Package ‘dbmss’

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Title Distance-Based Measures of Spatial Structures

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Description Simple computation of spatial statistic functions of distance to characterize the spatial structures of mapped objects, including classical ones (Ripley's K and others) and more recent ones used by spatial economists (Duranton and Overman's Kd, Marcon and Puech's M). Relies on spatstat for some core calculation.

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`dbmss-package` *Distance Based Measures of Spatial Structures*

Description

Simple computation of spatial statistic functions of distance to characterize the spatial structures of mapped objects, including classical ones (Ripley's K and others) and more recent ones used by spatial economists (Duranton and Overman's Kd, Marcon and Puech's M). Relies on spatstat for some core calculation.

Details

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Author(s)

Eric Marcon, Gabriel Lang, Stephane Traissac, Florence Puech

Maintainer: Eric Marcon <Eric.Marcon@ecofog.gf>

References

Marcon, E., Lang, G., Traissac, S. and F. Puech (in press). Tools to Characterize Point Patterns: dbmss for R. *Journal of Statistical Software*.

`as.wmppp` *Converts data to class wmppp*

Description

Creates a Weighted, Marked, Planar Point Pattern, *i.e.* an object of class "wmppp" representing a two-dimensional point pattern with weights and labels. This is a generic method.

Usage

```
as.wmppp(X, ...)
  ## S3 method for class 'ppp'
as.wmppp(X, ...)
  ## S3 method for class 'data.frame'
as.wmppp(X, window = NULL, unitname = NULL, ...)
```

Arguments

`X`	Data to be converted into a weighted, marked, planar point pattern (`wmppp.object`)
`window`	An object of calls "owin" (`owin.object`).
`unitname`	Name of unit of length. Either a single character string, or a vector of two character strings giving the singular and plural forms, respectively.
`...`	Extra arguments.

Details

This is a generic method, implemented for `ppp` and `data.frame`:

- If the dataset `X` is an object of class "ppp" (`ppp.object`), the marks are converted to point weights if they are numeric or to point types if they are factors. Default weights are set to 1, default types to "All". If marks are a dataframe with column names equal to `PointType` and `PointWeight`, they are not modified.
- If the dataset `X` is a dataframe, see `wmppp`.

Value

An object of class "wmppp".

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

See Also

wmppp.object

---

dbmssEnvelope.object *Class of envelope of function values (fv)*

Description

A class "dbmssEnvelope", *i.e.* a particular type of see envelope to represent several estimates of the same function and its confidence envelope.

Details

"dbmssEnvelope" objects are similar to envelope objects. The differences are that the risk level is chosen (instead of the simulation rank to use as the envelope), so the rank is calculated (interpolation is used if necessary), and a global envelope can be calculated following Duranton and Overman (2005).

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106

See Also

summary.dbmssEnvelope, KdEnvelope, MEnvelope

`DEnvelope` *Estimation of the confidence envelope of the D function under its null hypothesis*

Description

Simulates point patterns according to the null hypothesis and returns the envelope of *D* according to the confidence level.

Usage

```
DEnvelope(X, r = NULL, NumberOfSimulations = 100, Alpha = 0.05,
          Cases, Controls, Intertype = FALSE, Global = FALSE)
```

Arguments

`X`	A point pattern (`wmppp.object`).
`r`	A vector of distances. If `NULL`, a sensible default value is chosen (512 intervals, from 0 to half the diameter of the window) following `spatstat`.
`NumberOfSimulations`	The number of simulations to run, 100 by default.
`Alpha`	The risk level, 5% by default.
`Cases`	One of the point types
`Controls`	One of the point types.
`Intertype`	Logical; if `TRUE`, *D* is computed as *Di* in Marcon and Puech (2012).
`Global`	Logical; if `TRUE`, a global envelope sensu Duranton and Overman (2005) is calculated.

Details

The only null hypothesis is random labeling: marks are distributed randomly across points.

This envelope is local by default, that is to say it is computed separately at each distance. See Loosmore and Ford (2006) for a discussion.

The global envelope is calculated by iteration: the simulations reaching one of the upper or lower values at any distance are eliminated at each step. The process is repeated until *Alpha / Number of simulations* simulations are dropped. The remaining upper and lower bounds at all distances constitute the global envelope. Interpolation is used if the exact ratio cannot be reached.

Value

An envelope object (`envelope`). There are methods for print and plot for this class.

The `fv` contains the observed value of the function, its average simulated value and the confidence envelope.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106.

Kenkel, N. C. (1988). Pattern of Self-Thinning in Jack Pine: Testing the Random Mortality Hypothesis. *Ecology* 69(4): 1017-1024.

Loosmore, N. B. and Ford, E. D. (2006). Statistical inference using the G or K point pattern spatial statistics. *Ecology* 87(8): 1925-1931.

Marcon, E. and F. Puech (2012). A typology of distance-based measures of spatial concentration. *HAL SHS*. 00679993.

See Also

Dhat

Examples

```
data(paracou16)
# Keep only 20% of points to run this example
X <- as.wmppp(rthin(paracou16, 0.2))
plot(X)

# Calculate confidence envelope (should be 1000 simulations, reduced to 20 to save time)
r <- 0:30
NumberOfSimulations <- 20
Alpha <- .05
# Plot the envelope (after normalization by pi.r^2)
plot(DEnvelope(X, r, NumberOfSimulations, Alpha,
    "V. Americana", "Q. Rosea", Intertype = TRUE), ./(pi*r^2) ~ r)
```

Dhat *Estimation of the D function*

Description

Estimates the *D* function

Usage

```
Dhat(X, r = NULL, Cases, Controls = NULL, Intertype = FALSE, CheckArguments = TRUE)
```

Arguments

X	A weighted, marked, planar point pattern (wmppp.object).
r	A vector of distances. If NULL, a sensible default value is chosen (512 intervals, from 0 to half the diameter of the window) following spatstat.
Cases	One of the point types.
Controls	One of the point types. If NULL, controls are all types except for cases.
Intertype	Logical; if TRUE, *D* is computed as *Di* in Marcon and Puech (2012).
CheckArguments	Logical; if TRUE, the function arguments are verified. Should be set to FALSE to save time in simulations for example, when the arguments have been checked elsewhere.

Details

The *Di* function allows comparing the structure of the cases to that of the controls around cases, that is to say the comparison is made around the same points. This has been advocated by Arbia et al. (2008) and formalized by Marcon and Puech (2012).

Value

An object of class fv, see fv.object, which can be plotted directly using plot.fv.

Note

The computation of Dhat relies on spatstat functions Kest and Kcross.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Arbia, G., Espa, G. and Quah, D. (2008). A class of spatial econometric methods in the empirical analysis of clusters of firms in the space. *Empirical Economics* 34(1): 81-103.

Diggle, P. J. and Chetwynd, A. G. (1991). Second-Order Analysis of Spatial Clustering for Inhomogeneous Populations. *Biometrics* 47(3): 1155-1163.

Marcon, E. and F. Puech (2012). A typology of distance-based measures of spatial concentration. *HAL SHS*. 00679993.

See Also

Khat, DEnvelope, Kest, Kcross

Examples

```
data(paracou16)
plot(paracou16)

# Calculate D
r <- 0:30
(Paracou <- Dhat(paracou16, r, "V. Americana", "Q. Rosea", Intertype = TRUE))

# Plot (after normalization by pi.r^2)
plot(Paracou, ./(pi*r^2) ~ r)
```

---

gEnvelope — *Estimation of the confidence envelope of the g function under its null hypothesis*

Description

Simulates point patterns according to the null hypothesis and returns the envelope of *g* according to the confidence level.

Usage

```
gEnvelope(X, r = NULL, NumberOfSimulations = 100, Alpha = 0.05,
        ReferenceType = "", NeighborType = "", SimulationType = "RandomPosition",
          Global = FALSE)
```

Arguments

`X`	A point pattern (`wmppp.object`).
`r`	A vector of distances. If `NULL`, a sensible default value is chosen (512 intervals, from 0 to half the diameter of the window) following `spatstat`.
`NumberOfSimulations`	The number of simulations to run, 100 by default.
`Alpha`	The risk level, 5% by default.
`ReferenceType`	One of the point types. Default is all point types.
`NeighborType`	One of the point types. Default is all point types.
`SimulationType`	A string describing the null hypothesis to simulate. The null hypothesis may be "*RandomPosition*": points are drawn in a Poisson process (default); "*RandomLabeling*": randomizes point types, keeping locations unchanged; "*PopulationIndependence*": keeps reference points unchanged, shifts other point locations.
`Global`	Logical; if `TRUE`, a global envelope sensu Duranton and Overman (2005) is calculated.

Details

This envelope is local by default, that is to say it is computed separately at each distance. See Loosmore and Ford (2006) for a discussion.

The global envelope is calculated by iteration: the simulations reaching one of the upper or lower values at any distance are eliminated at each step. The process is repeated until *Alpha / Number of simulations* simulations are dropped. The remaining upper and lower bounds at all distances constitute the global envelope. Interpolation is used if the exact ratio cannot be reached.

Value

An envelope object (`envelope`). There are methods for print and plot for this class.

The `fv` contains the observed value of the function, its average simulated value and the confidence envelope.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106.

Kenkel, N. C. (1988). Pattern of Self-Thinning in Jack Pine: Testing the Random Mortality Hypothesis. *Ecology* 69(4): 1017-1024.

Loosmore, N. B. and Ford, E. D. (2006). Statistical inference using the G or K point pattern spatial statistics. *Ecology* 87(8): 1925-1931.

Marcon, E. and F. Puech (2012). A typology of distance-based measures of spatial concentration. *HAL SHS*. 00679993.

See Also

`ghat`, `rRandomPositionK`, `rRandomLocation`, `rPopulationIndependenceK`

Examples

```
data(paracou16)
# Keep only 20% of points to run this example
X <- as.wmppp(rthin(paracou16, 0.2))
plot(X)

# Calculate confidence envelope (should be 1000 simulations, reduced to 10 to save time)
r <- 0:40
NumberOfSimulations <- 10
# Plot the envelope
plot(gEnvelope(X, r, NumberOfSimulations))
```

ghat *Estimation of the g function*

Description

Estimates the *g* function

Usage

```
ghat(X, r = NULL, ReferenceType = "", NeighborType = "", CheckArguments = TRUE)
```

Arguments

X	A weighted, marked, planar point pattern (wmppp.object).
r	A vector of distances. If NULL, a sensible default value is chosen (512 intervals, from 0 to half the diameter of the window) following spatstat.
ReferenceType	One of the point types. Default is all point types.
NeighborType	One of the point types. Default is all point types.
CheckArguments	Logical; if TRUE, the function arguments are verified. Should be set to FALSE to save time in simulations for example, when the arguments have been checked elsewhere.

Details

The computation of ghat relies on spatstat function sewpcf.

Value

An object of class fv, see fv.object, which can be plotted directly using plot.fv.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Stoyan, D. and Stoyan, H. (1994) *Fractals, random shapes and point fields: methods of geometrical statistics*. John Wiley and Sons.

See Also

gEnvelope

Examples

```
data(paracou16)
plot(paracou16)

# Calculate g
r <- 0:30
(Paracou <- ghat(paracou16, r, "Q. Rosea", "V. Americana"))

# Plot
plot(Paracou)
```

GoFtest — *Goodness of Fit test between a distance based measure of spatial structure and simulations of its null hypothesis*

Description

Calculates the risk to reject the null hypothesis erroneously, based on the distribution of the simulations.

Usage

```
GoFtest(Envelope)
```

Arguments

`Envelope`	An envelope object (`envelope`) containing simulations in its `simfuns` attribute. It may be the result of any estimation function of the dbmss package or obtained by the `envelope` function with argument `savefuns=TRUE`.

Details

This test was introduced by Diggle(1983) and extensively developped by Loosmore and Ford (2006) for *K*, and applied to *M* by Marcon et al. (2012).

Value

A p-value.

Note

No support exists in the literature to apply the GoF test to non-cumulative functions (*g*, *Kd*...).

`Ktest` is a much better test (it does not rely on simulations) but it is limited to the *K* function against complete spatial randomness (CSR) in a rectangle window.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Diggle, P. J. (1983). *Statistical analysis of spatial point patterns*. Academic Press, London. 148 p.

Loosmore, N. B. and Ford, E. D. (2006). Statistical inference using the G or K point pattern spatial statistics. *Ecology* 87(8): 1925-1931.

Marcon, E., F. Puech, et al. (2012). Characterizing the relative spatial structure of point patterns. International *Journal of Ecology* 2012(Article ID 619281): 11.

See Also

Ktest

Examples

```
# Simulate a Matern (Neyman Scott) point pattern
nclust <- function(x0, y0, radius, n) {
  return(runifdisc(n, radius, centre=c(x0, y0)))
}
X <- rNeymanScott(20, 0.2, nclust, radius=0.3, n=10)
plot(X)

# Calculate confidence envelope (should be 1000 simulations, reduced to 50 to save time)
r <- seq(0, 0.3, 0.01)
NumberOfSimulations <- 50
Alpha <- .10
Envelope <- KEnvelope(as.wmppp(X), r, NumberOfSimulations, Alpha)
plot(Envelope, ./(pi*r^2) ~ r)

# GoF test. Power is correct if enough simulations are run (say >1000).
paste("p-value =", GoFtest(Envelope))
```

---

is.wmppp — *Test whether an object is a weighted, marked, planar point pattern*

Description

Check whether its argument is an object of class "wmppp" (wmppp.object).

Usage

```
is.wmppp(X)
```

Arguments

`X`	Any object

Value

`TRUE` if `X` is a weighted, marked, planar point pattern, otherwise `FALSE`.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

See Also

`wmppp.object`

KdEnvelope — *Estimation of the confidence envelope of the Kd function under its null hypothesis*

Description

Simulates point patterns according to the null hypothesis and returns the envelope of *Kd* according to the confidence level.

Usage

```
KdEnvelope(X, r = NULL, NumberOfSimulations = 100, Alpha = 0.05, ReferenceType,
           NeighborType = ReferenceType, Weighted = FALSE, Original = TRUE,
         Approximate = ifelse(X$n < 10000, 0, 1), Adjust = 1, MaxRange = "ThirdW",
           SimulationType = "RandomLocation", Global = FALSE)
```

Arguments

`X`	A point pattern (`wmppp.object`).
`r`	A vector of distances. If `NULL`, a default value is set: 512 equally spaced values are used, and the first 256 are returned, corresponding to half the maximum distance between points (following Duranton and Overman, 2005).
`NumberOfSimulations`	The number of simulations to run, 100 by default.
`Alpha`	The risk level, 5% by default.
`ReferenceType`	One of the point types.
`NeighborType`	One of the point types. By default, the same as reference type.
`Weighted`	Logical; if `TRUE`, estimates the *Kemp* function.

`Original` Logical; if `TRUE` (by default), the original bandwidth selection by Duranton and Overman (2005) following Silverman (2006: eq 3.31) is used. If `FALSE`, it is calculated following Sheather and Jones (1991), *i.e.* the state of the art. See `bw.SJ` for more details.

`Approximate` if not 0 (1 is a good choice), exact distances between pairs of points are rounded to 1024 times `Approximate` single values equally spaced between 0 and the largest distance. This technique (Scholl and Brenner, 2013) allows saving a lot of memory when addressing large point sets (the default value is 1 over 10000 points). Increasing `Approximate` allows better precision at the cost of proportional memory use.

`Adjust` Force the automatically selected bandwidth (following Silverman, 1986) to be multiplied by `Adjust`. Setting it to values lower than one (1/2 for example) will sharpen the estimation. If not 1, `Original` is ignored.

`MaxRange` The maximum value of `r` to consider, ignored if `r` is not `NULL`. Default is "ThirdW", one third of the diameter of the window. Other choices are "HalfW", and "QuarterW" and "D02005". "HalfW", and "QuarterW" are for half or the quarter of the diameter of the window. "D02005" is for the median distance observed between points, following Duranton and Overman (2005). "ThirdW" should be close to "DO2005" but has the advantage to be independent of the point types chosen as `ReferenceType` and `NeighborType`, to simplify comparisons between different types. "D02005" is approximated by "ThirdW" if `Approximate` is not 0.

`SimulationType` A string describing the null hypothesis to simulate. The null hypothesis may be "*RandomLocation*": points are redistributed on the actual locations (default); "*RandomLabeling*": randomizes point types, keeping locations and weights unchanged; "*PopulationIndependence*": keeps reference points unchanged, randomizes other point locations.

`Global` Logical; if `TRUE`, a global envelope sensu Duranton and Overman (2005) is calculated.

Details

This envelope is local by default, that is to say it is computed separately at each distance. See Loosmore and Ford (2006) for a discussion.

The global envelope is calculated by iteration: the simulations reaching one of the upper or lower values at any distance are eliminated at each step. The process is repeated until *Alpha / Number of simulations* simulations are dropped. The remaining upper and lower bounds at all distances constitute the global envelope. Interpolation is used if the exact ratio cannot be reached.

Value

An envelope object (`envelope`). There are methods for print and plot for this class.

The `fv` contains the observed value of the function, its average simulated value and the confidence envelope.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106.

Kenkel, N. C. (1988). Pattern of Self-Thinning in Jack Pine: Testing the Random Mortality Hypothesis. *Ecology* 69(4): 1017-1024.

Loosmore, N. B. and Ford, E. D. (2006). Statistical inference using the G or K point pattern spatial statistics. *Ecology* 87(8): 1925-1931.

Marcon, E. and F. Puech (2012). A typology of distance-based measures of spatial concentration. *HAL SHS*. 00679993.

Scholl, T. and Brenner, T. (2013) Optimizing Distance-Based Methods for Big Data Analysis, *Working Papers on Innovation and Space* No 2013-09, Philipps University Marburg

Silverman, B. W. (1986). *Density estimation for statistics and data analysis*. Chapman and Hall, London.

See Also

Kdhat

Examples

```
data(paracou16)
plot(paracou16[paracou16$marks$PointType=="Q. Rosea"])

# Calculate confidence envelope
plot(KdEnvelope(paracou16, , ReferenceType="Q. Rosea", Global=TRUE))

# Center of the confidence interval
Kdhat(paracou16, ReferenceType="") -> kd
lines(kd$Kd ~ kd$r, lty=3, col="green")
```

Kdhat *Estimation of the Kd function*

Description

Estimates the *Kd* function

Usage

```
Kdhat(X, r = NULL, ReferenceType, NeighborType = ReferenceType, Weighted = FALSE,
      Original = TRUE, Approximate = ifelse(X$n < 10000, 0, 1), Adjust = 1,
      MaxRange = "ThirdW", CheckArguments = TRUE)
```

Arguments

`X`	A point pattern (`wmppp.object`).
`r`	A vector of distances. If `NULL`, a default value is set: 512 equally spaced values are used, from the smallest distance between points to half the diameter of the window.
`ReferenceType`	One of the point types. If "", all points are considered (this is not the default value; `NeighborType` is ignored then) to estimate the average value of simulated *Kd* values under the null hypothesis of *RandomLocation* (Marcon and Puech, 2012).
`NeighborType`	One of the point types. By default, the same as reference type.
`Weighted`	Logical; if `TRUE`, estimates the *Kemp* function.
`Original`	Logical; if `TRUE` (by default), the original bandwidth selection by Duranton and Overman (2005) following Silverman (1986: eq 3.31) is used. If `FALSE`, it is calculated following Sheather and Jones (1991), *i.e.* the state of the art. See `bw.SJ` for more details.
`Approximate`	if not 0 (1 is a good choice), exact distances between pairs of points are rounded to 1024 times `Approximate` single values equally spaced between 0 and the largest distance. This technique (Scholl and Brenner, 2013) allows saving a lot of memory when addressing large point sets (the default value is 1 over 10000 points). Increasing `Approximate` allows better precision at the cost of proportional memory use.
`Adjust`	Force the automatically selected bandwidth (following `Original`) to be multiplied by `Adjust`. Setting it to values lower than one (1/2 for example) will sharpen the estimation.
`MaxRange`	The maximum value of `r` to consider, ignored if `r` is not `NULL`. Default is "ThirdW", one third of the diameter of the window. Other choices are "HalfW", and "QuarterW" and "D02005". "HalfW", and "QuarterW" are for half or the quarter of the diameter of the window. "D02005" is for the median distance observed between points, following Duranton and Overman (2005). "ThirdW" should be close to "DO2005" but has the advantage to be independent of the point types chosen as `ReferenceType` and `NeighborType`, to simplify comparisons between different types. "D02005" is approximated by "ThirdW" if `Approximate` is not 0.
`CheckArguments`	Logical; if `TRUE`, the function arguments are verified. Should be set to `FALSE` to save time in simulations for example, when the arguments have been checked elsewhere.

Details

Kd is a density, absolute measure of a point pattern structure. *Kd* is computed efficiently by building a matrix of distances between point pairs and calculating the density of their distribution (the default values of `r` are those of the `density` function). The kernel estimator is Gaussian.

The weighted *Kd* function has been named *Kemp* (*emp* is for employees) by Duranton and Overman (2005).

The maximum value of `r` is obtained from the geometry of the window rather than caculating the median distance between points as suggested by Duranton and Overman (2005) to save (a lot of) calculation time.

Value

An object of class fv, see fv.object, which can be plotted directly using plot.fv.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106.

Marcon, E. and F. Puech (2012). A typology of distance-based measures of spatial concentration. *HAL SHS*. 00679993.

Scholl, T. and Brenner, T. (2013) Optimizing Distance-Based Methods for Big Data Analysis, *Working Papers on Innovation and Space* No 2013-09, Philipps University Marburg

Sheather, S. J. and Jones, M. C. (1991) A reliable data-based bandwidth selection method for kernel density estimation. *Journal of the Royal Statistical Society series B*, 53, 683-690.

Silverman, B. W. (1986). *Density estimation for statistics and data analysis*. Chapman and Hall, London.

See Also

KdEnvelope, Mhat

Examples

```
data(paracou16)
plot(paracou16)

# Calculate Kd
(Paracou <- Kdhat(paracou16, , "Q. Rosea", "V. Americana"))
# Plot
plot(Paracou)
```

KEnvelope — *Estimation of the confidence envelope of the K function under its null hypothesis*

Description

Simulates point patterns according to the null hypothesis and returns the envelope of K according to the confidence level.

Usage

```
KEnvelope(X, r = NULL, NumberOfSimulations = 100, Alpha = 0.05,
          ReferenceType = "", NeighborType = ReferenceType,
          SimulationType = "RandomPosition", Global = FALSE)
```

Arguments

X	A point pattern (wmppp.object).
r	A vector of distances. If NULL, a sensible default value is chosen (512 intervals, from 0 to half the diameter of the window) following spatstat.
NumberOfSimulations	The number of simulations to run, 100 by default.
Alpha	The risk level, 5% by default.
ReferenceType	One of the point types. Default is all point types.
NeighborType	One of the point types. By default, the same as reference type.
SimulationType	A string describing the null hypothesis to simulate. The null hypothesis may be "*RandomPosition*": points are drawn in a Poisson process (default); "*RandomLabeling*": randomizes point types, keeping locations unchanged; "*PopulationIndependence*": keeps reference points unchanged, shifts other point locations.
Global	Logical; if TRUE, a global envelope sensu Duranton and Overman (2005) is calculated.

Details

This envelope is local by default, that is to say it is computed separately at each distance. See Loosmore and Ford (2006) for a discussion.

The global envelope is calculated by iteration: the simulations reaching one of the upper or lower values at any distance are eliminated at each step. The process is repeated until *Alpha / Number of simulations* simulations are dropped. The remaining upper and lower bounds at all distances constitute the global envelope. Interpolation is used if the exact ratio cannot be reached.

Value

An envelope object (envelope). There are methods for print and plot for this class.

The fv contains the observed value of the function, its average simulated value and the confidence envelope.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106.

Kenkel, N. C. (1988). Pattern of Self-Thinning in Jack Pine: Testing the Random Mortality Hypothesis. *Ecology* 69(4): 1017-1024.

Loosmore, N. B. and Ford, E. D. (2006). Statistical inference using the G or K point pattern spatial statistics. *Ecology* 87(8): 1925-1931.

Marcon, E. and F. Puech (2012). A typology of distance-based measures of spatial concentration. *HAL SHS*. 00679993.

Silverman, B. W. (1986). *Density estimation for statistics and data analysis*. Chapman and Hall, London.

See Also

Khat, rRandomPositionK, rRandomLocation, rPopulationIndependenceK

Examples

```
data(paracou16)
# Keep only 20% of points to run this example
X <- as.wmppp(rthin(paracou16, 0.2))
plot(X)

# Calculate confidence envelope (should be 1000 simulations, reduced to 20 to save time)
r <- 0:30
NumberOfSimulations <- 20
# Plot the envelope
plot(KEnvelope(X, r, NumberOfSimulations), ./(pi*r^2) ~ r)
```

Khat *Estimation of the K function*

Description

Estimates the K function

Usage

```
Khat(X, r = NULL, ReferenceType = "", NeighborType = ReferenceType, CheckArguments = TRUE)
```

Arguments

X	A weighted, marked, planar point pattern (wmppp.object).
r	A vector of distances. If NULL, a sensible default value is chosen (512 intervals, from 0 to half the diameter of the window) following spatstat.
ReferenceType	One of the point types. Default is all point types.
NeighborType	One of the point types. By default, the same as reference type.
CheckArguments	Logical; if TRUE, the function arguments are verified. Should be set to FALSE to save time in simulations for example, when the arguments have been checked elsewhere.

Details

K is a cumulative, topographic measure of a point pattern structure.

Value

An object of class fv, see fv.object, which can be plotted directly using plot.fv.

Note

The computation of Khat relies on spatstat functions Kest and Kcross.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Ripley, B. D. (1976). The Foundations of Stochastic Geometry. *Annals of Probability* 4(6): 995-998.

Ripley, B. D. (1977). Modelling Spatial Patterns. *Journal of the Royal Statistical Society B* 39(2): 172-212.

See Also

Lhat, KEnvelope, Ktest

Examples

```
data(paracou16)
plot(paracou16)

# Calculate K
r <- 0:30
(Paracou <- Khat(paracou16, r))

# Plot (after normalization by pi.r^2)
plot(Paracou, ./(pi*r^2) ~ r)
```

KinhomEnvelope — *Estimation of the confidence envelope of the Kinhom function under its null hypothesis*

Description

Simulates point patterns according to the null hypothesis and returns the envelope of *Kinhom* according to the confidence level.

Usage

```
KinhomEnvelope(X, r = NULL, NumberOfSimulations = 100, Alpha = 0.05,
            ReferenceType = "", lambda = NULL, SimulationType = "RandomPosition",
               Global = FALSE)
```

Arguments

X	A point pattern (wmppp.object).
r	A vector of distances. If NULL, a sensible default value is chosen (512 intervals, from 0 to half the diameter of the window) following spatstat.
NumberOfSimulations	The number of simulations to run.
Alpha	The risk level.
ReferenceType	One of the point types. Default is all point types.
lambda	An estimation of the point pattern density, obtained by the density.ppp function.
SimulationType	A string describing the null hypothesis to simulate. The null hypothesis, may be "*RandomPosition*": points are drawn in an inhomogenous Poisson process (intensity is either lambda or estimated from X); "*RandomLocation*": points are redistributed across actual locations; "*RandomLabeling*": randomizes point types, keeping locations unchanged; "*PopulationIndependence*": keeps reference points unchanged, redistributes others across actual locations.
Global	Logical; if TRUE, a global envelope sensu Duranton and Overman (2005) is calculated.

Details

The random location null hypothesis is that of Duranton and Overman (2005). It is appropriate to test the univariate *Kinhom* function of a single point type, redistributing it over all point locations.

The random labeling hypothesis is appropriate for the bivariate *Kinhom* function.

The population independence hypothesis is that of Marcon and Puech (2010).

This envelope is local by default, that is to say it is computed separately at each distance. See Loosmore and Ford (2006) for a discussion.

The global envelope is calculated by iteration: the simulations reaching one of the upper or lower values at any distance are eliminated at each step. The process is repeated until *Alpha / Number of simulations* simulations are dropped. The remaining upper and lower bounds at all distances constitute the global envelope. Interpolation is used if the exact ratio cannot be reached.

Value

An envelope object (`envelope`). There are methods for print and plot for this class.

The `fv` contains the observed value of the function, its average simulated value and the confidence envelope.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106.

Kenkel, N. C. (1988). Pattern of Self-Thinning in Jack Pine: Testing the Random Mortality Hypothesis. *Ecology* 69(4): 1017-1024.

Loosmore, N. B. and Ford, E. D. (2006). Statistical inference using the G or K point pattern spatial statistics. *Ecology* 87(8): 1925-1931.

Marcon, E. and Puech, F. (2010). Measures of the Geographic Concentration of Industries: Improving Distance-Based Methods. *Journal of Economic Geography* 10(5): 745-762.

Marcon, E. and F. Puech (2012). A typology of distance-based measures of spatial concentration. *HAL SHS*. 00679993.

See Also

`Kinhomhat`

Examples

```
data(paracou16)
# Keep only 20% of points to run this example
X <- as.wmppp(rthin(paracou16, 0.2))
plot(X)

# Density of all trees
lambda <- density.ppp(X, bw.diggle(X))
plot(lambda)
V.americana <- X[X$marks$PointType=="V. Americana"]
plot(V.americana, add=TRUE)

# Calculate Kinhom according to the density of all trees
# and confidence envelope (should be 1000 simulations, reduced to 4 to save time)
r <- 0:30
```

```
NumberOfSimulations <- 4
Alpha <- .10
plot(KinhomEnvelope(X, r,NumberOfSimulations, Alpha, ,
    SimulationType="RandomPosition", lambda=lambda), ./(pi*r^2) ~ r)
```

Kinhomhat *Estimation of the inhomogenous K function*

Description

Estimates the *Kinhom* function

Usage

```
Kinhomhat(X, r = NULL, ReferenceType = "", lambda = NULL, CheckArguments = TRUE)
```

Arguments

X	A weighted, marked, planar point pattern (wmppp.object).
r	A vector of distances. If NULL, a sensible default value is chosen (512 intervals, from 0 to half the diameter of the window) following spatstat.
ReferenceType	One of the point types. Default is all point types.
lambda	An estimation of the point pattern density, obtained by the density.ppp function.
CheckArguments	Logical; if TRUE, the function arguments are verified. Should be set to FALSE to save time in simulations for example, when the arguments have been checked elsewhere.

Details

Kinhom is a cumulative, topographic measure of an inhomogenous point pattern structure.

By default, density estimation is performed at points by density.ppp using the optimal bandwith (bw.diggle). It can be calculated separately (see example), including at pixels if the point pattern is too large for the default estimation to succeed, and provided as the argument lambda: Arbia et al. (2012) for example use another point pattern as a reference to estimate density.

Bivariate *Kinhom* is not currently supported.

Value

An object of class fv, see fv.object, which can be plotted directly using plot.fv.

Note

The computation of Kinhomhat relies on spatstat functions Kinhom, density.ppp and bw.diggle.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Baddeley, A. J., J. Moller, et al. (2000). Non- and semi-parametric estimation of interaction in inhomogeneous point patterns. *Statistica Neerlandica* 54(3): 329-350.

Arbia, G., G. Espa, et al. (2012). Clusters of firms in an inhomogeneous space: The high-tech industries in Milan. *Economic Modelling* 29(1): 3-11.

See Also

KinhomEnvelope, Kinhom

Examples

```
data(paracou16)

# Density of all trees
lambda <- density.ppp(paracou16, bw.diggle(paracou16))
plot(lambda)
# Reduce the point pattern to one type of trees
V.americana <- paracou16[paracou16$marks$PointType=="V. Americana"]
plot(V.americana, add=TRUE)

# Calculate Kinhom according to the density of all trees
r <- 0:30
plot(Kinhomhat(paracou16, r, "V. Americana", lambda), ./(pi*r^2) ~ r)
```

`KmmEnvelope` *Estimation of the confidence envelope of the Lmm function under its null hypothesis*

Description

Simulates point patterns according to the null hypothesis and returns the envelope of *Lmm* according to the confidence level.

Usage

```
KmmEnvelope(X, r = NULL, NumberOfSimulations = 100, Alpha = 0.05, ReferenceType = "",
            Global = FALSE)
```

Arguments

X	A point pattern (`wmppp.object`).
r	A vector of distances. If `NULL`, a sensible default value is chosen (512 intervals, from 0 to half the diameter of the window) following `spatstat`.
NumberOfSimulations	The number of simulations to run, 100 by default.
Alpha	The risk level, 5% by default.
ReferenceType	One of the point types. Others are ignored. Default is all point types.
Global	Logical; if `TRUE`, a global envelope sensu Duranton and Overman (2005) is calculated.

Details

This envelope is local by default, that is to say it is computed separately at each distance. See Loosmore and Ford (2006) for a discussion.

The global envelope is calculated by iteration: the simulations reaching one of the upper or lower values at any distance are eliminated at each step. The process is repeated until *Alpha / Number of simulations* simulations are dropped. The remaining upper and lower bounds at all distances constitute the global envelope. Interpolation is used if the exact ratio cannot be reached.

Value

An envelope object (`envelope`). There are methods for print and plot for this class.

The `fv` contains the observed value of the function, its average simulated value and the confidence envelope.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106.

Kenkel, N. C. (1988). Pattern of Self-Thinning in Jack Pine: Testing the Random Mortality Hypothesis. *Ecology* 69(4): 1017-1024.

Loosmore, N. B. and Ford, E. D. (2006). Statistical inference using the G or K point pattern spatial statistics. *Ecology* 87(8): 1925-1931.

Marcon, E. and F. Puech (2012). A typology of distance-based measures of spatial concentration. *HAL SHS*. 00679993.

See Also

`Kmmhat`

Examples

```
data(paracou16)
# Keep only 20% of points to run this example
X <- as.wmppp(rthin(paracou16, 0.2))
plot(X)

# Calculate confidence envelope (should be 1000 simulations, reduced to 4 to save time)
r <- seq(0, 30, 2)
NumberOfSimulations <- 4
Alpha <- .10
plot(KmmEnvelope(X, r, NumberOfSimulations, Alpha), ./(pi*r^2) ~ r)
```

Kmmhat — *Estimation of the Kmm function*

Description

Estimates of the *Kmm* function

Usage

```
Kmmhat(X, r = NULL, ReferenceType = "", CheckArguments = TRUE)
```

Arguments

X	A weighted, marked, planar point pattern (wmppp.object).
r	A vector of distances. If NULL, a sensible default value is chosen (512 intervals, from 0 to half the diameter of the window) following spatstat.
ReferenceType	One of the point types. Others are ignored. Default is all point types.
CheckArguments	Logical; if TRUE, the function arguments are verified. Should be set to FALSE to save time in simulations for example, when the arguments have been checked elsewhere.

Details

The *Kmm* function is used to test the independence of marks.

Value

An object of class fv, see fv.object, which can be plotted directly using plot.fv.

Note

The function is computed using markcorrint in spatstat.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Penttinen, A., Stoyan, D. and Henttonen, H. M. (1992). Marked Point Processes in Forest Statistics. *Forest Science* 38(4): 806-824.

Penttinen, A. (2006). Statistics for Marked Point Patterns. in *The Yearbook of the Finnish Statistical Society*. The Finnish Statistical Society, Helsinki: 70-91.

See Also

Lmmhat, LmmEnvelope, markcorrint

Examples

```
data(paracou16)
# Keep only 50% of points to run this example
X <- as.wmppp(rthin(paracou16, 0.5))
plot(X)

# Calculate Kmm
r <- seq(0, 30, 2)
(Paracou <- Kmmhat(X, r))

# Plot
plot(Paracou, ./(pi*r^2) ~ r)
```

Ktest — *Test of a point pattern against Complete Spatial Randomness*

Description

Tests the point pattern against CSR using values of the K function

Usage

```
Ktest(X, r)
```

Arguments

X	A point pattern (ppp.object). Marks are ignored. The window must be a rectangle sensu spatstat (tested by is.rectangle).
r	A vector of distances.

Details

The test returns the risk to reject CSR erroneously, based on the distribution of the K function.

Value

A p-value.

Author(s)

Gabriel Lang <Gabriel.Lang@agroparistech.fr>, Eric Marcon<Eric.Marcon@ecofog.gf>

References

Lang, G. and Marcon, E. (2013). Testing randomness of spatial point patterns with the Ripley statistic. *ESAIM: Probability and Statistics.* 17: 767-788.

Marcon, E., S. Traissac, and Lang, G. (2013). A Statistical Test for Ripley's Function Rejection of Poisson Null Hypothesis. *ISRN Ecology* 2013(Article ID 753475): 9.

See Also

Khat, GoFtest

Examples

```
# Simulate a Matern (Neyman Scott) point pattern
nclust <- function(x0, y0, radius, n) {
  return(runifdisc(n, radius, centre=c(x0, y0)))
}
X <- rNeymanScott(20, 0.1, nclust, radius=0.2, n=5)
plot(X)

# Test it
Ktest(X, r=seq(0.1, .5, .1))
```

LEnvelope — *Estimation of the confidence envelope of the L function under its null hypothesis*

Description

Simulates point patterns according to the null hypothesis and returns the envelope of L according to the confidence level.

Usage

```
LEnvelope(X, r = NULL, NumberOfSimulations = 100, Alpha = 0.05,
        ReferenceType = "", NeighborType = "", SimulationType = "RandomPosition",
          Global = FALSE)
```

Arguments

- `X` — A point pattern (`wmppp.object`).
- `r` — A vector of distances. If `NULL`, a sensible default value is chosen (512 intervals, from 0 to half the diameter of the window) following `spatstat`.
- `NumberOfSimulations` — The number of simulations to run, 100 by default.
- `Alpha` — The risk level, 5% by default.
- `ReferenceType` — One of the point types. Default is all point types.
- `NeighborType` — One of the point types. Default is all point types.
- `SimulationType` — A string describing the null hypothesis to simulate. The null hypothesis may be "*RandomPosition*": points are drawn in a Poisson process (default); "*RandomLabeling*": randomizes point types, keeping locations unchanged; "*PopulationIndependence*": keeps reference points unchanged, randomizes other point locations.
- `Global` — Logical; if `TRUE`, a global envelope sensu Duranton and Overman (2005) is calculated.

Details

This envelope is local by default, that is to say it is computed separately at each distance. See Loosmore and Ford (2006) for a discussion.

The global envelope is calculated by iteration: the simulations reaching one of the upper or lower values at any distance are eliminated at each step. The process is repeated until *Alpha / Number of simulations* simulations are dropped. The remaining upper and lower bounds at all distances constitute the global envelope. Interpolation is used if the exact ratio cannot be reached.

Value

An envelope object (`envelope`). There are methods for print and plot for this class.

The `fv` contains the observed value of the function, its average simulated value and the confidence envelope.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106.

Kenkel, N. C. (1988). Pattern of Self-Thinning in Jack Pine: Testing the Random Mortality Hypothesis. *Ecology* 69(4): 1017-1024.

Loosmore, N. B. and Ford, E. D. (2006). Statistical inference using the G or K point pattern spatial statistics. *Ecology* 87(8): 1925-1931.

Marcon, E. and F. Puech (2012). A typology of distance-based measures of spatial concentration. *HAL SHS*. 00679993.

See Also

Khat

Examples

```
data(paracou16)
# Keep only 20% of points to run this example
X <- as.wmppp(rthin(paracou16, 0.2))
plot(X)

# Calculate confidence envelope (should be 1000 simulations, reduced to 20 to save time)
r <- 0:30
NumberOfSimulations <- 20
# Plot the envelope
plot(LEnvelope(X, r, NumberOfSimulations))
```

Lhat — *Estimation of the L function*

Description

Estimates the *L* function

Usage

```
Lhat(X, r = NULL, ReferenceType = "", NeighborType = "", CheckArguments = TRUE)
```

Arguments

X	A weighted, marked, planar point pattern (wmppp.object).
r	A vector of distances. If NULL, a sensible default value is chosen (512 intervals, from 0 to half the diameter of the window) following spatstat.
ReferenceType	One of the point types. Default is all point types.
NeighborType	One of the point types. Default is all point types.

`CheckArguments` Logical; if `TRUE`, the function arguments are verified. Should be set to `FALSE` to save time in simulations for example, when the arguments have been checked elsewhere.

Details

L is the normalized version of K: $L(r) = \sqrt{\frac{K}{\pi}} - r$.

Value

An object of class `fv`, see `fv.object`, which can be plotted directly using `plot.fv`.

Note

L was originally defined as $L(r) = \sqrt{\frac{K}{\pi}}$. It has been used as $L(r) = \sqrt{\frac{K}{\pi}} - r$ in a part of the literature because this normalization is easier to plot.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Besag, J. E. (1977). Comments on Ripley's paper. *Journal of the Royal Statistical Society B* 39(2): 193-195.

See Also

`Khat`, `LEnvelope`

Examples

```
data(paracou16)
plot(paracou16)

# Calculate L
r <- 0:30
(Paracou <- Lhat(paracou16, r))

# Plot
plot(Paracou)
```

LmmEnvelope	*Estimation of the confidence envelope of the Lmm function under its null hypothesis*

Description

Simulates point patterns according to the null hypothesis and returns the envelope of *Lmm* according to the confidence level.

Usage

```
LmmEnvelope(X, r = NULL, NumberOfSimulations = 100, Alpha = 0.05, ReferenceType = "",
            Global = FALSE)
```

Arguments

X	A weighted, marked, planar point pattern (wmppp.object).
r	A vector of distances. If NULL, a sensible default value is chosen (512 intervals, from 0 to half the diameter of the window) following spatstat.
NumberOfSimulations	The number of simulations to run, 100 by default.
Alpha	The risk level, 5% by default.
ReferenceType	One of the point types. Others are ignored. Default is all point types.
Global	Logical; if TRUE, a global envelope sensu Duranton and Overman (2005) is calculated.

Details

This envelope is local by default, that is to say it is computed separately at each distance. See Loosmore and Ford (2006) for a discussion.

The global envelope is calculated by iteration: the simulations reaching one of the upper or lower values at any distance are eliminated at each step. The process is repeated until *Alpha / Number of simulations* simulations are dropped. The remaining upper and lower bounds at all distances constitute the global envelope. Interpolation is used if the exact ratio cannot be reached.

Value

An envelope object (envelope). There are methods for print and plot for this class.

The fv contains the observed value of the function, its average simulated value and the confidence envelope.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106.

Kenkel, N. C. (1988). Pattern of Self-Thinning in Jack Pine: Testing the Random Mortality Hypothesis. *Ecology* 69(4): 1017-1024.

Loosmore, N. B. and Ford, E. D. (2006). Statistical inference using the G or K point pattern spatial statistics. *Ecology* 87(8): 1925-1931.

Marcon, E. and F. Puech (2012). A typology of distance-based measures of spatial concentration. *HAL SHS*. 00679993.

See Also

Lmmhat

Examples

```
data(paracou16)
# Keep only 20% of points to run this example
X <- as.wmppp(rthin(paracou16, 0.2))
plot(X)

# Calculate confidence envelope (should be 1000 simulations, reduced to 4 to save time)
r <- seq(0, 30, 2)
NumberOfSimulations <- 4
Alpha <- .10
plot(LmmEnvelope(X, r, NumberOfSimulations, Alpha))
```

Lmmhat — *Estimation of the Lmm function*

Description

Estimates the *Lmm* function

Usage

```
Lmmhat(X, r = NULL, ReferenceType = "", CheckArguments = TRUE)
```

Arguments

X	A weighted, marked, planar point pattern (wmppp.object).
r	A vector of distances. If NULL, a sensible default value is chosen (512 intervals, from 0 to half the diameter of the window) following spatstat.
ReferenceType	One of the point types. Others are ignored. Default is all point types.

`CheckArguments` Logical; if `TRUE`, the function arguments are verified. Should be set to `FALSE` to save time in simulations for example, when the arguments have been checked elsewhere.

Details

Lmm is the normalized version of *Kmm*: $Lmm(r) = \sqrt{\frac{Kmm}{\pi}} - r$.

Value

An object of class `fv`, see `fv.object`, which can be plotted directly using `plot.fv`.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Penttinen, A., Stoyan, D. and Henttonen, H. M. (1992). Marked Point Processes in Forest Statistics. *Forest Science* 38(4): 806-824.

Espa, G., Giuliani, D. and Arbia, G. (2010). Weighting Ripley's K-function to account for the firm dimension in the analysis of spatial concentration. *Discussion Papers*, 12/2010. Universita di Trento, Trento: 26.

See Also

`Kmmhat`, `LmmEnvelope`

Examples

```
data(paracou16)
# Keep only 50% of points to run this example
X <- as.wmppp(rthin(paracou16, 0.5))
plot(X)

# Calculate Lmm
r <- seq(0, 30, 2)
(Paracou <- Lmmhat(X, r))

# Plot
plot(Paracou)
```

MEnvelope *Estimation of the confidence envelope of the M function under its null hypothesis*

Description

Simulates point patterns according to the null hypothesis and returns the envelope of *M* according to the confidence level.

Usage

```
MEnvelope(X, r = NULL, NumberOfSimulations = 100, Alpha = 0.05,
          ReferenceType, NeighborType = ReferenceType,
         CaseControl = FALSE, SimulationType = "RandomLocation", Global = FALSE)
```

Arguments

`X`	A point pattern (`wmppp.object`).
`r`	A vector of distances. If `NULL`, a default value is set: 32 unequally spaced values are used up to half the maximum distance between points d_m. The first value is 0, first steps are small ($d_m/200$) then incresase progressively up to $d_m/20$.
`NumberOfSimulations`	The number of simulations to run, 100 by default.
`Alpha`	The risk level, 5% by default.
`ReferenceType`	One of the point types.
`NeighborType`	One of the point types, equal to the reference type by default to caculate univariate M.
`CaseControl`	Logical; if `TRUE`, the case-control version of *M* is computed. *ReferenceType* points are cases, *NeighborType* points are controls.
`SimulationType`	A string describing the null hypothesis to simulate. The null hypothesis may be "*RandomLocation*": points are redistributed on the actual locations (default); "*RandomLabeling*": randomizes point types, keeping locations and weights unchanged; "*PopulationIndependence*": keeps reference points unchanged, randomizes other point locations.
`Global`	Logical; if `TRUE`, a global envelope sensu Duranton and Overman (2005) is calculated.

Details

This envelope is local by default, that is to say it is computed separately at each distance. See Loosmore and Ford (2006) for a discussion.

The global envelope is calculated by iteration: the simulations reaching one of the upper or lower values at any distance are eliminated at each step. The process is repeated until *Alpha / Number of simulations* simulations are dropped. The remaining upper and lower bounds at all distances constitute the global envelope. Interpolation is used if the exact ratio cannot be reached.

Value

An envelope object (envelope). There are methods for print and plot for this class.

The fv contains the observed value of the function, its average simulated value and the confidence envelope.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106.

Kenkel, N. C. (1988). Pattern of Self-Thinning in Jack Pine: Testing the Random Mortality Hypothesis. *Ecology* 69(4): 1017-1024.

Loosmore, N. B. and Ford, E. D. (2006). Statistical inference using the G or K point pattern spatial statistics. *Ecology* 87(8): 1925-1931.

Marcon, E. and F. Puech (2012). A typology of distance-based measures of spatial concentration. *HAL SHS*. 00679993.

See Also

Mhat

Examples

```
data(paracou16)
# Keep only 50% of points to run this example
X <- as.wmppp(rthin(paracou16, 0.5))
plot(X)

# Calculate confidence envelope (should be 1000 simulations, reduced to 4 to save time)
NumberOfSimulations <- 4
Alpha <- .10
plot(MEnvelope(X, , NumberOfSimulations, Alpha,
    "V. Americana", "Q. Rosea", FALSE, "RandomLabeling"))
```

---

mEnvelope *Estimation of the confidence envelope of the m function under its null hypothesis*

Description

Simulates point patterns according to the null hypothesis and returns the envelope of *m* according to the confidence level.

Usage

```
mEnvelope(X, r = NULL, NumberOfSimulations = 100, Alpha = 0.05,
          ReferenceType, NeighborType = ReferenceType, CaseControl = FALSE,
          Original = TRUE, Approximate = ifelse(X$n < 10000, 0, 1), Adjust = 1,
         MaxRange = "ThirdW", SimulationType = "RandomLocation", Global = FALSE)
```

Arguments

- `X` A point pattern (`wmppp.object`).
- `r` A vector of distances. If `NULL`, a default value is set: 512 equally spaced values are used up to the median distance between points (following Duranton and Overman, 2005).
- `NumberOfSimulations` The number of simulations to run, 100 by default.
- `Alpha` The risk level, 5% by default.
- `ReferenceType` One of the point types.
- `NeighborType` One of the point types, equal to the reference type by default to caculate univariate M.
- `CaseControl` Logical; if `TRUE`, the case-control version of *M* is computed. *ReferenceType* points are cases, *NeighborType* points are controls.
- `Original` Logical; if `TRUE` (by default), the original bandwidth selection by Duranton and Overman (2005) following Silverman (1986: eq 3.31) is used. If `FALSE`, it is calculated following Sheather and Jones (1991), *i.e.* the state of the art. See `bw.SJ` for more details.
- `Approximate` if not 0 (1 is a good choice), exact distances between pairs of points are rounded to 1024 times `Approximate` single values equally spaced between 0 and the largest distance. This technique (Scholl and Brenner, 2013) allows saving a lot of memory when addressing large point sets (the default value is 1 over 10000 points). Increasing `Approximate` allows better precision at the cost of proportional memory use.
- `Adjust` Force the automatically selected bandwidth (following `Original`) to be multiplied by `Adjust`. Setting it to values lower than one (1/2 for example) will sharpen the estimation.
- `MaxRange` The maximum value of `r` to consider, ignored if `r` is not `NULL`. Default is "ThirdW", one third of the diameter of the window. Other choices are "HalfW", and "QuarterW" and "D02005". "HalfW", and "QuarterW" are for half or the quarter of the diameter of the window. "D02005" is for the median distance observed between points, following Duranton and Overman (2005). "ThirdW" should be close to "DO2005" but has the advantage to be independent of the point types chosen as `ReferenceType` and `NeighborType`, to simplify comparisons between different types. "D02005" is approximated by "ThirdW" if `Approximate` is not 0.
- `SimulationType` A string describing the null hypothesis to simulate. The null hypothesis may be "*RandomLocation*": points are redistributed on the actual locations (default); "*RandomLabeling*": randomizes point types, keeping locations and weights unchanged; "*PopulationIndependence*": keeps reference points unchanged, randomizes other point locations.

`Global` Logical; if `TRUE`, a global envelope sensu Duranton and Overman (2005) is calculated.

Details

This envelope is local by default, that is to say it is computed separately at each distance. See Loosmore and Ford (2006) for a discussion.

The global envelope is calculated by iteration: the simulations reaching one of the upper or lower values at any distance are eliminated at each step. The process is repeated until *Alpha / Number of simulations* simulations are dropped. The remaining upper and lower bounds at all distances constitute the global envelope. Interpolation is used if the exact ratio cannot be reached.

Value

An envelope object (`envelope`). There are methods for print and plot for this class.

The `fv` contains the observed value of the function, its average simulated value and the confidence envelope.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106.

Kenkel, N. C. (1988). Pattern of Self-Thinning in Jack Pine: Testing the Random Mortality Hypothesis. *Ecology* 69(4): 1017-1024.

Lang G., Marcon E. and Puech F. (2014) Distance-Based Measures of Spatial Concentration: Introducing a Relative Density Function. *HAL* 01082178, 1-18.

Loosmore, N. B. and Ford, E. D. (2006). Statistical inference using the G or K point pattern spatial statistics. *Ecology* 87(8): 1925-1931.

Marcon, E. and F. Puech (2012). A typology of distance-based measures of spatial concentration. *HAL SHS*. 00679993.

Silverman, B. W. (1986). *Density estimation for statistics and data analysis*. Chapman and Hall, London.

See Also

`mhat`

Examples

```
data(paracou16)
# Keep only 50% of points to run this example
X <- as.wmppp(rthin(paracou16, 0.5))
plot(X)
```

```
# Calculate confidence envelope (should be 1000 simulations, reduced to 4 to save time)
NumberOfSimulations <- 4
Alpha <- .10
plot(mEnvelope(X, , NumberOfSimulations, Alpha,
    "V. Americana", "Q. Rosea", Original = FALSE, SimulationType = "RandomLabeling"))
```

Mhat *Estimation of the M function*

Description

Estimates the *M* function

Usage

```
Mhat(X, r = NULL, ReferenceType, NeighborType = ReferenceType,
    CaseControl = FALSE, CheckArguments = TRUE)
```

Arguments

X	A weighted, marked planar point pattern (wmppp.object).
r	A vector of distances. If NULL, a default value is set: 64 unequally spaced values are used up to half the maximum distance between points d_m. The first value is 0, first steps are small ($d_m/800$) then increase progressively up to $d_m/40$.
ReferenceType	One of the point types.
NeighborType	One of the point types. By default, the same as reference type.
CaseControl	Logical; if TRUE, the case-control version of *M* is computed. *ReferenceType* points are cases, *NeighborType* points are controls.
CheckArguments	Logical; if TRUE, the function arguments are verified. Should be set to FALSE to save time in simulations for example, when the arguments have been checked elsewhere.

Details

M is a weighted, cumulative, relative measure of a point pattern structure. Its value at any distance is the ratio of neighbors of the *NeighborType* to all points around *ReferenceType* points, normalized by its value over the windows.

Value

An object of class fv, see fv.object, which can be plotted directly using plot.fv.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Marcon, E. and Puech, F. (2010). Measures of the Geographic Concentration of Industries: Improving Distance-Based Methods. *Journal of Economic Geography* 10(5): 745-762.

Marcon, E., F. Puech, et al. (2012). Characterizing the relative spatial structure of point patterns. *International Journal of Ecology* 2012(Article ID 619281): 11.

See Also

MEnvelope, Kdhat

Examples

```
data(paracou16)
plot(paracou16)

# Calculate M
plot(Mhat(paracou16, , "V. Americana", "Q. Rosea"))
```

---

mhat *Estimation of the m function*

Description

Estimates the *m* function

Usage

```
mhat(X, r = NULL, ReferenceType, NeighborType = ReferenceType,
   CaseControl = FALSE, Original = TRUE, Approximate = ifelse(X$n < 10000, 0, 1),
    Adjust = 1, MaxRange = "ThirdW", CheckArguments = TRUE)
```

Arguments

X	A weighted, marked planar point pattern (wmppp.object).
r	A vector of distances. If NULL, a default value is set: 512 equally spaced values are used, from the smallest distance to the range defined by MaxRange. the between points to half the diameter of the window.
ReferenceType	One of the point types.
NeighborType	One of the point types. By default, the same as reference type.
CaseControl	Logical; if TRUE, the case-control version of *M* is computed. *ReferenceType* points are cases, *NeighborType* points are controls.
Original	Logical; if TRUE (by default), the original bandwidth selection by Duranton and Overman (2005) following Silverman (1986: eq 3.31) is used. If FALSE, it is calculated following Sheather and Jones (1991), *i.e.* the state of the art. See bw.SJ for more details.

Approximate	if not 0 (1 is a good choice), exact distances between pairs of points are rounded to 1024 times Approximate single values equally spaced between 0 and the largest distance. This technique (Scholl and Brenner, 2013) allows saving a lot of memory when addressing large point sets (the default value is 1 over 10000 points). Increasing Approximate allows better precision at the cost of proportional memory use.
Adjust	Force the automatically selected bandwidth (following Original) to be multiplied by Adjust. Setting it to values lower than one (1/2 for example) will sharpen the estimation.
MaxRange	The maximum value of r to consider, ignored if r is not NULL. Default is "ThirdW", one third of the diameter of the window. Other choices are "HalfW", and "QuarterW" and "D02005". "HalfW", and "QuarterW" are for half or the quarter of the diameter of the window. "D02005" is for the median distance observed between points, following Duranton and Overman (2005). "ThirdW" should be close to "DO2005" but has the advantage to be independent of the point types chosen as ReferenceType and NeighborType, to simplify comparisons between different types. "D02005" is approximated by "ThirdW" if Approximate is not 0.
CheckArguments	Logical; if TRUE, the function arguments are verified. Should be set to FALSE to save time in simulations for example, when the arguments have been checked elsewhere.

Details

m is a weighted, density, relative measure of a point pattern structure (Lang *et al.*, 2014). Its value at any distance is the ratio of neighbors of the *NeighborType* to all points around *ReferenceType* points, normalized by its value over the windows.

The number of neighbors at each distance is estimated by a Gaussian kernel whose bandwith is chosen optimally according to Silverman (1986: eq 3.31). It can be sharpened or smoothed by multiplying it by Adjust. The bandwidth of Sheather and Jones (1991) would be better but it is very slow to calculate for large point patterns and it sometimes fails. It is often sharper than that of Silverman.

Value

An object of class fv, see fv.object, which can be plotted directly using plot.fv.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106.

Lang G., Marcon E. and Puech F. (2014) Distance-Based Measures of Spatial Concentration: Introducing a Relative Density Function. *HAL* 01082178, 1-18.

Sheather, S. J. and Jones, M. C. (1991) A reliable data-based bandwidth selection method for kernel density estimation. *Journal of the Royal Statistical Society series B*, 53, 683-690.

Silverman, B. W. (1986). *Density estimation for statistics and data analysis*. Chapman and Hall, London.

See Also

mEnvelope, Kdhat

Examples

```
data(paracou16)
plot(paracou16)

# Calculate M
plot(mhat(paracou16, , "V. Americana", "Q. Rosea"))
```

---

paracou16 *Paracou field station plot 16, partial map*

Description

This point pattern is from Paracou field station, French Guiana, managed by Cirad.

Usage

```
data(paracou16)
```

Format

An object of class ppp.object representing the point pattern of tree locations in a 250 x 300 meter sampling region. Each tree is marked with its species ("Q. Rosea", "V. Americana" or "Other"), and basal area (square centimeters).

Source

Permanent data census of Paracou and Marcon et al. (2012).

References

Gourlet-Fleury, S., Guehl, J. M. and Laroussinie, O., Eds. (2004). *Ecology & management of a neotropical rainforest. Lessons drawn from Paracou, a long-term experimental research site in French Guiana*. Paris, Elsevier.

Marcon, E., F. Puech, et al. (2012). Characterizing the relative spatial structure of point patterns. *International Journal of Ecology* 2012(Article ID 619281): 11.

Examples

```
data(paracou16)
# Plot (second column of marks is Point Types)
plot(paracou16, which.marks=2, leg.side="right")
```

---

print.dbmssEnvelope *Print a confidence envelope*

Description

Prints useful information of a confidence envelope of class "dbmssEnvelope"

Usage

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

Arguments

x	An object of class "dbmssEnvelope".
...	Ignored.

Details

"dbmssEnvelope" objects are similar to envelope objects. The way they are printed is different to take into account the possibility of building global envelope following Duranton and Overman (2005): the global envelope is calculated by iteration: the simulations reaching one of the upper or lower values at any distance are eliminated at each step. The process is repeated until *Alpha / Number of simulations* simulations are dropped. The remaining upper and lower bounds at all distances constitute the global envelope. Interpolation is used if the exact ratio cannot be reached.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106

Examples

```
data(paracou16)
plot(paracou16)

# Calculate intertype K envelope
Envelope <- KEnvelope(paracou16, NumberOfSimulations = 20, Global = TRUE,
  ReferenceType = "V. Americana", NeighborType = "Q. Rosea")
plot(Envelope)
# print
print(Envelope)
```

---

rPopulationIndependenceK

Simulations of a point pattern according to the null hypothesis of population independence defined for K

Description

Simulates of a point pattern according to the null hypothesis of population independence defined for K.

Usage

```
rPopulationIndependenceK(X, ReferenceType, NeighborType, CheckArguments = TRUE)
```

Arguments

X	A weighted, marked, planar point pattern (wmppp.object).
ReferenceType	One of the point types.
NeighborType	One of the point types.
CheckArguments	Logical; if TRUE, the function arguments are verified. Should be set to FALSE to save time in simulations for example, when the arguments have been checked elsewhere.

Details

Reference points are kept unchanged, other point positions are shifted by rshift.

Value

A new weighted, marked, planar point pattern (an object of class wmppp, see wmppp.object).

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Goreaud, F. et Pelissier, R. (2003). Avoiding misinterpretation of biotic interactions with the intertype K12 fonction: population independence vs random labelling hypotheses. *Journal of Vegetation Science* 14(5): 681-692.

See Also

rPopulationIndependenceM, rRandomLabeling

Examples

```
# Simulate a point pattern with two types
X <- rpoispp(50)
PointType   <- sample(c("A", "B"), X$n, replace=TRUE)
PointWeight <- runif(X$n, min=1, max=10)
X$marks <- data.frame(PointType, PointWeight)
X <- as.wmppp(X)

par(mfrow=c(1,2))
# Plot the point pattern, using PointType as marks
plot(X, main="Original pattern, Point Type", which.marks=2)

# Randomize it
Y <- rPopulationIndependenceK(X, "A", "B")
# Points of type "A" are unchanged, points of type "B" have been moved altogether
plot(Y, main="Randomized pattern, Point Type", which.marks=2)
```

---

rPopulationIndependenceM

Simulations of a point pattern according to the null hypothesis of population independence defined for M

Description

Simulates of a point pattern according to the null hypothesis of population independence defined for *M*

Usage

```
rPopulationIndependenceM(X, ReferenceType, CheckArguments = TRUE)
```

Arguments

X	A weighted, marked, planar point pattern (wmppp.object).
ReferenceType	One of the point types.
CheckArguments	Logical; if TRUE, the function arguments are verified. Should be set to FALSE to save time in simulations for example, when the arguments have been checked elsewhere.

Details

Reference points are kept unchanged, other points are redistributed randomly across locations.

Value

A new weighted, marked, planar point pattern (an object of class wmppp, see wmppp.object).

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Marcon, E. and Puech, F. (2010). Measures of the Geographic Concentration of Industries: Improving Distance-Based Methods. *Journal of Economic Geography* 10(5): 745-762.

Marcon, E., F. Puech, et al. (2012). Characterizing the relative spatial structure of point patterns. *International Journal of Ecology* 2012(Article ID 619281): 11.

See Also

rPopulationIndependenceK, rRandomLabelingM

Examples

```
# Simulate a point pattern with five types
X <- rpoispp(50)
PointType   <- sample(c("A", "B", "C", "D", "E"), X$n, replace=TRUE)
PointWeight <- runif(X$n, min=1, max=10)
X$marks <- data.frame(PointType, PointWeight)
X <- as.wmppp(X)

par(mfrow=c(1,2))
plot(X, main="Original pattern, Point Type", which.marks=2)

# Randomize it
Y <- rPopulationIndependenceM(X, "A")
# Points of type "A" (circles) are unchanged,
# all other points have been redistributed randomly across locations
plot(Y, main="Randomized pattern, Point Type", which.marks=2)
```

---

rRandomLabeling — *Simulations of a point pattern according to the null hypothesis of random labeling*

Description

Simulates of a point pattern according to the null hypothesis of random labeling.

Usage

```
rRandomLabeling(X, CheckArguments = TRUE)
```

Arguments

X	A weighted, marked, planar point pattern (wmppp.object).
CheckArguments	Logical; if TRUE, the function arguments are verified. Should be set to FALSE to save time in simulations for example, when the arguments have been checked elsewhere.

Details

Marks are redistributed randomly across the original point pattern.

Value

A new weighted, marked, planar point pattern (an object of class wmppp, see wmppp.object).

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Goreaud, F. et Pelissier, R. (2003). Avoiding misinterpretation of biotic interactions with the intertype K12 fonction: population independence vs random labelling hypotheses. *Journal of Vegetation Science* 14(5): 681-692.

See Also

rRandomLabelingM, rPopulationIndependenceK

Examples

```
# Simulate a point pattern with five types
X <- rpoispp(50)
PointType   <- sample(c("A", "B", "C", "D", "E"), X$n, replace=TRUE)
PointWeight <- runif(X$n, min=1, max=10)
X$marks <- data.frame(PointType, PointWeight)
X <- as.wmppp(X)

par(mfrow=c(2,2))
plot(X, main="Original pattern, Point Type", which.marks=2)
plot(X, main="Original pattern, Point Weight", which.marks=1)

# Randomize it
Y <- rRandomLabeling(X)
Z <- Y
# Types have been redistributed randomly across locations
plot(Y, main="Randomized pattern, Point Type", which.marks=2)
```

```
# weights too
Y <- Z
plot(Y, main="Randomized pattern, Point Weight", which.marks=1)
```

`rRandomLabelingM` *Simulations of a point pattern according to the null hypothesis of random labelling defined for M*

Description

Simulates of a point pattern according to the null hypothesis of random labelling defined for *M*

Usage

```
rRandomLabelingM(X, CheckArguments = TRUE)
```

Arguments

`X`	A weighted, marked, planar point pattern (`wmppp.object`).
`CheckArguments`	Logical; if `TRUE`, the function arguments are verified. Should be set to `FALSE` to save time in simulations for example, when the arguments have been checked elsewhere.

Details

Point types are randomized. Locations and weights are kept unchanged. If both types and weights must be randomized together (Duranton and Overman, 2005; Marcon and Puech, 2010), use `rRandomLocation`.

Value

A new weighted, marked, planar point pattern (an object of class `wmppp`, see `wmppp.object`).

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106.

Marcon, E. and Puech, F. (2010). Measures of the Geographic Concentration of Industries: Improving Distance-Based Methods. *Journal of Economic Geography* 10(5): 745-762.

Marcon, E., F. Puech, et al. (2012). Characterizing the relative spatial structure of point patterns. *International Journal of Ecology* 2012(Article ID 619281): 11.

See Also

rRandomLabeling, rPopulationIndependenceM

Examples

```
# Simulate a point pattern with five types
X <- rpoispp(50)
PointType   <- sample(c("A", "B", "C", "D", "E"), X$n, replace=TRUE)
PointWeight <- runif(X$n, min=1, max=10)
X$marks <- data.frame(PointType, PointWeight)
X <- as.wmppp(X)

par(mfrow=c(2,2))
plot(X, main="Original pattern, Point Type", which.marks=2)
plot(X, main="Original pattern, Point Weight", which.marks=1)

# Randomize it
Y <- rRandomLabelingM(X)
Z <- Y
# Labels have been redistributed randomly across locations
plot(Y, main="Randomized pattern, Point Type", which.marks=2)
# But weights are unchanged
Y <- Z
plot(Y, main="Randomized pattern, Point Weight", which.marks=1)
```

---

rRandomLocation *Simulations of a point pattern according to the null hypothesis of random location*

Description

Simulates of a point pattern according to the null hypothesis of random location.

Usage

```
rRandomLocation(X, ReferenceType = "", CheckArguments = TRUE)
```

Arguments

X	A weighted, marked, planar point pattern (wmppp.object).
ReferenceType	One of the point types.
CheckArguments	Logical; if TRUE, the function arguments are verified. Should be set to FALSE to save time in simulations for example, when the arguments have been checked elsewhere.

Details

Points are redistributed randomly across the locations of the original point pattern. This randomization is equivalent to random labeling, considering the label is both point type and point weight.

Value

A new weighted, marked, planar point pattern (an object of class wmppp, see wmppp.object).

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106.

Marcon, E. and Puech, F. (2010). Measures of the Geographic Concentration of Industries: Improving Distance-Based Methods. *Journal of Economic Geography* 10(5): 745-762.

See Also

rRandomPositionK

Examples

```
# Simulate a point pattern with five types
X <- rpoispp(50)
PointType   <- sample(c("A", "B", "C", "D", "E"), X$n, replace=TRUE)
PointWeight <- runif(X$n, min=1, max=10)
X$marks <- data.frame(PointType, PointWeight)
X <- as.wmppp(X)

par(mfrow=c(2,2))
plot(X, main="Original pattern, Point Type", which.marks=2)
plot(X, main="Original pattern, Point Weight", which.marks=1)

# Randomize it
Y <- rRandomLabelingM(X)
Z <- Y
# Labels have been redistributed randomly across locations
plot(Y, main="Randomized pattern, Point Type", which.marks=2)
# But weights are unchanged
Y <- Z
plot(Y, main="Randomized pattern, Point Weight", which.marks=1)
```

`rRandomPositionK` *Simulations of a point pattern according to the null hypothesis of random position defined for K*

Description

Simulations of a point pattern according to the null hypothesis of random position defined for K.

Usage

```
rRandomPositionK(X, CheckArguments = TRUE)
```

Arguments

`X`	A weighted, marked, planar point pattern (`wmppp.object`).
`CheckArguments`	Logical; if `TRUE`, the function arguments are verified. Should be set to `FALSE` to save time in simulations for example, when the arguments have been checked elsewhere.

Details

Points marks are kept unchanged and their position is drawn in a binomial process by `runifpoint`.

Value

A new weighted, marked, planar point pattern (an object of class `wmppp`, see `wmppp.object`).

Note

Simulations in a binomial process keeps the same number of points, so that marks can be redistributed. If a real CSR simulation is needed and marks are useless, use `rpoispp`

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

See Also

`rRandomLocation`

Examples

```
# Simulate a point pattern with two types
X <- rpoispp(5)
PointType   <- sample(c("A", "B"), X$n, replace=TRUE)
PointWeight <- runif(X$n, min=1, max=10)
X$marks <- data.frame(PointType, PointWeight)
```

```
X <- as.wmppp(X)

par(mfrow=c(1,2))
plot(X, main="Original pattern, Point Type")

# Randomize it
Y <- rRandomPositionK(X)
# Invert the order of columns in mark to plot the point type, not the point weight
Y$marks <- data.frame(Y$marks$PointType, Y$marks$PointWeight)
# Points are randomly distributed
plot(Y, main="Randomized pattern, Point Type")
```

---

spatstat generic functions

Methods for weighted, marked planar point patterns (of class wmppp) from spatstat

---

Description

spatstat methods for a ppp.object applied to a wmppp.object.

Usage

```
## S3 method for class 'wmppp'
sharpen(...)
## S3 method for class 'wmppp'
split(...)
## S3 method for class 'wmppp'
superimpose(...)
## S3 method for class 'wmppp'
unique(...)
```

Arguments

...	Arguments passed to the ppp.object method.

Details

spatstat methods for ppp objects returning a ppp object can be applied to a wmppp and return a wpppp with these methods which just call the ppp.object method and change the class of the result for convenience.

Some spatstat functions such as rthin are not generic so they always return a ppp.object when applied to a wmppp.object. Their result may be converted by as.wmppp.

Value

An object of class "wmppp".

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

See Also

`sharpen.ppp`, `split.ppp`, `superimpose.ppp`, `unique.ppp`

---

summary.dbmssEnvelope *Summary of a confidence envelope*

Description

Prints a useful summary of a confidence envelope of class "dbmssEnvelope"

Usage

```
## S3 method for class 'dbmssEnvelope'
summary(object, ...)
```

Arguments

`object`	An object of class "dbmssEnvelope".
`...`	Ignored.

Details

"dbmssEnvelope" objects are similar to `envelope` objects. Their summary is different to take into account the possibility of building global envelope following Duranton and Overman (2005): the global envelope is calculated by iteration: the simulations reaching one of the upper or lower values at any distance are eliminated at each step. The process is repeated until *Alpha / Number of simulations* simulations are dropped. The remaining upper and lower bounds at all distances constitute the global envelope. Interpolation is used if the exact ratio cannot be reached.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

References

Duranton, G. and Overman, H. G. (2005). Testing for Localisation Using Micro-Geographic Data. *Review of Economic Studies* 72(4): 1077-1106

Examples

```
data(paracou16)
plot(paracou16)

# Calculate intertype K envelope
Envelope <- KEnvelope(paracou16, NumberOfSimulations = 20, Global = TRUE,
  ReferenceType = "V. Americana", NeighborType = "Q. Rosea")
plot(Envelope)
summary(Envelope)
```

---

wmppp *Create a Weighted, Marked, Planar Point Pattern*

Description

Creates an object of class "wmppp" represented a two-dimensional point pattern with weights and labels.

Usage

```
wmppp(df, window = NULL, unitname = NULL)
```

Arguments

df	A dataframe with at least two columns containing point coordinates.
window	An object of calls "owin" (owin.object).
unitname	Name of unit of length. Either a single character string, or a vector of two character strings giving the singular and plural forms, respectively. Ignored if window is not NULL.

Details

Columns named "X", "Y", "PointType", "PointWeight" (capitalization is ignored) are searched to build the "wmppp" object and set the point coordinates, type and weight. If they are not found, columns are used in this order. If columns are missing, PointType is set to "All" and PointWeight to 1. If the window is not specified, a rectangle containing all points is used, and unitname is used.

Value

An object of class "wmppp".

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

See Also

wmppp.object,

Examples

```
# Draw the coordinates of 10 points
X <- runif(10)
Y <- runif(10)
# Draw the point types.
PointType   <- sample(c("A", "B"), 10, replace=TRUE)
# Plot the point pattern. Weights are set to 1 ant the window is adjusted.
plot(wmppp(data.frame(X, Y, PointType)), , which.marks=2)
```

---

wmppp.object *Class of Weighted, Marked, Planar Point Patterns*

Description

A class "wmppp" to represent a two-dimensional point pattern of class ppp whose marks are a dataframe with two columns:

- PointType: labels, as factors
- PointWeight: weights.

Details

This class represents a two-dimensional point pattern dataset. wmppp objects are also of class ppp.

Objects of class wmppp may be created by the function wmppp and converted from other types of data by the function as.wmppp.

Author(s)

Eric Marcon <Eric.Marcon@ecofog.gf>

See Also

ppp.object, wmppp, as.wmppp

Examples

```
# Draw the coordinates of 10 points
X <- runif(10)
Y <- runif(10)
# Draw the point types and weights
PointType   <- sample(c("A", "B"), 10, replace=TRUE)
PointWeight <- runif(10)
# Build the point pattern
X <- wmppp(data.frame(X, Y, PointType, PointWeight), owin())
```

```
# Plot the point pattern. which.marks=1 for point weights, 2 for point types
par(mfrow=c(1,2))
plot(X, which.marks=1, main="Point weights")
plot(X, which.marks=2, main="Point types")
```

Index