P., Chetwynd, A., Haggkvist, R. and Morris, S. 1995 Second-order analysis of space-time clustering. Statistical Methods in Medical Research, 4, 124-136;Bailey, T. C. and Gatrell, A. C. 1995, Interactive spatial data analysis. Longman, Harlow, pp. 122-125; Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

stkhat, stsecal, stvmat, stdiagn

Examples

```
example(stkhat)
bur1se <- stsecal(burpts, burkitt$t, burbdy, c(400, 5800),
 seq(1,40,2), seq(100, 1500, 100))
```

`stvmat` *Variance matrix for space-time clustering*

Description

Compute the variance matrix for space-time clustering

Usage

```
stvmat(pts, times, poly, tlim, s, tm)
```

Arguments

`pts`	A set of points.
`times`	A vector of times, the same length as the number of points in `pts`
`poly`	A polygon that encloses the points
`tlim`	A vector of length 2 specifying the upper and lower temporal domain.
`s`	A vector of spatial distances for the analysis
`tm`	A vector of times for the analysis

Value

A four-dimensional matrix is returned. The covariance between space-time `t1,s1` and `t2,s2` is given by the corresponding element `[t1,s1,t2,s2]` For full details, see Diggle, Chetwynd, Haggkvist and Morris (1995)

References

Diggle, P., Chetwynd, A., Haggkvist, R. and Morris, S. 1995 Second-order analysis of space-time clustering. Statistical Methods in Medical Research, 4, 124-136; Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

`stkhat`, `stsecal`, `stmctest`, `stdiagn`

---

thin *Randomly thin a point data set*

Description

Randomly thin a point data set.

Usage

```
thin(pts,n)
```

Arguments

`pts`	a points data set.
`n`	the number of points to return

Value

Returns a point data set consisting of `n` points selected randomly from the set `pts`.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

`tor.shift` *Toroidal shift on a point data set*

Description

Perform a toroidal shift on a point data set

Usage

```
tor.shift(pts,xsh=0.0,ysh=0.0,rect)
```

Arguments

`pts`	The point data set to shift
`xsh`	Amount to shift along the x-axis
`ysh`	Amount to shift along the y-axis
`rect`	A rectangle defining the region for the toroidal map. If not given, the bounding box of `pts` is used.

Details

The planar region defined by `rect` is assumed connected at its top and bottom edges, and at its left and right sides. A shift of `xsh` and `ysh` is applied to the points and the resulting set of points returned.

Value

A point data set like `pts`, but after application of a toroidal shift along the x and y axes.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

`Shift`

tribble *Diggle-Rowlingson Raised Incidence Model*

Description

Fits the Diggle-Rowlingson Raised Incidence Model.

Usage

```
tribble(ccflag, vars=NULL, alphas=NULL, betas=NULL, rho,
 which=1:length(alphas), covars=NULL, thetas=NULL,
 steps=NULL, reqmin=0.001, icount=50, hessian=NULL)
```

Arguments

ccflag	Case-control flag : a vector of ones and zeroes.
vars	A matrix where vars[i,j] is the distance squared from point i to source j.
alphas	Initial value of the alpha parameters.
betas	Initial value of the beta parameters.
rho	Initial value of the rho parameter.
which	Defines the mapping from sources to parameters.
covars	A matrix of covariates to be modelled as log-linear terms. The element covars[i,j] is the value of covariate j for case/control i.
thetas	Initial values of covariate parameters.
steps	Step sizes for the Nelder-Mead simplex algorithm.
reqmin	Tolerance for simplex algorithm
icount	Iteration count for simplex algorithm
hessian	by default NULL, any other value causes hessian to be computed and returned

Value

The return value is a list with many components, and class ribfit.

alphas	A vector of the alpha parameters at the maximum
betas	A vector of the beta values at the maximum
rho	The value of rho at the maximum
logl	The maximised log-likelihood
null.logl	The null log-likelihood
call	The function call to tribble

For further information see Diggle and Rowlingson (1993).

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

triblik, dsquare

`triblik` *Log-likelihood for the Diggle-Rowlingson raised incidence model*

Description

Calculates the log-likelihood for the Diggle-Rowlingson raised incidence model.

Usage

```
triblik(ccflag, vars=NULL, alphas=NULL, betas=NULL, rho,
 which=1:length(alphas), covars=NULL, thetas=NULL)
```

Arguments

`ccflag`	Case-control flag : a vector of ones and zeroes.
`vars`	A matrix where `vars[i,j]` is the distance squared from point `i` to source `j`.
`alphas`	The `alpha` parameters.
`betas`	The `beta` parameters.
`rho`	The `rho` parameter.
`which`	Defines the mapping from sources to parameters.
`covars`	A matrix of covariates to be modelled as log-linear terms. The element `covars[i,j]` is the value of covariate `j` for case/control `i`.
`thetas`	The covariate parameters.

Value

The log-likelihood for the given parameters and the given distances and optional covariates is returned.

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

tribble, dsquare

---

uganda *Craters in Uganda*

Description

Locations of craters in a volcanic field in Uganda

Usage

```
data(uganda)
```

Format

A list corresponding to a Venables and Ripley point object with 120 observations

x	numeric	grid eastings
y	numeric	grid northings
area	list	bounding box with xl, xu, yl, yu
poly	array	polygon boundary with columns x and y

Source

Tinkler, 1971, - Bailey and Gatrell 1995, ch. 3.

References

Bailey, T. C. and Gatrell, A. C. 1995, Interactive spatial data analysis. Longman, Harlow.

---

zoom *Interactively specify a region of a plot for expansion*

Description

Interactively specify a region of a plot for expansion

Usage

```
zoom(quiet=FALSE,out=FALSE,...)
```

Arguments

quiet	If false, prompt the user to enter two coordinates. If true, say nothing.
out	If true, expand the limits of the current plot by a factor of three, centred on the current plot.
...	Other arguments are passed through to pointmap.

Details

A prompt is optionally displayed, and the user selects two points forming the diagonal of a rectangle. A new, empty plot is created that has its axis limits set to the bounding square of the selected rectangle. If out=TRUE, no prompt is displayed, and a new blank plot is created with its limits in x and y set to span an area three times the height and width centred on the current centre.

Value

None

References

Rowlingson, B. and Diggle, P. 1993 Splancs: spatial point pattern analysis code in S-Plus. Computers and Geosciences, 19, 627-655; the original sources can be accessed at: https://www.maths.lancs.ac.uk/~rowlings/Splancs/. See also Bivand, R. and Gebhardt, A. 2000 Implementing functions for spatial statistical analysis using the R language. Journal of Geographical Systems, 2, 307-317.

See Also

pointmap

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