

# spatstat Quick Reference 1.6-7

Type `demo(spatstat)` for an overall demonstration.

## Creation, manipulation and plotting of point patterns

An object of class "ppp" describes a point pattern. If the points have marks, these are included as a component vector `marks`.

### To create a point pattern:

<code>ppp</code>	create a point pattern from $(x, y)$ and window information
<code>ppp(x, y, xlim, ylim)</code>	for rectangular window
<code>ppp(x, y, poly)</code>	for polygonal window
<code>ppp(x, y, mask)</code>	for binary image window
<code>as.ppp</code>	convert other types of data to a ppp object
<code>setmarks</code>	
<code>%mark%</code>	attach/reassign marks to a point pattern

### To simulate a random point pattern:

<code>runifpoint</code>	generate $n$ independent uniform random points
<code>rpoint</code>	generate $n$ independent random points
<code>rmpoint</code>	generate $n$ independent multitype random points
<code>rpoispp</code>	simulate the (in)homogeneous Poisson point process
<code>rmppoispp</code>	simulate the (in)homogeneous multitype Poisson point process
<code>rMaternI</code>	simulate the Matérn Model I inhibition process
<code>rMaternII</code>	simulate the Matérn Model II inhibition process
<code>rSSI</code>	simulate Simple Sequential Inhibition process
<code>rNeymanScott</code>	simulate a general Neyman-Scott process
<code>rMatClust</code>	simulate the Matérn Cluster process
<code>rThomas</code>	simulate the Thomas process
<code>rmh</code>	simulate Gibbs point process using Metropolis-Hastings

To randomly change an existing point pattern:

<code>rlabel</code>	random (re)labelling
<code>rtoro</code>	random toroidal shift

### Standard point pattern datasets:

Remember to say `data(bramblecanes)` etc.

amacrine	Austin Hughes' rabbit amacrine cells
ants	Harkness-Isham ant nests data
betacells	Wässle et al. cat retinal ganglia data
bramblecanes	Bramble Canes data
cells	Crick-Ripley biological cells data
copper	Berman-Huntington copper deposits data
demopat	Synthetic point pattern
finpines	Finnish Pines data
hamster	Aherne's hamster tumour data
humberside	North Humberside childhood leukaemia data
japanesepines	Japanese Pines data
lansing	Lansing Woods data
longleaf	Longleaf Pines data
nztrees	Mark-Esler-Ripley trees data
redwood	Strauss-Ripley redwood saplings data
redwoodfull	Strauss redwood saplings data (full set)
simdat	Simulated point pattern (inhomogeneous, with interaction)
spruces	Spruce trees in Saxonia
swedishpines	Strand-Ripley swedish pines data

### To manipulate a point pattern:

plot.ppp	plot a point pattern plot(X)
"[.ppp"	extract or replace a subset of a point pattern pp[subset] pp[, subwindow]
superimpose	superimpose any number of point patterns
cut.ppp	discretise the marks in a point pattern
unmark	remove marks
setmarks	attach marks or reset marks
split.ppp	divide pattern into sub-patterns
rotate	rotate pattern
shift	translate pattern
affine	apply affine transformation
ksmooth.ppp	kernel smoothing
identify.ppp	interactively identify points
See spatstat.options to control plotting behaviour.	

### To create a window:

An object of class "owin" describes a spatial region (a window of observation).

<code>owin</code>	Create a window object <code>owin(xlim, ylim)</code> for rectangular window <code>owin(poly)</code> for polygonal window <code>owin(mask)</code> for binary image window
<code>as.owin</code>	Convert other data to a window object
<code>ripras</code>	Ripley-Rasson estimator of window, given only the points
<code>letterR</code>	polygonal window in the shape of the R logo

### To manipulate a window:

<code>plot.owin</code>	plot a window. <code>plot(W)</code>
<code>bounding.box</code>	Find a tight bounding box for the window
<code>erode.owin</code>	erode window by a distance <code>r</code>
<code>complement.owin</code>	invert (inside $\leftrightarrow$ outside)
<code>rotate</code>	rotate window
<code>shift</code>	translate window
<code>affine</code>	apply affine transformation

### Digital approximations:

<code>as.mask</code>	Make a discrete pixel approximation of a given window
<code>nearest.raster.point</code>	map continuous coordinates to raster locations
<code>raster.x</code>	raster x coordinates
<code>raster.y</code>	raster y coordinates
See <code>spatstat.options</code> to control the approximation	

### Geometrical computations with windows:

<code>intersect.owin</code>	intersection of two windows
<code>union.owin</code>	union of two windows
<code>inside.owin</code>	determine whether a point is inside a window
<code>area.owin</code>	compute window's area
<code>diameter</code>	compute window frame's diameter
<code>eroded.areas</code>	compute areas of eroded windows
<code>bdist.points</code>	compute distances from data points to window boundary
<code>bdist.pixels</code>	compute distances from all pixels to window boundary
<code>distmap.owin</code>	distance transform image
<code>centroid.owin</code>	compute centroid (centre of mass) of window
<code>is.subset.owin</code>	determine whether one window contains another
<code>trim.owin</code>	intersect a window with a rectangle

### Pixel images

An object of class "im" represents a pixel image. Such objects are returned by some of the functions in `spatstat` including `Kmeasure`, `setcov` and `ksmooth.ppp`.

<code>im</code>	create a pixel image
<code>as.im</code>	convert other data to a pixel image
<code>plot.im</code>	plot a pixel image on screen as a digital image
<code>contour.im</code>	draw contours of a pixel image
<code>persp.im</code>	draw perspective plot of a pixel image
<code>[.im</code>	extract subset of pixel image
<code>shift.im</code>	apply vector shift to pixel image
<code>X</code>	print very basic information about image <code>X</code>
<code>summary(X)</code>	summary of image <code>X</code>
<code>is.im</code>	test whether an object is a pixel image

# Exploratory Data Analysis

## Inspection of data

`summary(X)`    print useful summary of point pattern `X`  
`X`                print basic description of point pattern `X`

## Quadrat methods

`quadratcount`    Quadrat counts

## Summary statistics for a point pattern:

`Fest`            empty space function  $F$   
`Gest`            nearest neighbour distribution function  $G$   
`Kest`            Ripley's  $K$ -function  
`Jest`             $J$ -function  $J = (1 - G)/(1 - F)$   
`allstats`        all four functions  $F, G, J, K$   
`pcf`            pair correlation function  
`envelope`        simulation envelopes for  $K, G$  etc  
`Kinhom`          $K$  for inhomogeneous point patterns  
`Kest.fft`        fast  $K$ -function using FFT for large datasets  
`Kmeasure`        reduced second moment measure  
`ndist`           nearest neighbour distances  
`pairstat`        distances between all pairs of points  
`crossdist`       distances between points in two patterns  
`exactdt`        distance from any location to nearest data point  
`distmap`        distance map image

## Summary statistics for a multitype point pattern:

A multitype point pattern is represented by an object `X` of class "ppp" with a component `X$marks` which is a factor.

`Gcross, Gdot, Gmulti`    multitype nearest neighbour distributions  $G_{ij}, G_{i\bullet}$   
`Kcross, Kdot, Kmulti`    multitype  $K$ -functions  $K_{ij}, K_{i\bullet}$   
`Jcross, Jdot, Jmulti`    multitype  $J$ -functions  $J_{ij}, J_{i\bullet}$   
`alltypes`                estimates of the above for all  $i, j$  pairs  
`Iest`                    multitype  $I$ -function

## Summary statistics for a marked point pattern:

A marked point pattern is represented by an object `X` of class "ppp" with a component `X$marks`.

`markcorr`    mark correlation function  
`Gmulti`       multitype nearest neighbour distribution  
`Kmulti`       multitype  $K$ -function  
`Jmulti`       multitype  $J$ -function

Alternatively use `cut.ppp` to convert a marked point pattern to a multitype point pattern.

## Programming tools

`applynbd`    apply function to every neighbourhood  
              in a point pattern

## Model Fitting

### To fit a point process model:

Model fitting in **spatstat** version 1.6 is performed by the function **ppm**. Its result is an object of class **ppm**.

**ppm** Fit a point process model  
to a two-dimensional point pattern

### Manipulating the fitted model:

**plot.ppm** Plot the fitted model  
**predict.ppm** Compute the spatial trend  
and conditional intensity  
of the fitted point process model  
**coef.ppm** Extract the fitted model coefficients  
**fitted.ppm** Compute fitted conditional intensity at quadrature points  
**update.ppm** Update the fit  
**rmh.ppm** Simulate from fitted model  
**print.ppm** Print basic information about a fitted model  
**summary.ppm** Summarise a fitted model  
**anova.ppm** Analysis of deviance  
See **spatstat.options** to control plotting of fitted model.

### To specify a point process model:

The first order “trend” of the model is written as an **S** language formula.

**~1** No trend (stationary)  
**~x** First order term  $\lambda(x, y) = \exp(\alpha + \beta x)$   
where  $x, y$  are Cartesian coordinates  
**~polynom(x,y,3)** Log-cubic polynomial trend  
**~harmonic(x,y,2)** Log-harmonic polynomial trend

The higher order (“interaction”) components are described by an object of class **interact**.

Such objects are created by:

**Poisson()** the Poisson point process  
**Strauss()** the Strauss process  
**StraussHard()** the Strauss/hard core point process  
**Softcore()** pairwise interaction, soft core potential  
**PairPiece()** pairwise interaction, piecewise constant  
**DiggleGratton()** Diggle-Gratton potential  
**LennardJones()** Lennard-Jones potential  
**Pairwise()** pairwise interaction, user-supplied potential  
**Geyer()** Geyer’s saturation process  
**Saturated()** Saturated pair model, user-supplied potential  
**OrdThresh()** Ord process, threshold potential  
**Ord()** Ord model, user-supplied potential  
**MultiStrauss()** multitype Strauss process  
**MultiStraussHard()** multitype Strauss/hard core process

## Finer control over model fitting:

A quadrature scheme is represented by an object of class "quad".

<code>quadscheme</code>	generate a Berman-Turner quadrature scheme for use by <code>ppm</code>
<code>default.dummy</code>	default pattern of dummy points
<code>gridcentres</code>	dummy points in a rectangular grid
<code>stratrand</code>	stratified random dummy pattern
<code>spokes</code>	radial pattern of dummy points
<code>corners</code>	dummy points at corners of the window
<code>gridweights</code>	quadrature weights by the grid-counting rule
<code>dirichlet.weights</code>	quadrature weights are Dirichlet tile areas
<code>print(Q)</code>	print basic information about quadrature scheme Q
<code>summary(Q)</code>	summary of quadrature scheme Q

## Simulation and goodness-of-fit

<code>rmh.ppm</code>	simulate realisations of a fitted model
<code>envelope</code>	compute simulation envelopes for a fitted model

## Diagnostic plots

<code>diagnose.ppm</code>	diagnostic plots for spatial trend
<code>qqplot.ppm</code>	diagnostic plot for interpoint interaction