

Package ‘markstat’

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Title Mark Correlation Functions for Spatial Point Patterns

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Imports spatstat.univar, spatstat.geom, spatstat.random,
spatstat.explore, spatstat.linnet, spatstat.utils, GET, stats,
dplyr, ggplot2, tidyr, patchwork

Description Provides a range of functions for computing both global and local mark correlation functions for spatial point patterns in either Euclidean spaces or on linear networks, with points carrying either real-valued or function-valued marks. For a review of mark correlation functions, see Eckardt and Moradi (2024) <doi:10.1007/s13253-024-00605-1>.

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Contents

markstat-package	2
as.data.frame.mc	2
fmcorr	3
fmcorrinhom	5
lfmcorr	7
lfmcorrinhom	8

lmcrr.lpp	10
lmcrr.ppp	12
lmcrrinhom.lpp	14
lmcrrinhom.ppp	15
mcorr.lpp	17
mcorr.ppp	20
mcorrinhom.lpp	22
mcorrinhom.ppp	24
Pfynwald	27
plot.mc	28
plot.testmc	31
print.mc	34
testmc	35

Index	41
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markstat-package	<i>The markstat Package.</i>
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Description

markstat: mark correlation functions for spatial point patterns

Details

The markstat package provides a range of functions for computing both global and local mark correlation functions for spatial point patterns in either Euclidean spaces or on linear networks, with points carrying either real-valued or function-valued marks.

Author(s)

Maintainer: Mehdi Moradi <m2.moradi@yahoo.com> ([ORCID](#))

Authors:

- Matthias Eckardt

as.data.frame.mc	<i>Methods for mc objects.</i>
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Description

Methods for mc objects.

Usage

```
## S3 method for class 'mc'
as.data.frame(x, ...)
```

Arguments

x An object of class mc.
 ... Arguments passed to `as.data.frame`.

Value

A data frame.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

fmcorr *Mark correlation functions for homogeneous point patterns with function-valued marks.*

Description

Mark correlation functions for homogeneous point patterns with function-valued marks.

Usage

```
fmcorr(X,
ftype = c("variogram", "stoyan", "rcorr", "shimatani", "beisbart",
"isham", "stoyancov", "schlather"),
r = NULL,
method = c("density", "loess"),
normalise = TRUE,
f = NULL,
tol = 0.01,
...)
```

Arguments

X An object of class ppp or lpp.
 ftype Type of the test function t_f . Currently any selection of "variogram", "stoyan", "rcorr", "shimatani", "beisbart", "isham", "stoyancov", "schlather".
 r Optional. The values of the argument r at which the mark correlation function should be evaluated.
 method Type of smoothing, either density or loess. See details.
 normalise If normalise=FALSE, only the numerator of the expression for the mark correlation function will be computed.
 f Optional. Test function t_f used in the definition of the mark correlation function. If ftype is given, t_f should be NULL.
 tol Tolerance used in the calculation of the conditional mean of the marks. This is used only if ftype is schlather.
 ... Arguments passed to `unnormdensity` or `loess`.

Details

The object X should be an object of class `ppp` or `lpp`, with a function-valued mark. The mark should be a `data.frame` whose columns give the mark values per time point in an increasing order. The marks per each time point should be numeric.

See detailed information in the help pages of the functions `mcorr.ppp` and `mcorr.lpp`. As here, X has a function-valued mark, depending on the class of X being `ppp` or `lpp`, the function `mcorr.ppp` or `mcorr.lpp` will be applied to each time point of the function-valued mark, and at the end an overall mark correlation function will be given. See details in Eckardt et. al (2024).

Value

a `data.frame` which gives the estimated mark correlation function and the distance vector r at which the mark correlation function is estimated. The outputs of the mark correlation functions for each time point are stored as an attribute, which can be extracted as `attr(, "ests")`.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com> and Matthias Eckardt

References

Eckardt, M., Mateu, J., & Moradi, M. (2024). Function-Valued Marked Spatial Point Processes on Linear Networks: Application to Urban Cycling Profiles. *Stat*, 13(4), e70013.

See Also

[mcorr.ppp](#), [mcorr.lpp](#), [fmcorrinhom](#).

Examples

```
library(spatstat.random)
library(spatstat.geom)
X <- rpoispp(100)
marks(X) <- data.frame(
  t1 = runif(npoints(X),1,10),
  t2 = runif(npoints(X),1,10),
  t3 = runif(npoints(X),1,10),
  t4 = runif(npoints(X),1,10),
  t5 = runif(npoints(X),1,10))
fmcorr(X, ftype = "stoyan", method = "density")
```

fmcrrinhom	<i>Mark correlation functions for inhomogeneous point patterns with function-valued marks.</i>
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Description

Mark correlation functions for inhomogeneous point patterns with function-valued marks.

Usage

```
fmcrrinhom(X,
ftype = c("variogram", "stoyan", "rcorr", "shimatani", "beisbart",
"isham", "stoyancov", "schlather"),
r = NULL,
lambda = NULL,
method_lambda = c("kernel", "Voronoi"),
bw = NULL,
f = NULL,
method = c("density", "loess"),
correction = c("Ripley", "translate", "none"),
normalise = TRUE,
tol = 0.01,
...)
```

Arguments

X	An object of class ppp or lpp.
ftype	Type of the test function t_f . Currently any selection of "variogram", "stoyan", "rcorr", "shimatani", "beisbart", "isham", "stoyancov", "schlather".
r	Optional. The values of the argument r at which the mark correlation function should be evaluated.
lambda	Estimated intensity at data points. If not given, it will be estimated internally. See details.
method_lambda	The method to be used for estimating intensity at data points, if lambda = NULL.
bw	Bandwidth method to be used for estimating intensity at data points if lambda = NULL and method_lambda = "kernel".
f	Optional. Test function t_f used in the definition of the mark correlation function. If ftype is given, t_f should be NULL.
method	Type of smoothing, either density or loess.
correction	Type of edge correction to be applied, either of "Ripley", "translate", "none". This is used only if X is of class ppp.
normalise	If normalise=FALSE, only the numerator of the expression for the mark correlation function will be computed.
tol	Tolerance used in the calculation of the conditional mean of marks. This is used only if ftype is schlather.
...	Arguments passed to unnormdensity or loess .

Details

The object X should be an object of class `ppp` or `lpp`, with a function-valued mark. The mark should be a `data.frame` whose columns give the mark values per time point in an increasing order. The marks per each time point should be numeric.

See detailed information in the help pages of the functions `mcorrhom.ppp` and `mcorrhom.lpp`. As here, X has a function-valued mark, depending on the class of X being `ppp` or `lpp`, the function `mcorrhom.ppp` or `mcorrhom.lpp` will be applied to each time point of the function-valued mark, and at the end an overall mark correlation function will be given. See details in Eckardt et. al (2024).

Value

a `data.frame` which gives the estimated mark correlation function and the distance vector r at which the mark correlation function is estimated. The outputs of the mark correlation functions for each time point are stored as an attribute, which can be extracted as `attr(, "ests")`.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com> and Matthias Eckardt

References

Moradi, M., & Eckardt, M. (2025). Inhomogeneous mark correlation functions for general marked point processes. arXiv e-prints, arXiv-2505.

Eckardt, M., Mateu, J., & Moradi, M. (2024). Function-Valued Marked Spatial Point Processes on Linear Networks: Application to Urban Cycling Profiles. *Stat*, 13(4), e70013.

See Also

`fmcorr`, `mcorrhom.ppp`, `mcorrhom.lpp`.

Examples

```
library(spatstat.random)
library(spatstat.geom)
library(spatstat.explore)
X <- rpoispp(100)
marks(X) <- data.frame(
  t1 = runif(npoints(X),1,10),
  t2 = runif(npoints(X),1,10),
  t3 = runif(npoints(X),1,10),
  t4 = runif(npoints(X),1,10),
  t5 = runif(npoints(X),1,10))
fmcorrhom(X, ftype = "stoyan", method = "density", method_lambda = "kernel", bw = bw.scott)
```

lfmcorr	<i>Local mark correlation functions for homogeneous point patterns with function-valued marks.</i>
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Description

Local mark correlation functions for homogeneous point patterns with function-valued marks.

Usage

```
lfmcorr(X,
ftype = c("variogram", "stoyan", "rcorr", "shimatani", "beisbart",
"isham", "stoyancov", "schlather"),
r = NULL,
method = c("density", "loess"),
normalise = TRUE,
f = NULL,
tol = 0.01,
...)
```

Arguments

<code>X</code>	An object of class <code>ppp</code> or <code>lpp</code> .
<code>ftype</code>	Type of the test function t_f . Currently any selection of "variogram", "stoyan", "rcorr", "shimatani", "beisbart", "isham", "stoyancov", "schlather".
<code>r</code>	Optional. The values of the argument r at which the mark correlation function should be evaluated.
<code>method</code>	Type of smoothing, either density or loess. See details.
<code>normalise</code>	If <code>normalise=FALSE</code> , only the numerator of the expression for the mark correlation function will be computed.
<code>f</code>	Optional. Test function t_f used in the definition of the mark correlation function. If <code>ftype</code> is given, t_f should be <code>NULL</code> .
<code>tol</code>	Tolerance used in the calculation of the conditional mean of the marks. This is used only if <code>ftype</code> is <code>schlather</code> .
<code>...</code>	Arguments passed to <code>unnormdensity</code> or <code>loess</code> .

Details

This function computes local mark correlation functions for a homogeneous point pattern with a function-valued mark. See the details of test functions used in [fmcrr](#). Technical details are given in Eckardt and Moradi (2025).

Value

a data.frame which gives the estimated overall local mark correlation function and the distance vector r at which the local mark correlation function is estimated. The outputs of the local mark correlation functions for each time point are stored as an attribute, which can be extracted as `attr(, "ests.time")`. The outputs of the local mark correlation functions for each data point are stored as an attribute, which can be extracted as `attr(, "ests.points")`.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com> and Matthias Eckardt

References

Eckardt, M., Mateu, J., & Moradi, M. (2024). Function-Valued Marked Spatial Point Processes on Linear Networks: Application to Urban Cycling Profiles. *Stat*, 13(4), e70013.

Eckardt, M., & Moradi, M. (2025). Local indicators of mark association for marked spatial point processes.

See Also

[mcorr.ppp](#), [mcorr.lpp](#), [fmcrr](#).

Examples

```
library(spatstat.random)
library(spatstat.geom)
X <- rpoispp(100)
marks(X) <- data.frame(
  t1 = runif(npoints(X),1,10),
  t2 = runif(npoints(X),1,10),
  t3 = runif(npoints(X),1,10),
  t4 = runif(npoints(X),1,10),
  t5 = runif(npoints(X),1,10))
lfmcorr(X, ftype = "stoyan", method = "density")
```

lfmcorrinhom

Local mark correlation functions for inhomogeneous point patterns with function-valued marks.

Description

Local mark correlation functions for inhomogeneous point patterns with function-valued marks.

Usage

```
lfmcorrinhom(X,
  ftype = c("variogram", "stoyan", "rcorr", "shimatani", "beisbart",
    "isham", "stoyancov", "schlather"),
  r = NULL,
  lambda = NULL,
  method_lambda = c("kernel", "Voronoi"),
  bw = NULL,
  f = NULL,
  method = c("density", "loess"),
  correction = c("Ripley", "translate", "none"),
  normalise = TRUE,
  tol = 0.01,
  ...)
```

Arguments

X	An object of class <code>ppp</code> or <code>lpp</code> .
ftype	Type of the test function t_f . Currently any selection of "variogram", "stoyan", "rcorr", "shimatani", "beisbart", "isham", "stoyancov", "schlather".
r	Optional. The values of the argument <code>r</code> at which the mark correlation function should be evaluated.
lambda	Estimated intensity at data points. If not given, it will be estimated internally. See details.
method_lambda	The method to be used for estimating intensity at data points, if <code>lambda = NULL</code> .
bw	Bandwidth method to be used for estimating intensity at data points if <code>lambda = NULL</code> and <code>method_lambda = "kernel"</code> .
f	Optional. Test function t_f used in the definition of the mark correlation function. If <code>ftype</code> is given, t_f should be <code>NULL</code> .
method	Type of smoothing, either <code>density</code> or <code>loess</code> .
correction	Type of edge correction to be applied, either of "Ripley", "translate", "none". This is used only if <code>X</code> is of class <code>ppp</code> .
normalise	If <code>normalise=FALSE</code> , only the numerator of the expression for the mark correlation function will be computed.
tol	Tolerance used in the calculation of the conditional mean of marks. This is used only if <code>ftype</code> is <code>schlather</code> .
...	Arguments passed to <code>unnormdensity</code> or <code>loess</code> .

Details

This function computes local mark correlation functions for an inhomogeneous point pattern with a function-valued mark. See the details of test functions used in `fcorrinhom`. Technical details are given in Eckardt and Moradi (2025).

Value

a data.frame which gives the estimated overall local mark correlation function and the distance vector r at which the local mark correlation function is estimated. The outputs of the local mark correlation functions for each time point are stored as an attribute, which can be extracted as `attr(. , "ests.time")`. The outputs of the local mark correlation functions for each data point are stored as an attribute, which can be extracted as `attr(. , "ests.points")`.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com> and Matthias Eckardt

References

Eckardt, M., Mateu, J., & Moradi, M. (2024). Function-Valued Marked Spatial Point Processes on Linear Networks: Application to Urban Cycling Profiles. *Stat*, 13(4), e70013.

Eckardt, M., & Moradi, M. (2025). Local indicators of mark association for marked spatial point processes.

Moradi, M., & Eckardt, M. (2025). Inhomogeneous mark correlation functions for general marked point processes. arXiv e-prints, arXiv-2505.

See Also

[fmcrr](#), [mccrrinhom.ppp](#), [mccrrinhom.lpp](#).

Examples

```
library(spatstat.random)
library(spatstat.geom)
library(spatstat.explore)
X <- rpoispp(100)
marks(X) <- data.frame(
  t1 = runif(npoints(X),1,10),
  t2 = runif(npoints(X),1,10),
  t3 = runif(npoints(X),1,10),
  t4 = runif(npoints(X),1,10),
  t5 = runif(npoints(X),1,10))
lfmccrrinhom(X, ftype = "stoyan", method = "density", method_lambda = "kernel", bw = bw.scott)
```

lmcrr.lpp

Local mark correlation functions for homogeneous point patterns on linear networks.

Description

Local mark correlation functions for homogeneous point patterns on linear networks.

Usage

```
## S3 method for class 'lpp'
lmcrr(X,
      ftype = c("variogram", "stoyan", "rcorr", "shimatani", "beisbart",
                "isham", "stoyancov", "schlather"),
      r = NULL,
      method = c("density", "loess"),
      normalise = TRUE,
      f = NULL,
      tol = 0.01,
      ...)
```

Arguments

<code>X</code>	An object of class <code>lpp</code> .
<code>ftype</code>	Type of the test function t_f . Currently any selection of "variogram", "stoyan", "rcorr", "shimatani", "beisbart", "isham", "stoyancov", "schlather".
<code>r</code>	Optional. The values of the argument r at which the mark correlation function should be evaluated.
<code>method</code>	Type of smoothing, either density or loess. See details.
<code>normalise</code>	If <code>normalise=FALSE</code> , only the numerator of the expression for the mark correlation function will be computed.
<code>f</code>	Optional. Test function t_f used in the definition of the mark correlation function. If <code>ftype</code> is given, t_f should be <code>NULL</code> .
<code>tol</code>	Tolerance used in the calculation of the conditional mean of the marks. This is used only if <code>ftype</code> is <code>schlather</code> .
<code>...</code>	Arguments passed to unnormdensity or loess .

Details

This function computes local mark correlation functions for a homogeneous point pattern on a linear network. See the details of test functions used in [mcorr.lpp](#). Technical details are given in Eckardt and Moradi (2025).

Value

A `data.frame` where the first column contains the values of the argument r at which the mark correlation function is evaluated, and the remaining columns contain the estimated values of the mark correlation function for each data point; column names correspond to the IDs of the data points. If there are multiple numeric marks, the result will instead be a list, with each element corresponding to one of the marks.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com> and Matthias Eckardt

References

Eckardt, M., & Moradi, M. (2025). Local indicators of mark association for marked spatial point processes.

See Also

[mcorr.lpp](#).

Examples

```
library(spatstat.geom)
library(spatstat.linnet)
X <- rpoislpp(10, simplenet)
marks(X) <- runif(npoints(X), 1, 10)
lmcrr.lpp(X, ftype = "stoyan", method = "density")
```

lmcrr.ppp

Local mark correlation functions for homogeneous point patterns on Euclidean spaces.

Description

Local mark correlation functions for homogeneous point patterns on Euclidean spaces.

Usage

```
## S3 method for class 'ppp'
lmcrr(X,
  ftype = c("variogram", "stoyan", "rcorr", "shimatani", "beisbart",
    "isham", "stoyancov", "schlather"),
  r = NULL,
  method = c("density", "loess"),
  normalise = TRUE,
  f = NULL,
  tol = 0.01,
  ...)
```

Arguments

X	An object of class ppp.
ftype	Type of the test function t_f . Currently any selection of "variogram", "stoyan", "rcorr", "shimatani", "beisbart", "isham", "stoyancov", "schlather".
r	Optional. The values of the argument r at which the mark correlation function should be evaluated.
method	Type of smoothing, either density or loess. See details.

normalise	If normalise=FALSE, only the numerator of the expression for the mark correlation function will be computed.
f	Optional. Test function t_f used in the definition of the mark correlation function. If ftype is given, t_f should be NULL.
tol	Tolerance used in the calculation of the conditional mean of the marks. This is used only if ftype is schlather.
...	Arguments passed to unnormdensity or loess .

Details

This function computes local mark correlation functions for a stationary point pattern in \mathbb{R}^2 . See the details of test functions used in [mcorr.ppp](#). Technical details are given in Eckardt and Moradi (2025).

Value

A data.frame where the first column contains the values of the argument r at which the mark correlation function is evaluated, and the remaining columns contain the estimated values of the mark correlation function for each data point; column names correspond to the IDs of the data points. If there are multiple numeric marks, the result will instead be a list, with each element corresponding to one of the marks.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com> and Matthias Eckardt

References

Eckardt, M., & Moradi, M. (2025). Local indicators of mark association for marked spatial point processes.

See Also

[mcorr.ppp](#).

Examples

```
library(spatstat.geom)
library(spatstat.random)
X <- rpoispp(100)
marks(X) <- runif(npoints(X),10,11)
lmcrr.ppp(X, ftype = "stoyan", method = "density")
```

lmcrrinhom.lpp	<i>Local mark correlation functions for inhomogeneous point patterns on linear networks.</i>
----------------	--

Description

Local mark correlation functions for inhomogeneous point patterns on linear networks.

Usage

```
## S3 method for class 'lpp'
lmcrrinhom(X,
  ftype = c("variogram", "stoyan", "rcorr", "shimatani",
    "beisbart", "isham", "stoyancov", "schlather"),
  r = NULL,
  lambda = NULL,
  method_lambda = c("kernel", "Voronoi"),
  bw = bw.scott.iso,
  f = NULL,
  method = c("density", "loess"),
  normalise = TRUE,
  tol = 0.01,
  ...)
```

Arguments

X	An object of class lpp.
ftype	Type of the test function t_f . Currently any selection of "variogram", "stoyan", "rcorr", "shimatani", "beisbart", "isham", "stoyancov", "schlather".
r	Optional. The values of the argument r at which the mark correlation function should be evaluated.
lambda	Estimated intensity at data points. If not given, it will be estimated internally. See details.
method_lambda	The method to be used for estimating intensity at data points, if lambda = NULL.
bw	Bandwidth method to be used for estimating intensity at data points if lambda = NULL and method_lambda = "kernel".
f	Optional. Test function t_f used in the definition of the mark correlation function. If ftype is given, t_f should be NULL.
method	Type of smoothing, either density or loess.
normalise	If normalise=FALSE, only the numerator of the expression for the mark correlation function will be computed.
tol	Tolerance used in the calculation of the conditional mean of marks. This is used only if ftype is schlather.
...	Arguments passed to unnormdensity or loess .

Details

This function computes local mark correlation functions for an inhomogeneous point pattern on a linear network. See the details of test functions used in [mcorrinhom.lpp](#). Technical details are given in Eckardt and Moradi (2025) and Moradi and Eckardt (2025).

Value

A data.frame where the first column contains the values of the argument r at which the mark correlation function is evaluated, and the remaining columns contain the estimated values of the mark correlation function for each data point; column names correspond to the IDs of the data points. If there are multiple numeric marks, the result will instead be a list, with each element corresponding to one of the marks.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com> and Matthias Eckardt

References

Moradi, M., & Eckardt, M. (2025). Inhomogeneous mark correlation functions for general marked point processes. arXiv e-prints, arXiv-2505.

Eckardt, M., & Moradi, M. (2025). Local indicators of mark association for marked spatial point processes.

See Also

[mcorrinhom.lpp](#).

Examples

```
library(spatstat.linnet)
library(spatstat.geom)
library(spatstat.explore)
X <- rpoislpp(10, simplenet)
marks(X) <- runif(npoints(X), 1, 10)
lmcrrinhom.lpp(X, ftype = "stoyan", method = "density",
               method_lambda = "kernel", bw = bw.scott.iso)
```

lmcrrinhom.ppp

Local mark correlation functions for inhomogeneous point patterns on Euclidean spaces.

Description

Local mark correlation functions for inhomogeneous point patterns on Euclidean spaces.

Usage

```
## S3 method for class 'ppp'
Imcorrinhom(X,
  ftype = c("variogram", "stoyan", "rcorr", "shimatani",
    "beisbart", "isham", "stoyancov", "schlather"),
  r = NULL,
  lambda = NULL,
  method_lambda = c("kernel", "Voronoi"),
  bw = bw.scott,
  f = NULL,
  method = c("density", "loess"),
  correction = c("Ripley", "translate", "none"),
  normalise = TRUE,
  tol = 0.01,
  ...)
```

Arguments

<code>X</code>	An object of class <code>ppp</code> .
<code>ftype</code>	Type of the test function t_f . Currently any selection of "variogram", "stoyan", "rcorr", "shimatani", "beisbart", "isham", "stoyancov", "schlather".
<code>r</code>	Optional. The values of the argument <code>r</code> at which the mark correlation function should be evaluated.
<code>lambda</code>	Estimated intensity at data points. If not given, it will be estimated internally. See details.
<code>method_lambda</code>	The method to be used for estimating intensity at data points, if <code>lambda = NULL</code> .
<code>bw</code>	Bandwidth method to be used for estimating intensity at data points if <code>lambda = NULL</code> and <code>method_lambda = "kernel"</code> .
<code>f</code>	Optional. Test function t_f used in the definition of the mark correlation function. If <code>ftype</code> is given, t_f should be <code>NULL</code> .
<code>method</code>	Type of smoothing, either <code>density</code> or <code>loess</code> .
<code>correction</code>	Type of edge correction to be applied, either of "Ripley", "translate", "none".
<code>normalise</code>	If <code>normalise=FALSE</code> , only the numerator of the expression for the mark correlation function will be computed.
<code>tol</code>	Tolerance used in the calculation of the conditional mean of marks. This is used only if <code>ftype</code> is <code>schlather</code> .
<code>...</code>	Arguments passed to unnormdensity or loess .

Details

This function computes local mark correlation functions for an inhomogeneous point pattern in \mathbb{R}^2 . See the details of test functions used in [mcorrinhom.ppp](#). Technical details are given in Eckardt and Moradi (2025) and Moradi and Eckardt (2025).

Value

A data.frame where the first column contains the values of the argument r at which the mark correlation function is evaluated, and the remaining columns contain the estimated values of the mark correlation function for each data point; column names correspond to the IDs of the data points. If there are multiple numeric marks, the result will instead be a list, with each element corresponding to one of the marks.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com> and Matthias Eckardt

References

Moradi, M., & Eckardt, M. (2025). Inhomogeneous mark correlation functions for general marked point processes. arXiv e-prints, arXiv-2505.

Eckardt, M., & Moradi, M. (2025). Local indicators of mark association for marked spatial point processes.

See Also

[mcorrinhom.ppp](#).

Examples

```
library(spatstat.geom)
library(spatstat.random)
library(spatstat.explore)
X <- rpoispp(function(x,y) {100 * exp(-3*x)}, 100)
marks(X) <- runif(npoints(X), 1, 10)
mcorrinhom.ppp(X, ftype = "stoyan",
               method = "density", correction = "translate",
               method_lambda = "kernel", bw = bw.scott)
```

mcorr.lpp

Mark correlation functions for homogeneous point patterns on linear networks.

Description

Mark correlation functions for homogeneous point patterns on linear networks.

Usage

```
## S3 method for class 'lpp'
mcorr(X,
      ftype = c("variogram", "stoyan", "rcorr", "shimatani", "beisbart",
               "isham", "stoyancov", "schlather"),
      r = NULL,
```

```

method = c("density","loess"),
normalise = TRUE,
f = NULL,
tol = 0.01,
...)
```

Arguments

X	An object of class lpp.
f type	Type of the test function t_f . Currently any selection of "variogram", "stoyan", "rcorr", "shimatani", "beisbart", "isham", "stoyancov", "schlather".
r	Optional. The values of the argument r at which the mark correlation function should be evaluated.
method	Type of smoothing, either density or loess. See details.
normalise	If normalise=FALSE, only the numerator of the expression for the mark correlation function will be computed.
f	Optional. Test function t_f used in the definition of the mark correlation function. If f type is given, t_f should be NULL.
tol	Tolerance used in the calculation of the conditional mean of the marks. This is used only if f type is schlather.
...	Arguments passed to unnormdensity or loess .

Details

For a homogeneous point process X on a linear network, the t_f -correlation function $\kappa_{t_f}(r)$ is given as

$$\kappa_{t_f}(r) = \frac{\mathbb{E}[t_f(m_x, m_y) \mid x, y \in X]}{c_{t_f}}, \quad d(x, y) = r,$$

where m_x, m_y are the marks of $x, y \in X$, c_{t_f} is a normalizing factor, and $d(x, y) = r$ is the shortest-path distance. Therefore, each mark correlation function is defined by a specific test function $t_f(m_x, m_y)$ and its associated normalising factor c_{t_f} . Let μ_m and σ_m^2 be the mean and variance of marks, then, the list below gives different test functions t_f and their normalised factors c_{t_f} , following distinct available ftype.

variogram: $t_f(m_x, m_y) = \frac{1}{2}(m_x - m_y)^2$, $c_{t_f} = \sigma_m^2$.

stoyan: $t_f(m_x, m_y) = m_x m_y$, $c_{t_f} = \mu_m^2$.

rcorr: $t_f(m_x, m_y) = m_x$, $c_{t_f} = \mu_m$.

shimatani: $t_f(m_x, m_y) = (m_x - \mu_m)(m_y - \mu_m)$, $c_{t_f} = \sigma_m^2$.

beisbart: $t_f(m_x, m_y) = m_x + m_y$, $c_{t_f} = 2\mu_m$.

isham: $t_f(m_x, m_y) = m_x m_y - \mu_m^2$, $c_{t_f} = \sigma_m^2$.

stoyancov: $t_f(m_x, m_y) = m_x m_y - \mu_m^2$, $c_{t_f} = 1$.

schlather: $t_f(m_x, m_y) = (m_x - \mu_m(r))(m_y - \mu_m(r))$, $c_{t_f} = \sigma_m^2$.

For `f` type="schlather", $\mu_m(r)$ denotes the mean of the marks of all pairs of points whose pairwise distance lies within a tolerance `tol` of r . We refer to Eckardt and Moradi (2024) for details of these mark correlation functions.

Regarding the smoothing functions, if `method="density"`, the functions `unnormdensity` will be called, and if `method="loess"`, the function `loess` will be called.

If your `f` type is not one of the defaults, then you need to give your test function $t_f(m_1, m_2)$ using the argument `f`. In this case, `normalise` should be set as `FALSE`, as only the unnormalised version will be calculated. Depending on the form of the test function $t_f(m_1, m_2)$, one can manually compute the normalisation factor.

If the point pattern X has multiple real-valued marks, the function estimates the mark correlation function for each mark individually. In such case, marks are given as a `data.frame` whose columns represents different marks. The functions checks which columns are numeric, and for those the mark correlation function will be computed.

Value

a `data.frame` which gives the estimated mark correlation function and the distance vector r at which the mark correlation function is estimated. If the point pattern X has multiple real-valued marks, the estimated mark correlation function will be given for each mark. Name of columns will be the name of marks.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com> and Matthias Eckardt

References

Eckardt, M., & Moradi, M. (2024). Marked spatial point processes: current state and extensions to point processes on linear networks. *Journal of Agricultural, Biological and Environmental Statistics*, 29(2), 346-378.

See Also

[mcorr.ppp](#).

Examples

```
library(spatstat.linnet)
library(spatstat.geom)
X <- rpoislpp(10, simplenet)
marks(X) <- runif(npoints(X), 1, 10)
mcorr.lpp(X, ftype = "stoyan", method = "density")
```

mcorr.ppp

Mark correlation functions for homogeneous point patterns on Euclidean spaces.

Description

Mark correlation functions for homogeneous point patterns on Euclidean spaces.

Usage

```
## S3 method for class 'ppp'
mcorr(X,
      ftype = c("variogram", "stoyan", "rcorr", "shimatani", "beisbart",
               "isham", "stoyancov", "schlather"),
      r = NULL,
      method = c("density", "loess"),
      normalise = TRUE,
      f = NULL,
      tol = 0.01,
      ...)
```

Arguments

X	An object of class ppp.
ftype	Type of the test function t_f . Currently any selection of "variogram", "stoyan", "rcorr", "shimatani", "beisbart", "isham", "stoyancov", "schlather".
r	Optional. The values of the argument r at which the mark correlation function should be evaluated.
method	Type of smoothing, either density or loess. See details.
normalise	If normalise=FALSE, only the numerator of the expression for the mark correlation function will be computed.
f	Optional. Test function t_f used in the definition of the mark correlation function. If ftype is given, t_f should be NULL.
tol	Tolerance used in the calculation of the conditional mean of the marks. This is used only if ftype is schlather.
...	Arguments passed to unnormdensity or loess .

Details

For a homogeneous point process X in R^2 , the t_f -correlation function $\kappa_{t_f}(r)$ is given as

$$\kappa_{t_f}(r) = \frac{\mathbb{E}[t_f(m_x, m_y) \mid x, y \in X]}{c_{t_f}}, \quad d(x, y) = r,$$

where m_x, m_y are the marks of $x, y \in X$, c_{t_f} is a normalizing factor, and $d(x, y) = r$ is the Euclidean distance. Therefore, each mark correlation function is defined by a specific test function

$t_f(m_x, m_y)$ and its associated normalising factor c_{t_f} . Let μ_m and σ_m^2 be the mean and variance of marks, then, the list below gives different test functions t_f and their normalised factors c_{t_f} , following distinct available ftype.

variogram: $t_f(m_x, m_y) = \frac{1}{2}(m_x - m_y)^2$, $c_{t_f} = \sigma_m^2$.

stoyan: $t_f(m_x, m_y) = m_x m_y$, $c_{t_f} = \mu_m^2$.

rcorr: $t_f(m_x, m_y) = m_x$, $c_{t_f} = \mu_m$.

shimatani: $t_f(m_x, m_y) = (m_x - \mu_m)(m_y - \mu_m)$, $c_{t_f} = \sigma_m^2$.

beisbart: $t_f(m_x, m_y) = m_x + m_y$, $c_{t_f} = 2\mu_m$.

isham: $t_f(m_x, m_y) = m_x m_y - \mu_m^2$, $c_{t_f} = \sigma_m^2$.

stoyancov: $t_f(m_x, m_y) = m_x m_y - \mu_m^2$, $c_{t_f} = 1$.

schlather: $t_f(m_x, m_y) = (m_x - \mu_m(r))(m_y - \mu_m(r))$, $c_{t_f} = \sigma_m^2$.

For ftype="schlather", $\mu_m(r)$ denotes the mean of the marks of all pairs of points whose pairwise distance lies within a tolerance tol of r . We refer to Eckardt and Moradi (2024) for details of these mark correlation functions.

Regarding the smoothing functions, if method="density", the functions `unnormdensity` will be called, and if method="loess", the function `loess` will be called.

If your ftype is not one of the defaults, then you need to give your test function $t_f(m_1, m_2)$ using the argument `f`. In this case, `normalise` should be set as FALSE, as only the unnormalised version will be calculated. Depending on the form of the test function $t_f(m_1, m_2)$, one can manually compute the normalisation factor.

If the point patten X has multiple real-valued marks, the function estimates the mark correlation function for each mark individually. In such case, marks are given as a `data.frame` whose columns represents different marks. The functions checks which columns are numeric, and for those the mark correlation function will be computed.

Value

a `data.frame` which gives the estimated mark correlation function and the distance vector r at which the mark correlation function is estimated. If the point patten X has multiple real-valued marks, the estimated mark correlation function will be given for each mark. Name of columns will be the name of marks.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com> and Matthias Eckardt

References

Eckardt, M., & Moradi, M. (2024). Marked spatial point processes: current state and extensions to point processes on linear networks. *Journal of Agricultural, Biological and Environmental Statistics*, 29(2), 346-378.

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

See Also

[markcorr](#), [mcorr.lpp](#).

Examples

```
library(spatstat.geom)
library(spatstat.random)
X <- rpoispp(100)
marks(X) <- runif(npoints(X),1,10)
mcorr.ppp(X, ftype = "stoyan", method = "density")
```

mcorrinhom.lpp

Mark correlation functions for inhomogeneous point patterns on linear networks.

Description

Mark correlation functions for inhomogeneous point patterns on linear networks.

Usage

```
## S3 method for class 'lpp'
mcorrinhom(X,
  ftype = c("variogram", "stoyan", "rcorr", "shimatani",
    "beisbart", "isham", "stoyancov", "schlather"),
  r = NULL,
  lambda = NULL,
  method_lambda = c("kernel", "Voronoi"),
  bw = bw.scott.iso,
  f = NULL,
  method = c("density", "loess"),
  normalise = TRUE,
  tol = 0.01,
  ...)
```

Arguments

X	An object of class lpp.
ftype	Type of the test function t_f . Currently any selection of "variogram", "stoyan", "rcorr", "shimatani", "beisbart", "isham", "stoyancov", "schlather".
r	Optional. The values of the argument r at which the mark correlation function should be evaluated.
lambda	Estimated intensity at data points. If not given, it will be estimated internally. See details.
method_lambda	The method to be used for estimating intensity at data points, if lambda = NULL.

bw	Bandwidth method to be used for estimating intensity at data points if lambda = NULL and method_lambda = "kernel".
f	Optional. Test function t_f used in the definition of the mark correlation function. If ftype is given, t_f should be NULL.
method	Type of smoothing, either density or loess.
normalise	If normalise=FALSE, only the numerator of the expression for the mark correlation function will be computed.
tol	Tolerance used in the calculation of the conditional mean of marks. This is used only if ftype is schlather.
...	Arguments passed to unnormdensity or loess .

Details

Most of the details are given in [mcorrinhom.ppp](#). However, here distances are measured via the shortest-path distances, and intensities are estimated differently. If method_lambda = "kernel", then the function calls [densityQuick.lpp](#) in combination with the bandwidth chosen via [bw.scott.iso](#). If method_lambda = "Voronoi", the functions calls [densityVoronoi.lpp](#) with arguments $f=0.2$, $nrep = 400$ which are recommended by Moradi et al. (2019).

In the case of point processes on linear networks, adding correction will slow down the calculations. Given that, it is argued that the type of correction does not have significant effect on the final output, we have here ignored correction terms. We refer to Eckardt and Moradi (2024) and Moradi and Eckardt (2025) for further details.

If the point patten X has multiple real-valued marks, the function estimates the mark correlation function for each mark individually. In such case, marks are given as a `data.frame` whose columns represents different marks. The functions checks which columns are numeric, and for those the mark correlation function will be computed.

Value

a `data.frame` which gives the estimated mark correlation function and the distance vector r at which the mark correlation function is estimated. If the point patten X has multiple real-valued marks, the estimated mark correlation function will be given for each mark. Name of columns will be the name of marks.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com> and Matthias Eckardt

References

- Moradi, M., Cronie, O., Rubak, E., Lachieze-Rey, R., Mateu, J., & Baddeley, A. (2019). Resample-smoothing of Voronoi intensity estimators. *Statistics and computing*, 29(5), 995-1010.
- Moradi, M., & Eckardt, M. (2025). Inhomogeneous mark correlation functions for general marked point processes. *arXiv e-prints*, arXiv-2505.

See Also

[mcorr.lpp](#), [mcorrinhom.ppp](#).

Examples

```

library(spatstat.linnet)
library(spatstat.geom)
library(spatstat.explore)
X <- rpoislpp(10, simplenet)
marks(X) <- runif(npoints(X), 1, 10)
mcorrinhom.lpp(X, ftype = "stoyan", method = "density",
               method_lambda = "kernel", bw = bw.scott.iso)

```

mcorrinhom.ppp	<i>Mark correlation functions for inhomogeneous point patterns on Euclidean spaces.</i>
----------------	---

Description

Mark correlation functions for inhomogeneous point patterns on Euclidean spaces.

Usage

```

## S3 method for class 'ppp'
mcorrinhom(X,
  ftype = c("variogram", "stoyan", "rcorr", "shimatani",
            "beisbart", "isham", "stoyancov", "schlather"),
  r = NULL,
  lambda = NULL,
  method_lambda = c("kernel", "Voronoi"),
  bw = bw.scott,
  f = NULL,
  method = c("density", "loess"),
  correction = c("Ripley", "translate", "none"),
  normalise = TRUE,
  tol = 0.01,
  ...)

```

Arguments

X	An object of class ppp.
ftype	Type of the test function t_f . Currently any selection of "variogram", "stoyan", "rcorr", "shimatani", "beisbart", "isham", "stoyancov", "schlather".
r	Optional. The values of the argument r at which the mark correlation function should be evaluated.
lambda	Estimated intensity at data points. If not given, it will be estimated internally. See details.
method_lambda	The method to be used for estimating intensity at data points, if lambda = NULL.
bw	Bandwidth method to be used for estimating intensity at data points if lambda = NULL and method_lambda = "kernel".

f	Optional. Test function t_f used in the definition of the mark correlation function. If ftype is given, t_f should be NULL.
method	Type of smoothing, either density or loess.
correction	Type of edge correction to be applied, either of "Ripley", "translate", "none".
normalise	If normalise=FALSE, only the numerator of the expression for the mark correlation function will be computed.
tol	Tolerance used in the calculation of the conditional mean of marks. This is used only if ftype is schlather.
...	Arguments passed to unnormdensity or loess .

Details

For an inhomogeneous point process X in R^2 , the t_f -correlation function $\kappa_{t_f}^{inhom}(r)$ is given as

$$\kappa_{t_f}^{inhom}(r) = \frac{\mathbb{E}_w [t_f(m_x, m_y) \mid x, y \in X]}{c_{t_f}}, \quad d(x, y) = r,$$

where m_x, m_y are the marks of $x, y \in X$, \mathbb{E}_w is a conditional expectation with respect to a weighted Palm distribution, c_{t_f} is a normalising factor, and $d(x, y) = r$ is the Euclidean distance. Therefore, each mark correlation function is defined by a specific test function $t_f(m_x, m_y)$ and its associated normalising factor c_{t_f} . Let μ_m and σ_m^2 be the mean and variance of marks, then, the list below gives different test functions t_f and their normalised factors c_{t_f} , following distinct available ftype.

variogram: $t_f(m_x, m_y) = \frac{1}{2}(m_x - m_y)^2$, $c_{t_f} = \sigma_m^2$.

stoyan: $t_f(m_x, m_y) = m_x m_y$, $c_{t_f} = \mu_m^2$.

rcorr: $t_f(m_x, m_y) = m_x$, $c_{t_f} = \mu_m$.

shimatani: $t_f(m_x, m_y) = (m_x - \mu_m)(m_y - \mu_m)$, $c_{t_f} = \sigma_m^2$.

beisbart: $t_f(m_x, m_y) = m_x + m_y$, $c_{t_f} = 2\mu_m$.

isham: $t_f(m_x, m_y) = m_x m_y - \mu_m^2$, $c_{t_f} = \sigma_m^2$.

stoyancov: $t_f(m_x, m_y) = m_x m_y - \mu_m^2$, $c_{t_f} = 1$.

schlather: $t_f(m_x, m_y) = (m_x - \mu_m(r))(m_y - \mu_m(r))$, $c_{t_f} = \sigma_m^2$.

For ftype="schlather", $\mu_m(r)$ denotes the mean of the marks of all pairs of points whose pairwise distance lies within a tolerance tol of r . We refer to Eckardt and Moradi (2024) for details of these mark correlation functions.

Regarding the smoothing functions, if method="density", the functions [unnormdensity](#) will be called, and if method="loess", the function [loess](#) will be called.

If your ftype is not one of the defaults, then you need to give your test function $t_f(m_1, m_2)$ using the argument f. In this case, normalise should be set as FALSE, as only the unnormalised version will be calculated. Depending on the form of the test function $t_f(m_1, m_2)$, one can manually compute the normalisation factor.

If lambda = NULL, the function internally estimates the intensity function using the given method via method_lambda. If method_lambda = "kernel", the function calls [density.ppp](#), with the bandwidth chosen by the given method bw, and argument diggle=TRUE. If method_lambda = "Voronoi",

then the functions calls `densityVoronoi.ppp` with arguments $f=0.2$, $nrep = 400$ which are recommended by Moradi et al. (2019).

Regarding the smoothing functions, if `method="density"`, the functions `unnormdensity` will be called, and if `method="loess"`, the function `loess` will be called.

Type of edge correction is chosen among "Ripley", "translate", "none". See details in `edge.Trans` and `edge.Ripley`.

If the point patten X has multiple real-valued marks, the function estimates the mark correlation function for each mark individually. In such case, marks are given as a `data.frame` whose columns represents different marks. The functions checks which columns are numeric, and for those the mark correlation function will be computed.

Value

a `data.frame` which gives the estimated mark correlation function and the distance vector r at which the mark correlation function is estimated. If the point patten X has multiple real-valued marks, the estimated mark correlation function will be given for each mark. Name of columns will be the name of marks.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com> and Matthias Eckardt

References

Moradi, M., Cronie, O., Rubak, E., Lachieze-Rey, R., Mateu, J., & Baddeley, A. (2019). Resample-smoothing of Voronoi intensity estimators. *Statistics and computing*, 29(5), 995-1010.

Moradi, M., & Eckardt, M. (2025). Inhomogeneous mark correlation functions for general marked point processes. *arXiv e-prints*, arXiv-2505.

See Also

`mcorr.ppp`, `mcorrinhom.lpp`.

Examples

```
library(spatstat.geom)
library(spatstat.random)
library(spatstat.explore)
X <- rpoispp(function(x,y) {100 * exp(-3*x)}, 100)
marks(X) <- runif(npoints(X), 1, 10)
mcorrinhom.ppp(X, ftype = "stoyan",
               method = "density", correction = "translate",
               method_lambda = "kernel", bw = bw.scott)
```

Pfywald

Scots pine trees in Pfywald, Switzerland.

Description

Location and height of trees from the Pfywald project, available via an Open Database License (<https://opendata.swiss>), which originates from a long-term irrigation experiment begun in 2003 within Switzerland's Pfy-Finges national park.

Usage

```
data(Pfywald)
```

Format

An object of class `ppp`, giving Cartesian `xy`-coordinate of trees in meters, and their height as mark.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com> and Matthias Eckardt

Source

<https://envidat.ch/#/metadata/pfywald>

References

Schaub, M., Haeni, M., Hug, C., Gessler, A., Rigling, A. (2016). Tree measurements 2002-2016 from the long-term irrigation experiment Pfywald, Switzerland. *EnviDat*. <https://www.doi.org/10.16904/11>.

Moradi, M., & Eckardt, M. (2025). Inhomogeneous mark correlation functions for general marked point processes. *arXiv e-prints*, arXiv-2505.

Examples

```
library(spatstat.geom)
data(Pfywald)
plot(Pfywald)
```

Description

Plots objects of class 'mc' (mark correlation functions). Supports global and local types, multiple marks, and fully customizable appearance via 'layers' or '...'.

Usage

```
## S3 method for class 'mc'
plot(
  x,
  which_marks = NULL,
  which_points = NULL,
  layers = list(),
  xlab = "Distance r",
  ylab = "Mark correlation",
  ...
)
```

Arguments

x	An object of class 'mc'.
which_marks	For global or local multi-mark objects: character or numeric vector specifying which marks to plot. Default 'NULL' (all marks).
which_points	For local MC objects: numeric or character vector specifying which points to overlay. Default 'NULL' (all points).
layers	A list of additional ggplot2 layers (themes, labs, scales, etc.) to add to the plot.
xlab	Label for x-axis (default "Distance r").
ylab	Label for y-axis (default "Mark correlation").
...	Additional arguments passed to 'geom_line()'.

Value

Invisibly returns the ggplot object.

Additional graphical customization

The object returned by `plot.testmc()` is a ggplot object. This means that all standard graphical components from the **ggplot2** package (such as layers, scales, and themes) can be added to the plot using the `+` operator. This allows users to further customize labels, colors, axes, and the overall appearance of the plot.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

Examples

```
library(spatstat.geom)
library(spatstat.random)
library(spatstat.explore)
library(spatstat.linnet)
library(ggplot2)

# --- Example 1: Single mark -----

X1 <- rpoispp(100)
marks(X1) <- cbind(m1 = runif(npoints(X1), 1, 10))

mc1 <- mcorr.ppp(X1, ftype = "stoyan", method = "density")

plot(mc1) +
  labs(
    title = "Mark correlation for a single mark",
    x = expression(r),
    y = "Correlation"
  ) +
  theme_minimal() +
  theme(
    plot.title = element_text(size = 14, face = "bold"),
    axis.title = element_text(size = 12),
    axis.text = element_text(size = 10),
    legend.title = element_text(size = 11),
    legend.text = element_text(size = 10)
  )

# --- Example 2: Two marks -----

X2 <- rpoispp(100)
marks(X2) <- cbind(
  m1 = runif(npoints(X2), 1, 10),
  m2 = runif(npoints(X2), 1, 10)
)

mc2 <- mcorr.ppp(X2, ftype = "stoyan", method = "density")

# Plot both marks
plot(mc2) +
  labs(
    title = "Mark correlation for two marks",
    x = expression(r),
    y = "Correlation"
  ) +
```

```

theme_bw() +
theme(
  plot.title = element_text(size = 14, face = "bold"),
  axis.title = element_text(size = 12),
  axis.text = element_text(size = 10),
  legend.title = element_text(size = 11),
  legend.text = element_text(size = 10),
  legend.position = "top"
)

# Plot only mark m1
plot(mc2, which_marks = "m1") +
  labs(
    title = "Mark correlation for mark m1 only",
    x = expression(r),
    y = "Correlation"
  ) +
  theme_minimal() +
  theme(
    plot.title = element_text(size = 14, face = "bold"),
    axis.title = element_text(size = 12),
    axis.text = element_text(size = 10),
    legend.position = "none"
  )

# --- Example 3: Local mark correlation -----

lc1 <- lmcrr.ppp(X2, ftype = "stoyan", method = "density")

# Two selected points, mark m1
plot(lc1, which_points = 1:2, which_marks = "m1") +
  labs(
    title = "Local mark correlation (points 1-2, mark m1)",
    x = expression(r),
    y = "Local correlation"
  ) +
  theme_classic() +
  theme(
    plot.title = element_text(size = 13, face = "bold"),
    axis.title = element_text(size = 12),
    axis.text = element_text(size = 10),
    legend.title = element_text(size = 11),
    legend.text = element_text(size = 10),
    legend.position = "right"
  )

# Single selected point
plot(lc1, which_points = 1) +
  labs(
    title = "Local mark correlation (single selected point)",
    x = expression(r),
    y = "Local correlation"
  )

```

```
) +  
theme_light() +  
theme(  
  plot.title = element_text(size = 13, face = "bold"),  
  axis.title = element_text(size = 12),  
  axis.text = element_text(size = 10),  
  legend.position = "bottom"  
)
```

plot.testmc

Plot function.

Description

Plots objects of class 'testmc'. Supports global and local types, multiple marks, and fully customizable appearance via 'layers' or '...'.

Usage

```
## S3 method for class 'testmc'  
plot(x, ...)
```

Arguments

x An object of class 'testmc' or 'global_envelope'.
... Ignored.

Value

Invisibly returns the ggplot object.

Additional graphical customization

The object returned by `plot.testmc()` is a ggplot object. This means that all standard graphical components from the **ggplot2** package (such as layers, scales, and themes) can be added to the plot using the `+` operator. This allows users to further customize labels, colors, axes, and the overall appearance of the plot.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

Examples

```

library(spatstat.geom)
library(spatstat.random)
library(spatstat.explore)
library(spatstat.linnet)
library(ggplot2)

#####
## 1. Planar point patterns (ppp)
#####

# Global mark correlation (real-valued marks)
X_ppp <- rpoispp(200)
marks(X_ppp) <- data.frame(m1 = runif(npoints(X_ppp), 1, 10))

tc_ppp1 <- testmc(X_ppp,
                  fun = mcorr.ppp,
                  fun_args = list(ftype = "stoyan", method = "density"))

plot(tc_ppp1) +
  labs(
    title = "Global mark correlation (ppp)",
    x = expression(r),
    y = "Observed / Envelope"
  ) +
  theme_minimal() +
  theme(
    plot.title = element_text(size = 14, face = "bold"),
    axis.title = element_text(size = 12),
    axis.text = element_text(size = 10),
    legend.title = element_text(size = 11),
    legend.text = element_text(size = 10)
  )

# Local mark correlation (real-valued marks)
X_ppp2 <- rpoispp(200)
marks(X_ppp2) <- data.frame(m1 = runif(npoints(X_ppp2), 1, 10))

tc_ppp2 <- testmc(X_ppp2,
                  fun = lmcorr.ppp,
                  fun_args = list(ftype = "stoyan", method = "density"))

plot(tc_ppp2[[1]]) +
  labs(
    title = "Local mark correlation (ppp)",
    x = expression(r),
    y = "Local correlation"
  ) +
  theme_classic() +
  theme(
    plot.title = element_text(size = 13, face = "bold"),
    axis.title = element_text(size = 12),

```



```

    axis.text = element_text(size = 10),
    legend.title = element_text(size = 11),
    legend.text = element_text(size = 10),
    legend.position = "right"
  )

plot(tc_ppp2) +
  labs(
    title = "Effective range",
    x = expression(r),
    y = "Id of significant points"
  ) +
  theme_classic() +
  theme(
    plot.title = element_text(size = 23, face = "bold"),
    axis.title = element_text(size = 12),
    axis.text = element_text(size = 20),
    legend.title = element_text(size = 21),
    legend.text = element_text(size = 30),
    legend.position = "right"
  )

#####
## 2. Linear network point patterns (lpp)
#####

X_lpp <- rpoislpp(40, simplenet)
marks(X_lpp) <- data.frame(m1 = runif(npoints(X_lpp), 1, 10))

tc_lpp1 <- testmc(X_lpp,
  fun = mcorr.lpp,
  fun_args = list(ftype = "stoyan", method = "density"))

plot(tc_lpp1) +
  labs(
    title = "Global mark correlation (lpp)",
    x = expression(r),
    y = "Observed / Envelope"
  ) +
  theme_bw() +
  theme(
    plot.title = element_text(size = 14, face = "bold"),
    axis.title = element_text(size = 12),
    axis.text = element_text(size = 10),
    legend.title = element_text(size = 11),
    legend.text = element_text(size = 10),
    legend.position = "top"
  )

# Local functional mark correlation (function-valued marks)
marks(X_lpp) <- data.frame(
  t1 = runif(npoints(X_lpp), 1, 10),
  t2 = runif(npoints(X_lpp), 1, 10)
)

```

```
)  
  
tc_lpp2 <- testmc(X_lpp,  
                 fun = lfmcorr,  
                 fun_args = list(ftype = "stoyan", method = "density"))  
  
plot(tc_lpp2[[1]]) +  
  labs(  
    title = "Local functional mark correlation (lpp)",  
    x = expression(r),  
    y = "Local correlation"  
  ) +  
  theme_light() +  
  theme(  
    plot.title = element_text(size = 13, face = "bold"),  
    axis.title = element_text(size = 12),  
    axis.text = element_text(size = 10),  
    legend.title = element_text(size = 11),  
    legend.text = element_text(size = 10),  
    legend.position = "bottom"  
  )  
)
```

print.mc

Print function.

Description

Print function.

Usage

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

Arguments

x	An object of class mc.
...	Ignored.

Value

No return value. Used for printing.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

`testmc`*Global envelope tests for random labelling.*

Description

Generic function to perform global envelope test for random labelling using mark correlation functions.

Usage

```
testmc(X,  
  fun,  
  nsim = 100,  
  fun_args = list(),  
  get_args = list(),  
  rlabel_args = list()  
)
```

Arguments

<code>X</code>	An object of class <code>ppp</code> or <code>lpp</code> .
<code>fun</code>	Function that computes the desired mark correlation function.
<code>nsim</code>	Number of permutations.
<code>fun_args</code>	Arguments passed to the chosen mark correlation function.
<code>get_args</code>	Arguments passed to the global_envelope_test .
<code>rlabel_args</code>	Arguments passed to the rlabel .

Details

Generic function to perform global envelope test for random labelling using mark correlation functions.

If the point pattern has several real-valued marks, then the random labelling test will be performed for each mark individually, and the output will be a list of global envelop tests one per each mark.

If the mark correlation function is any of the LIMA family, a random labelling test will be performed for each individual point.

Value

Either an object of class `global_envelope` or a list of such objects if the point pattern has multiple marks or the employed mark correlation function is of type LIMA.

Author(s)

Mehdi Moradi <m2.moradi@yahoo.com>

References

Eckardt, M., & Moradi, M. (2024). Marked spatial point processes: current state and extensions to point processes on linear networks. *Journal of Agricultural, Biological and Environmental Statistics*, 29(2), 346-378.

Moradi, M., & Eckardt, M. (2025). Inhomogeneous mark correlation functions for general marked point processes.

Eckardt, M., & Moradi, M. (2025). Local indicators of mark association for marked spatial point processes.

See Also

[global_envelope_test](#), [mcorr.ppp](#), [mcorr.lpp](#), [mcorrinhom.ppp](#), [mcorrinhom.lpp](#), [fmcorr](#), [lmcorr.ppp](#), [lmcorr.lpp](#).

Examples

```
library(spatstat.geom)
library(spatstat.random)
library(spatstat.explore)
library(spatstat.linnet)

#####
## 1. Planar point patterns (ppp)
#####

# -----
# GLOBAL MARK CORRELATION (real-valued marks)
# -----
X <- rpoispp(200)
marks(X) <- data.frame(m1 = runif(npoints(X), 1, 10))

ts1 <- testmc(X,
              fun = mcorr.ppp,
              fun_args = list(ftype = "stoyan", method = "density"))
plot(ts1)
# Global mark correlation (real-valued marks)

ts2 <- testmc(X,
              fun = mcorrinhom.ppp,
              fun_args = list(ftype = "stoyan",
                              method = "density",
                              method_lambda = "kernel"))
plot(ts2)
# Inhomogeneous global mark correlation (real-valued marks)

# -----
# GLOBAL FUNCTIONAL MARK CORRELATION (function-valued marks)
# -----
marks(X) <- data.frame(
  t1 = runif(npoints(X), 1, 10),
```

```

    t2 = runif(npoints(X), 1, 10),
    t3 = runif(npoints(X), 1, 10),
    t4 = runif(npoints(X), 1, 10),
    t5 = runif(npoints(X), 1, 10)
  )

ts3 <- testmc(X,
              fun = fmcorr,
              fun_args = list(ftype = "stoyan", method = "density"))
plot(ts3)
# Global functional mark correlation (function-valued marks)

ts4 <- testmc(X,
              fun = fmcorrinhom,
              fun_args = list(ftype = "stoyan",
                              method = "density",
                              method_lambda = "kernel",
                              bw = bw.scott))

plot(ts4)
# Inhomogeneous functional mark correlation (function-valued marks)

# -----
# LOCAL MARK CORRELATION (real-valued marks)
# -----
X <- rpoispp(200)
marks(X) <- data.frame(m1 = runif(npoints(X), 1, 10))

ts5 <- testmc(X,
              fun = lmcrr.ppp,
              fun_args = list(ftype = "stoyan", method = "density"))
plot(ts5[[1]])
# Local mark correlation (real-valued marks)

ts6 <- testmc(X,
              fun = lmcrrinhom.ppp,
              fun_args = list(ftype = "stoyan",
                              method = "density",
                              method_lambda = "kernel"))

plot(ts6[[1]])
# Inhomogeneous local mark correlation (real-valued marks)

# -----
# LOCAL FUNCTIONAL MARK CORRELATION (function-valued marks)
# -----
marks(X) <- data.frame(
  t1 = runif(npoints(X), 1, 10),
  t2 = runif(npoints(X), 1, 10),
  t3 = runif(npoints(X), 1, 10),
  t4 = runif(npoints(X), 1, 10),
  t5 = runif(npoints(X), 1, 10)
)

```

```

ts7 <- testmc(X,
              fun = lfmcorr,
              fun_args = list(ftype = "stoyan", method = "density"))
plot(ts7[[1]])
# Local functional mark correlation (function-valued marks)

ts8 <- testmc(X,
              fun = lfmcorrinhom,
              fun_args = list(ftype = "stoyan",
                              method = "density",
                              method_lambda = "kernel",
                              bw = bw.scott))
plot(ts8[[1]])
# Inhomogeneous local functional mark correlation (function-valued marks)

#####
## 2. Linear network point patterns (lpp)
#####

X1 <- rpoislpp(40, simplenet)

# -----
# GLOBAL MARK CORRELATION (real-valued marks)
# -----
marks(X1) <- data.frame(m1 = runif(npoints(X1), 1, 10))

ts9 <- testmc(X1,
              fun = mcorr.lpp,
              fun_args = list(ftype = "stoyan", method = "density"))
plot(ts9)
# Global mark correlation on linear networks (real-valued marks)

ts10 <- testmc(X1,
              fun = mcorrinhom.lpp,
              fun_args = list(ftype = "stoyan",
                              method = "density",
                              method_lambda = "kernel"))
plot(ts10)
# Inhomogeneous global mark correlation on linear networks (real-valued marks)

# -----
# GLOBAL FUNCTIONAL MARK CORRELATION (function-valued marks)
# -----
marks(X1) <- data.frame(
  t1 = runif(npoints(X1), 1, 10),
  t2 = runif(npoints(X1), 1, 10),
  t3 = runif(npoints(X1), 1, 10),
  t4 = runif(npoints(X1), 1, 10),
  t5 = runif(npoints(X1), 1, 10)
)

```

```

ts11 <- testmc(X1,
              fun = fmcorr,
              fun_args = list(ftype = "stoyan", method = "density"))
plot(ts11)
# Global functional mark correlation on linear networks (function-valued marks)

ts12 <- testmc(X1,
              fun = fmcorrinhom,
              fun_args = list(ftype = "stoyan",
                              method = "density",
                              method_lambda = "kernel",
                              bw = bw.scott.iso))

plot(ts12)
# Inhomogeneous global functional mark correlation on linear networks
# (function-valued marks)

# -----
# LOCAL MARK CORRELATION (real-valued marks)
# -----
marks(X1) <- data.frame(m1 = runif(npoints(X1), 1, 10))

ts13 <- testmc(X1,
              fun = lmcorr.lpp,
              fun_args = list(ftype = "stoyan", method = "density"))
plot(ts13[[1]])
# Local mark correlation on linear networks (real-valued marks)

ts14 <- testmc(X1,
              fun = lmcorrinhom.lpp,
              fun_args = list(ftype = "stoyan",
                              method = "density",
                              method_lambda = "kernel"))
plot(ts14[[1]])
# Inhomogeneous local mark correlation on linear networks (real-valued marks)

# -----
# LOCAL FUNCTIONAL MARK CORRELATION (function-valued marks)
# -----
marks(X1) <- data.frame(
  t1 = runif(npoints(X1), 1, 10),
  t2 = runif(npoints(X1), 1, 10),
  t3 = runif(npoints(X1), 1, 10),
  t4 = runif(npoints(X1), 1, 10),
  t5 = runif(npoints(X1), 1, 10)
)

ts15 <- testmc(X1,
              fun = lfmcorr,
              fun_args = list(ftype = "stoyan", method = "density"))
plot(ts15[[1]])

```

```
# Local functional mark correlation on linear networks (function-valued marks)

ts16 <- testmc(X1,
              fun = lfmcorrinhom,
              fun_args = list(ftype = "stoyan",
                             method = "density",
                             method_lambda = "kernel",
                             bw = bw.scott.iso))

plot(ts16[[1]])
# Inhomogeneous local functional mark correlation on linear networks
# (function-valued marks)
```


Index

* datasets

- Pfynwald, 27
- as.data.frame, 3
- as.data.frame.mc, 2
- bw.scott.iso, 23
- density.ppp, 25
- densityQuick.lpp, 23
- densityVoronoi.lpp, 23
- densityVoronoi.ppp, 26
- edge.Ripley, 26
- edge.Trans, 26
- fmcorr, 3, 6–8, 10, 36
- fmcorrinhom, 4, 5, 9
- global_envelope_test, 35, 36
- lfmcorr, 7
- lfmcorrinhom, 8
- lmcorr.lpp, 10, 36
- lmcorr.ppp, 12, 36
- lmcorrinhom.lpp, 14
- lmcorrinhom.ppp, 15
- loess, 3, 5, 7, 9, 11, 13, 14, 16, 18–21, 23, 25, 26
- lpp, 4, 6
- markcorr, 22
- markstat (markstat-package), 2
- markstat-package, 2
- mcorr.lpp, 4, 8, 11, 12, 17, 22, 23, 36
- mcorr.ppp, 4, 8, 13, 19, 20, 26, 36
- mcorrinhom.lpp, 6, 10, 15, 22, 26, 36
- mcorrinhom.ppp, 6, 10, 16, 17, 23, 24, 36
- Pfynwald, 27
- plot.mc, 28
- plot.testmc, 31
- ppp, 4, 6
- print.mc, 34
- rlabel, 35
- testmc, 35
- unnormdensity, 3, 5, 7, 9, 11, 13, 14, 16, 18–21, 23, 25, 26