

# spatstat Quick Reference 1.3-3

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 <code>ppp</code> 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>rpoispp</code>	simulate the (in)homogeneous 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
<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

### Standard point pattern datasets:

Remember to say `data( Bramblecanes )` etc.

<code>amacrine</code>	Austin Hughes' rabbit amacrine cells
<code>bramblecanes</code>	Bramble Canes data
<code>cells</code>	Crick-Ripley biological cells data
<code>ganglia</code>	Wässle et al. cat retinal ganglia data
<code>hamster</code>	Aherne's hamster tumour data
<code>lansing</code>	Lansing Woods data
<code>longleaf</code>	Longleaf Pines data
<code>nztrees</code>	Mark-Esler-Ripley trees data
<code>redwood</code>	Strauss-Ripley redwood saplings data
<code>redwoodfull</code>	Strauss redwood saplings data (full set)
<code>swedishpines</code>	Strand-Ripley swedish pines data

### To manipulate a point pattern:

<code>plot.ppp</code>	plot a point pattern <code>plot(X)</code>
<code>"[.ppp"</code>	extract a subset of a point.pattern <code>pp[subset]</code> <code>pp[, subwindow]</code>
<code>superimpose</code>	superimpose any number of point patterns
<code>cut.ppp</code>	discretise the marks in a point pattern
<code>unmark</code>	remove marks
<code>setmarks</code>	attach marks or reset marks
<code>rotate</code>	rotate pattern
<code>shift</code>	translate pattern
<code>affine</code>	apply affine transformation
<code>ksmooth.ppp</code>	kernel smoothing
<code>identify.ppp</code>	interactively identify points
	See <code>spatstat.options</code> 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 r
<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>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>centroid.owin</code>	compute centroid (centre of mass) of window

### 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>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

## Exploratory Data Analysis

### Inspection of data

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

### 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  
`Kinhom`         $K$  for inhomogeneous point patterns  
`Kest.fft`       fast  $K$ -function using FFT for large datasets  
`Kmeasure`      reduced second moment measure

### 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

### 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 1.3 is performed by the function `mpl`. Its result is an object of class `ppm`.

```
mpl  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 data points
rmh.ppm        Simulate from fitted model
               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
```

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>mpl</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