

# Datasets provided in `spatstat`

Adrian Baddeley, Rolf Turner and Ege Rubak

For `spatstat` version 1.48-0

This document is an overview of the spatial datasets that are provided in the `spatstat` package.

To flick through a nice display of all the data sets that come with `spatstat` type `demo(data)`. To see information about a given data set, type `help(name)` where *name* is the name of the data set To plot a given data set, type `plot(name)`.

Datasets in `spatstat` are “lazy-loaded”, which means that they can be accessed simply by typing their name. Not all packages do this; in some packages you have to type `data(name)` in order to access a data set.

## 1 List of datasets

### 1.1 Point patterns in 2D

Here is a list of the standard point pattern data sets that are supplied with the current installation of `spatstat`:

| name           | description           | marks                    | covariates                                 | window  |
|----------------|-----------------------|--------------------------|--|---|
| amacrine       | rabbit amacrine cells | cell type                | .  |    |
| anemones       | sea anemones          | diameter                 | .  |    |
| ants           | ant nests             | species                  | zones                                      |    |
| bdspots        | breakdown spots       | .                        | .  |    |
| bei            | rainforest trees      | .                        | topography                                 |    |
| betacells      | cat retinal ganglia   | cell type, area          | .  |    |
| bramblecanes   | bramble canes         | age                      | .  |    |
| bronzefilter   | bronze particles      | diameter                 | .  |    |
| cells          | biological cells      | .                        | .  |    |
| chorley        | cancers               | case/control             | .  |    |
| clmfires       | forest fires          | cause, size, date        | elevation, orientation,<br>slope, land use |    |
| copper         | copper deposits       | .                        | fault lines                                |    |
| demopat        | artificial data       | type                     | .  |    |
| finpines       | trees                 | diam, height             | .  |    |
| gordon         | people in a park      | .                        | .  |    |
| gorillas       | gorilla nest sites    | group, season            | terrain, vegetation,<br>heat, water        |    |
| hamster        | hamster tumour cells  | cell type                | .  |    |
| humberside     | child leukaemia       | case/control             | .  |    |
| hyytiala       | mixed forest          | species                  | .  |    |
| japanese pines | Japanese pines        | .                        | .  |    |
| lansing        | mixed forest          | species                  | .  |   |
| longleaf       | trees                 | diameter                 | .  |  |
| mucosa         | gastric mucosa cells  | cell type                | .  |  |
| murchison      | gold deposits         | .                        | faults, rock type                          |  |
| nbfires        | wildfires             | several                  | .  |  |
| nztrees        | trees                 | .                        | .  |  |
| paracou        | trees                 | adult/juvenile           | .  |  |
| ponderosa      | trees                 | .                        | .  |  |
| redwood        | saplings              | .                        | .  |  |
| redwood3       | saplings              | .                        | .  |  |
| redwoodfull    | saplings              | .                        | zones                                      |  |
| shapley        | galaxies              | magnitude, recession, SE | .  |  |
| simdat         | simulated pattern     | .                        | .  |  |
| sporophores    | fungi                 | species                  | .  |  |
| spruces        | trees                 | diameter                 | .  |  |
| swedish pines  | trees                 | .                        | .  |  |
| urkiola        | mixed forest          | species                  | .  |  |
| vesicles       | synaptic vesicles     | .                        | zones                                      |  |
| waka           | trees                 | diameter                 | .  |  |

The shape of the window containing the point pattern is indicated by the symbols  (rectangle),  (disc),  (convex polygon) and  (irregular polygon).

Additional information about the data set *name* may be stored in a separate list *name.extra*. Currently these are the available options:

| NAME                           | CONTENTS  |
|--------------------------------|---|
| <code>ants.extra</code>        | field and scrub subregions;<br>additional map elements; plotting function |
| <code>bei.extra</code>         | covariate images  |
| <code>chorley.extra</code>     | incinerator location; plotting function                                   |
| <code>gorillas.extra</code>    | covariate images  |
| <code>nbfires.extra</code>     | inscribed rectangle   |
| <code>ponderosa.extra</code>   | data points of interest; plotting function                                |
| <code>redwoodfull.extra</code> | subregions; plotting function   |
| <code>shapley.extra</code>     | individual survey fields; plotting function                               |
| <code>vesicles.extra</code>    | anatomical regions  |

For demonstration and instruction purposes, raw data files are available for the datasets `vesicles`, `gorillas` and `osteo`.

## 1.2 Other Data Types

There are also the following spatial data sets which are not 2D point patterns:

| name                        | description                            | format                                       |
|-----------------------------|--|--|
| <code>austates</code>       | Australian states                      | tessellation                                 |
| <code>chicago</code>        | street crimes                          | point pattern on linear network              |
| <code>dendrite</code>       | dendritic spines                       | point pattern on linear network              |
| <code>spiders</code>        | spider webs                            | point pattern on linear network              |
| <code>flu</code>            | virus proteins                         | replicated 2D point patterns                 |
| <code>heather</code>        | heather mosaic                         | binary image (three versions)                |
| <code>demohyper</code>      | simulated data                         | replicated 2D point patterns with covariates |
| <code>osteo</code>          | osteocyte lacunae                      | replicated 3D point patterns with covariates |
| <code>pyramidal</code>      | pyramidal neurons                      | replicated 2D point patterns in 3 groups     |
| <code>residualspaper</code> | data & code from Baddeley et al (2005) | 2D point patterns, R function                |
| <code>simba</code>          | simulated data                         | replicated 2D point patterns in 2 groups     |
| <code>waterstriders</code>  | insects on water                       | replicated 2D point patterns                 |

Additionally there is a dataset `Kovesi` containing several colour maps with perceptually uniform contrast.

## 2 Information on each dataset

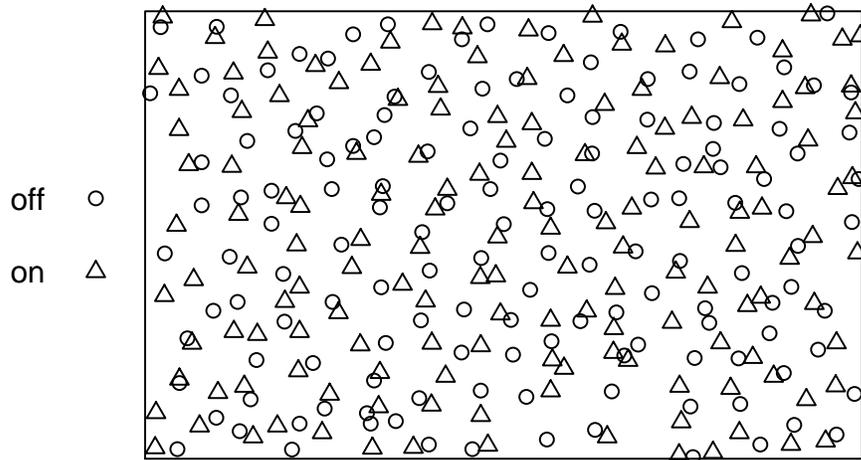
Here we give basic information about each dataset. For further information, consult the help file for the particular dataset.

### `amacrine`: Amacrine cells

Locations of displaced amacrine cells in the retina of a rabbit. There are two types of points, “on” and “off”.

```
> plot(amacrine)
```

### amacrine

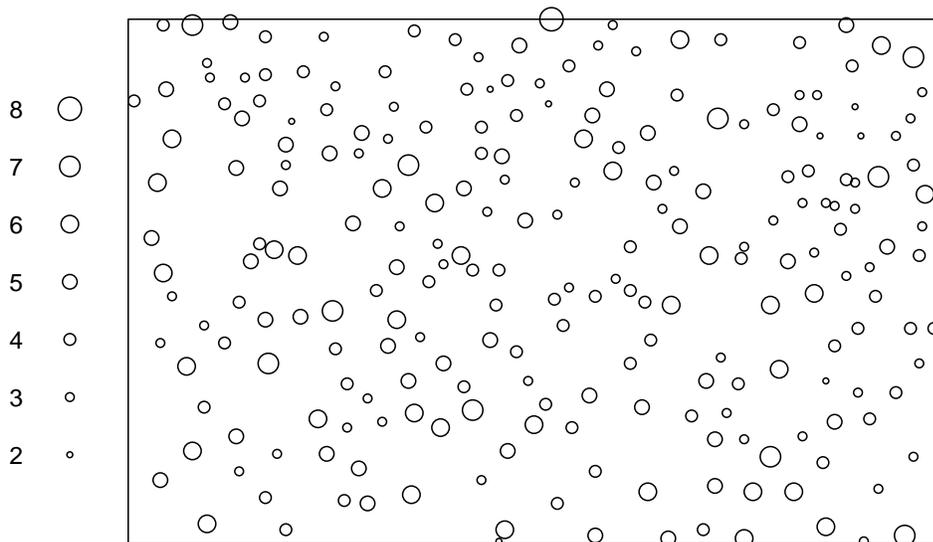


### anemones: Sea Anemones

These data give the spatial locations and diameters of sea anemones on a boulder near sea level.

```
> plot(anemones, markscale=1)
```

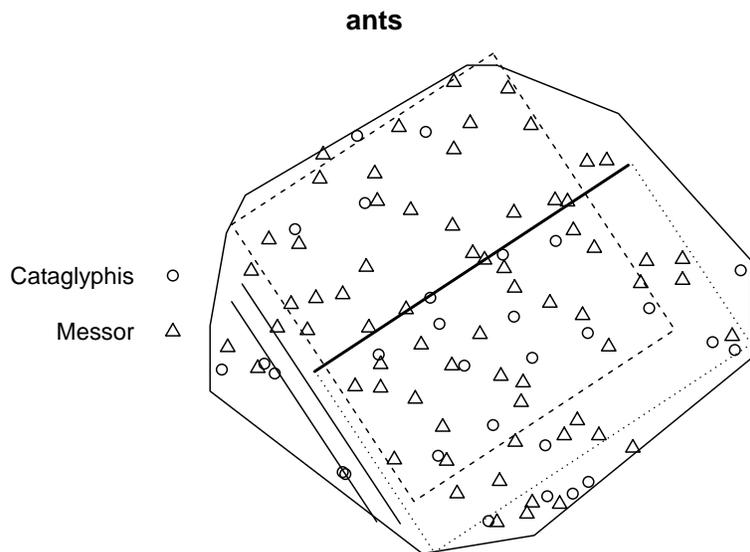
### anemones



### ants: Ants' nests

Spatial locations of nests of two species of ants at a site in Greece. The full dataset (supplied here) has an irregular polygonal boundary, while most analyses have been confined to two rectangular subsets of the pattern (also supplied here).

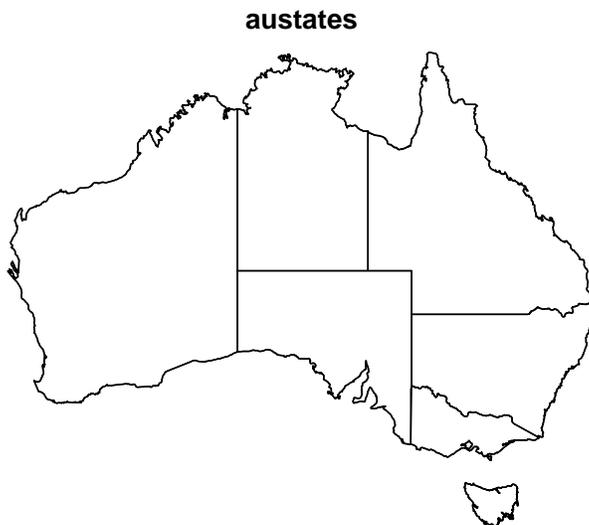
```
> ants.extra$plotit()
```



**austates: Australian states**

The states and large mainland territories of Australia are represented as polygonal regions forming a tessellation.

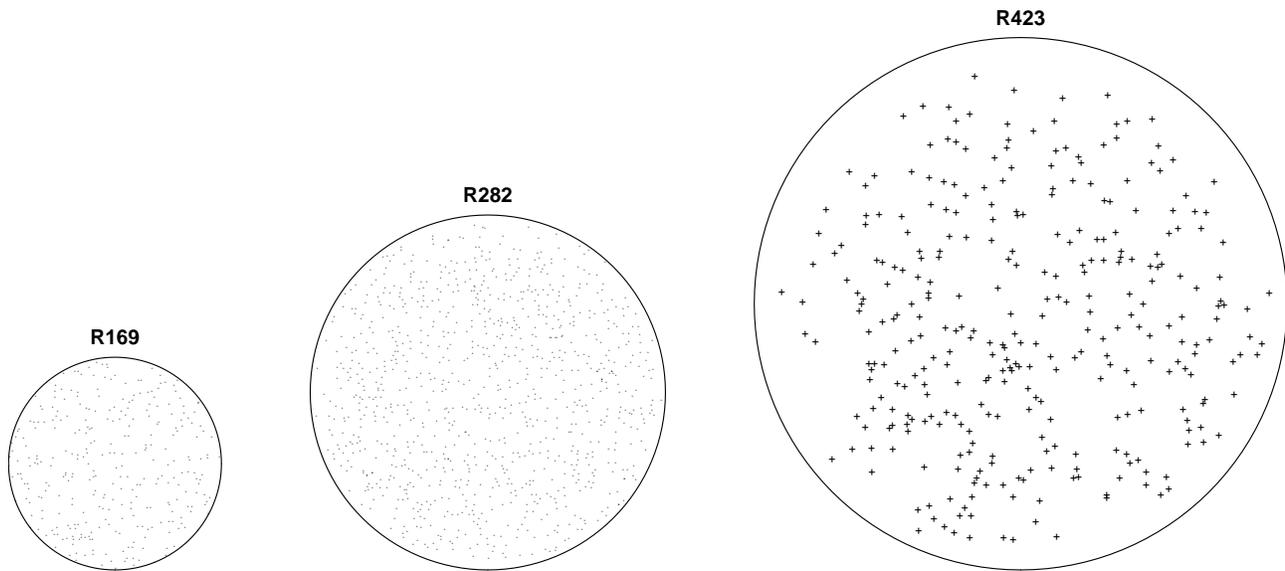
```
> plot(austates)
```



**bdspots: Breakdown spots**

A list of three point patterns, each giving the locations of electrical breakdown spots on a circular electrode in a microelectronic capacitor.

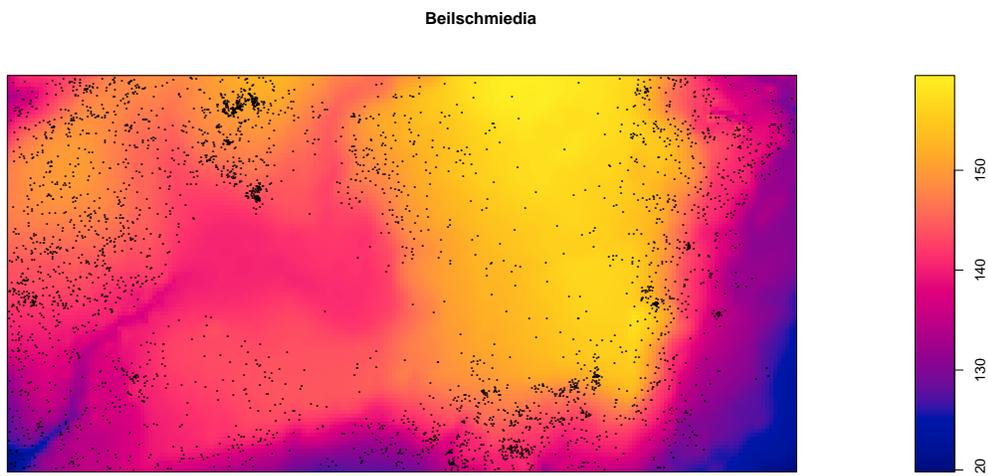
```
> plot(bdspots, equal.scales=TRUE, pch="+",  
+      panel.args=function(i)list(cex=c(0.15, 0.2, 0.7)[i]))
```



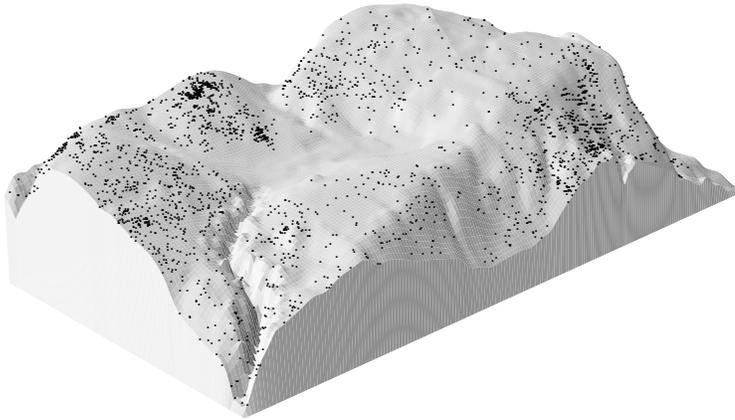
**bei: Beilschmiedia data**

Locations of 3605 trees in a tropical rain forest. Accompanied by covariate data giving the elevation (altitude) and slope of elevation in the study region.

```
> plot(bei.extra$elev, main="Beilschmiedia")
> plot(bei, add=TRUE, pch=16, cex=0.3)
```



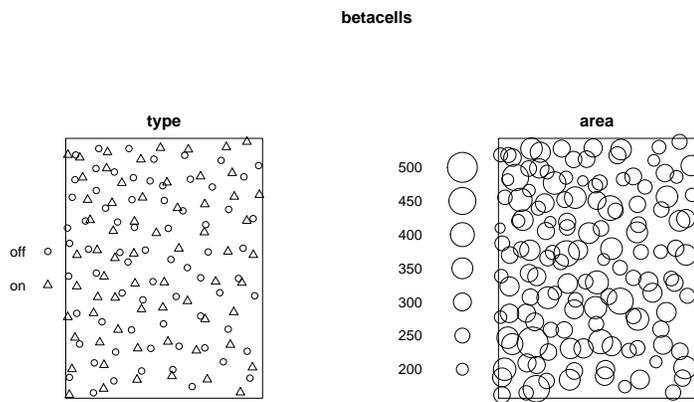
```
> M <- persp(bei.extra$elev,
+           theta=-45, phi=18, expand=7,
+           border=NA, apron=TRUE, shade=0.3,
+           box=FALSE, visible=TRUE,
+           main="")
> perspPoints(bei, Z=bei.extra$elev, M=M, pch=16, cex=0.3)
```



**betacells: Beta ganglion cells**

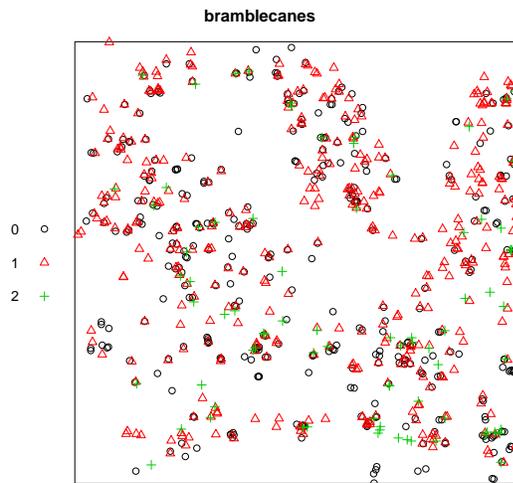
Locations of beta ganglion cells in cat retina, each cell classified as 'on' or 'off' and also labelled with the cell profile area.

```
> plot(betacells)
```

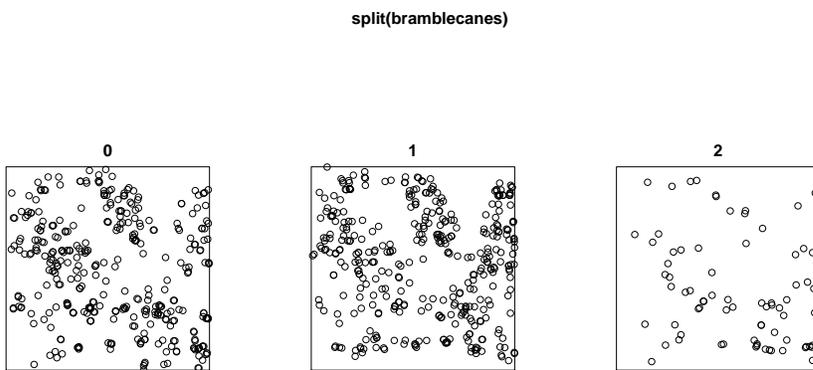


**bramblecanes: Bramble canes**

```
> plot(bramblecanes, cols=1:3)
```



```
> plot(split(bramblecanes))
```

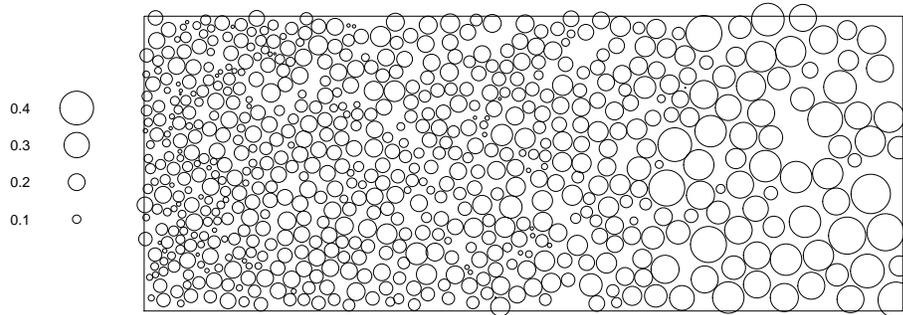


**bronzefilter: Bronze filter section profiles**

Spatially inhomogeneous pattern of circular section profiles of particles, observed in a longitudinal plane section through a gradient sinter filter made from bronze powder.

```
> plot(bronzefilter,markscale=2)
```

bronzefilter

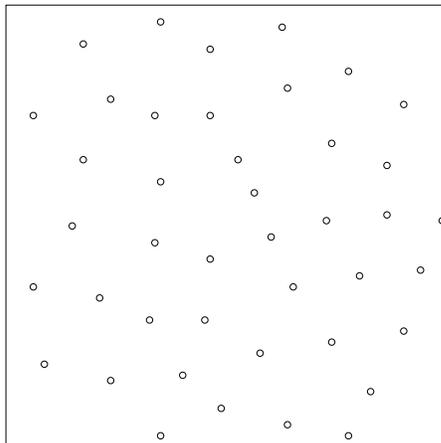


**cells: Biological cells**

Locations of the centres of 42 biological cells observed under optical microscopy in a histological section. Often used as a demonstration example.

```
> plot(cells)
```

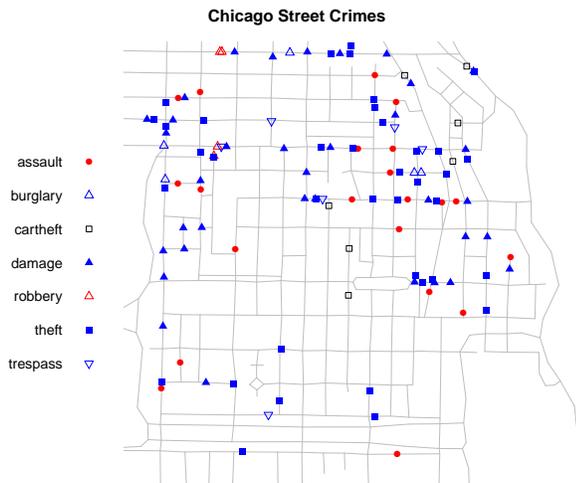
cells



**chicago: Chicago street crimes**

Street crimes reported in a two-week period in an area close to the University of Chicago. A multitype point pattern on a linear network.

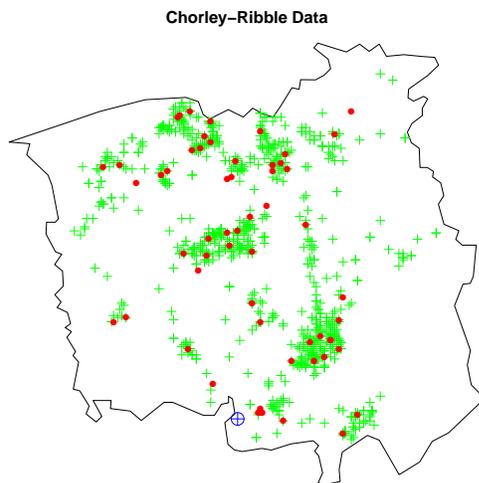
```
> plot(chicago, main="Chicago Street Crimes", col="grey",  
+      cols=c("red", "blue", "black", "blue", "red", "blue", "blue"),  
+      chars=c(16,2,22,17,24,15,6), leg.side="left", show.window=FALSE)
```



**chorley: Chorley-Ribble cancer data**

Spatial locations of cases of cancer of the larynx and cancer of the lung, and the location of a disused industrial incinerator. A marked point pattern, with an irregular window and a simple covariate.

```
> chorley.extra$plotit()
```

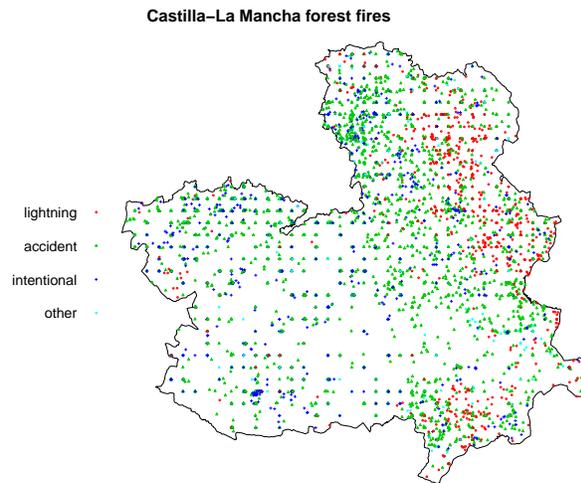


**clmfires: Castilla-La Mancha Fires**

Forest fires in the Castilla-La Mancha region of Spain between 1998 and 2007. A point pattern with 4 columns of marks:

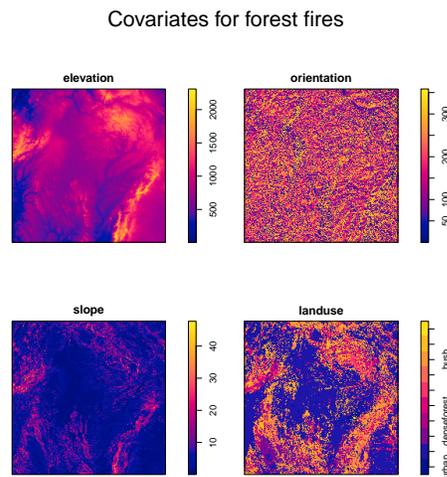
- cause            cause of fire
- burnt.area     total area burned, in hectares
- date            date of fire
- julian.date    date of fire in days since 1.1.1998

```
> plot(clmfires, which.marks="cause", cols=2:5, cex=0.25,
+        main="Castilla-La Mancha forest fires")
```



The accompanying dataset `clmfires.extra` is a list of two items `clmcov100` and `clmcov200` containing covariate information for the entire Castilla-La Mancha region. Each of these two elements is a list of four pixel images named `elevation`, `orientation`, `slope` and `landuse`.

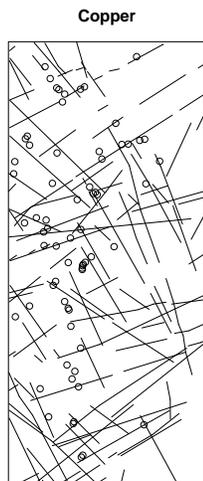
```
> plot(clmfires.extra$clmcov200, main="Covariates for forest fires")
```



### copper: Queensland copper data

These data come from an intensive geological survey in central Queensland, Australia. They consist of 67 points representing copper ore deposits, and 146 line segments representing geological 'lineaments', mostly faults.

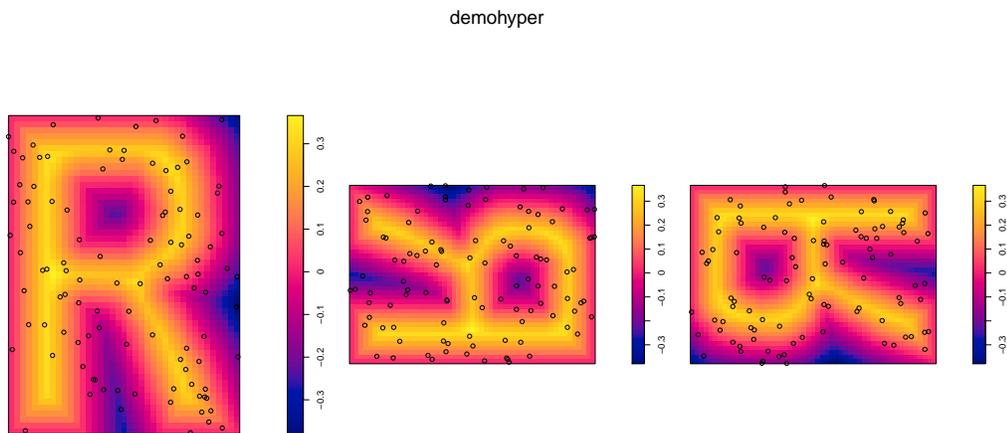
```
> plot(copper$Points, main="Copper")
> plot(copper$Lines, add=TRUE)
```



demohyper

A synthetic example of a hyperframe for demonstration purposes.

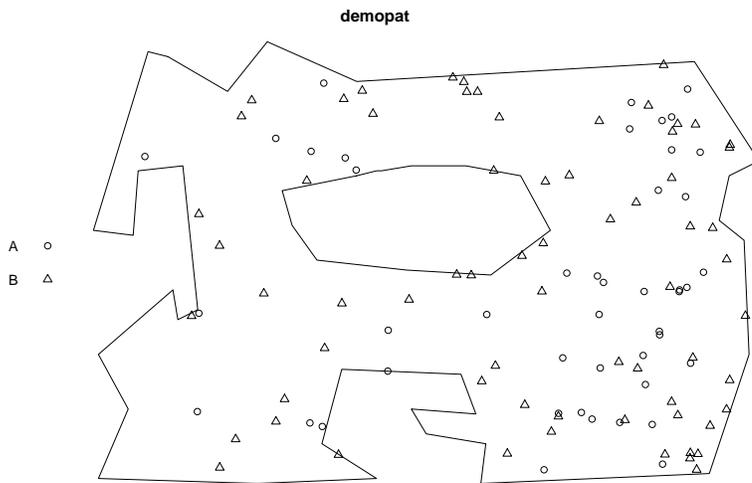
```
> plot(demohyper, quote({ plot(Image, main=""); plot(Points, add=TRUE) }),
+       parargs=list(mar=rep(1,4)))
```



demopat

A synthetic example of a point pattern for demonstration purposes.

```
> plot(demopat)
```

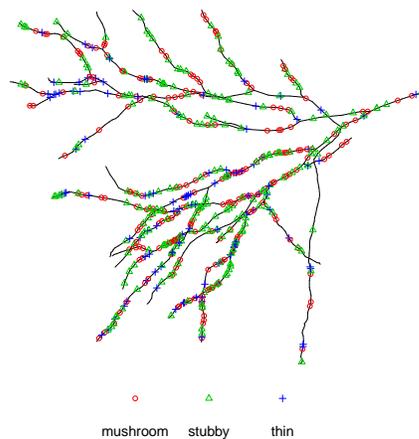


### dendrite

Dendrites are branching filaments which extend from the main body of a neuron (nerve cell) to propagate electrochemical signals. Spines are small protrusions on the dendrites.

This dataset gives the locations of 566 spines observed on one branch of the dendritic tree of a rat neuron. The spines are classified according to their shape into three types: mushroom, stubby or thin.

```
> plot(dendrite, leg.side="bottom", main="", cex=0.75, cols=2:4)
```

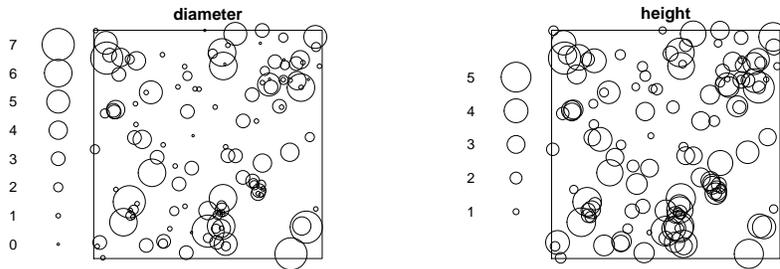


### finpines: Finnish pine saplings

Locations of 126 pine saplings in a Finnish forest, their heights and their diameters.

```
> plot(finpines, main="Finnish pines")
```

### Finnish pines

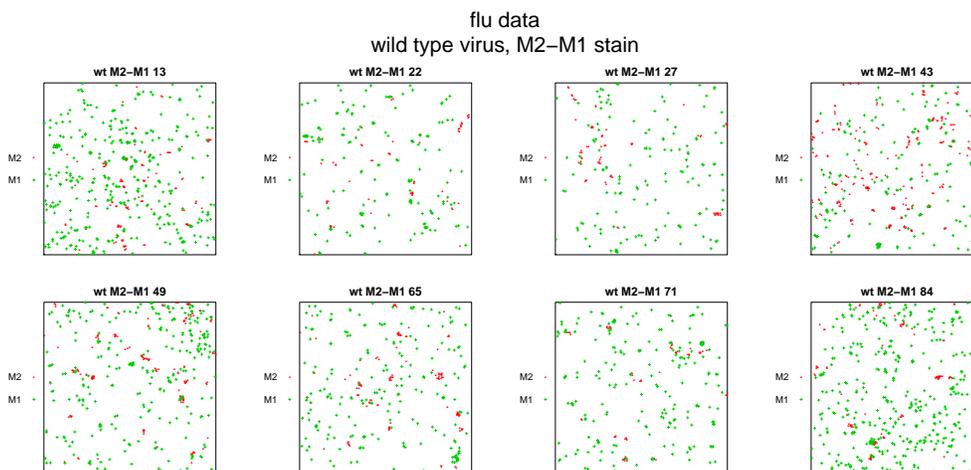


### flu: Influenza virus proteins

The `flu` dataset contains replicated spatial point patterns giving the locations of two different virus proteins on the membranes of cells infected with influenza virus.

It is a `hyperframe` containing point patterns and explanatory variables.

```
> wildM1 <- with(flu, virustype == "wt" & stain == "M2-M1")
> plot(flu[wildM1, 1, drop=TRUE],
+      main=c("flu data", "wild type virus, M2-M1 stain"),
+      chars=c(16,3), cex=0.4, cols=2:3)
```

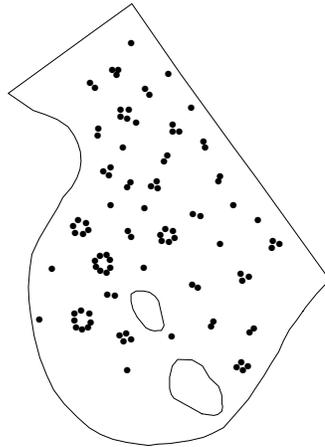


### gordon: People in Gordon Square

Locations of people sitting on a grass patch on a sunny afternoon.

```
> plot(gordon, main="People in Gordon Square", pch=16)
```

People in Gordon Square



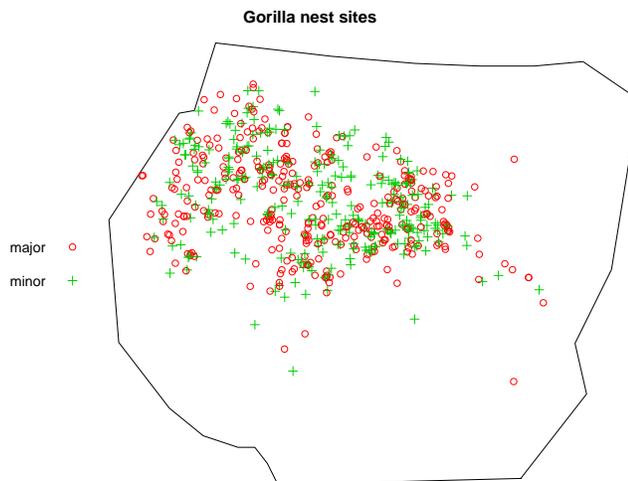
### gorillas: Gorilla nesting sites

Locations of nesting sites of gorillas, and associated covariates, in a National Park in Cameroon.

`gorillas` is a marked point pattern (object of class "ppp") representing nest site locations.

`gorillas.extra` is a named list of 7 pixel images (objects of class "im") containing spatial covariates. It also belongs to the class "listof".

```
> plot(gorillas, which.marks=1, chars=c(1,3), cols=2:3, main="Gorilla nest sites")
```



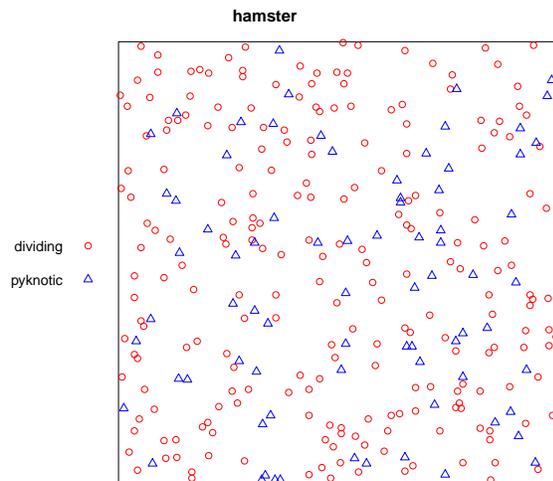
The vegetation covariate is also available as a raw ASCII format file,

```
> system.file("rawdata/gorillas/vegetation.asc", package="spatstat")
```

### hamster: Hamster kidney cells

Cell nuclei in hamster kidney, each nucleus classified as either 'dividing' or 'pyknotic'. A multitype point pattern.

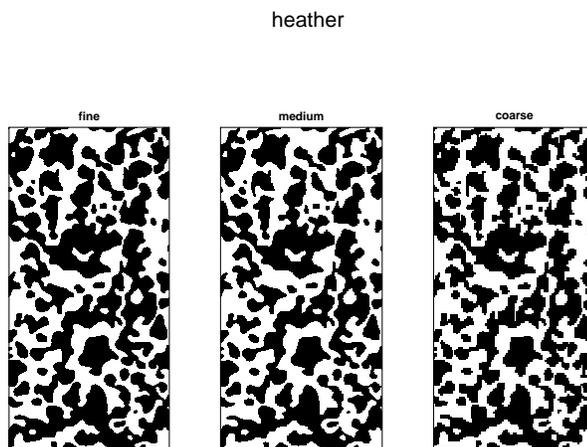
```
> plot(hamster, cols=c(2,4))
```



**heather: Heather mosaic**

The spatial mosaic of vegetation of the heather plant, recorded in a 10 by 20 metre sampling plot in Sweden. A list with three entries, representing the same data at different spatial resolutions.

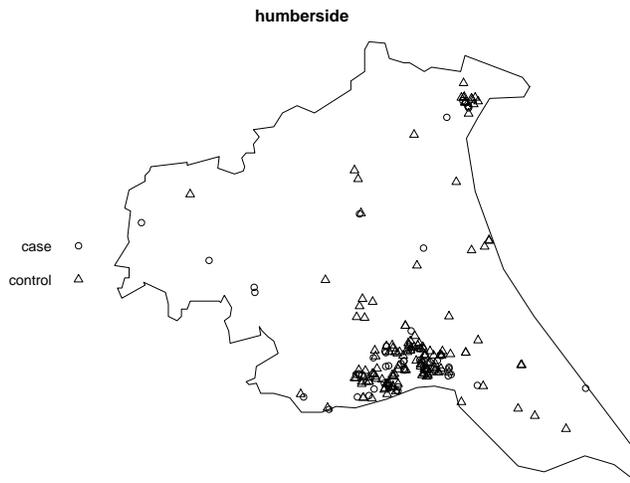
```
> plot(heather)
```



**humberside: Childhood Leukemia and Lymphoma**

Spatial locations of cases of childhood leukaemia and lymphoma, and randomly-selected controls, in North Humberside. A marked point pattern.

```
> plot(humberside)
```

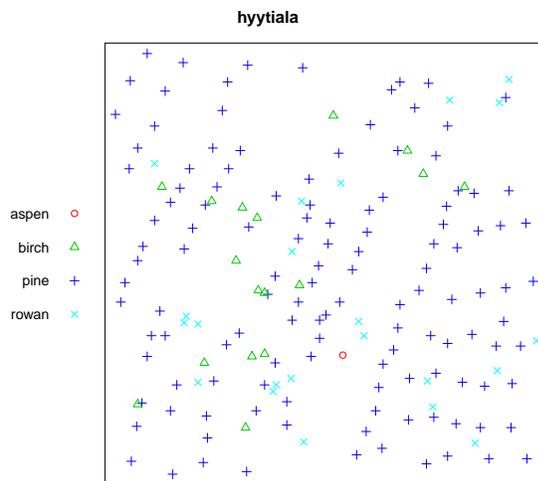


The dataset `humberside.convex` is an object of the same format, representing the same point pattern data, but contained in a larger, 5-sided convex polygon.

**hyytiala: Mixed forest**

Spatial locations and species classification for trees in a Finnish forest.

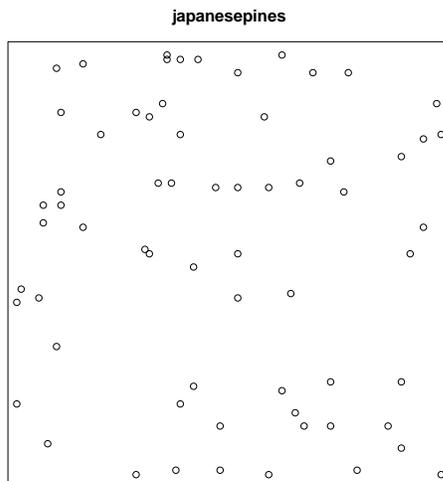
```
> plot(hyytiala, cols=2:5)
```



**japanesepines: Japanese black pine saplings**

Locations of Japanese black pine saplings in a square sampling region in a natural forest. Often used as a standard example.

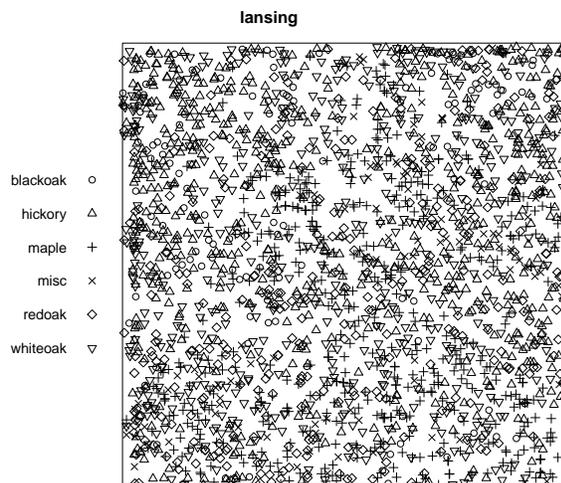
```
> plot(japanesepines)
```



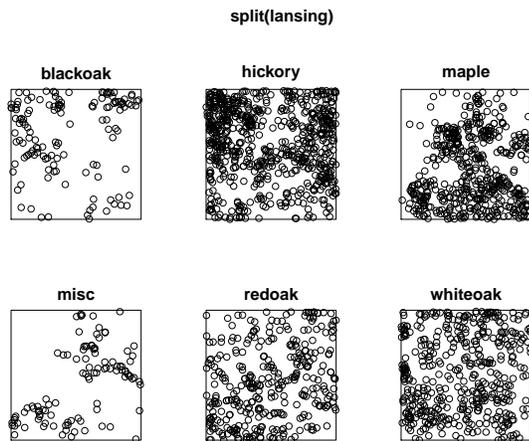
**lansing: Lansing Woods**

Locations and botanical classification of trees in a forest. A multitype point pattern with 6 different types of points. Includes duplicated points.

```
> plot(lansing)
```



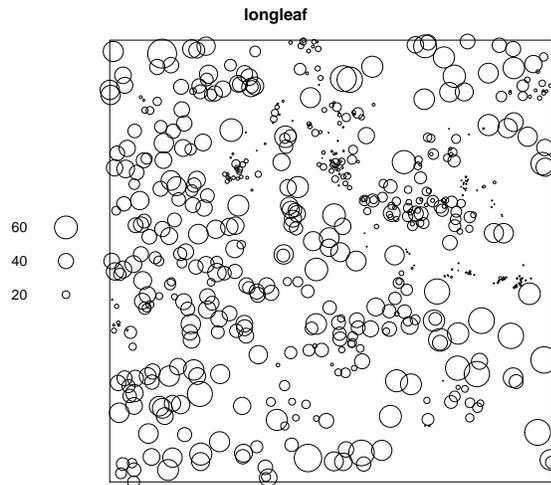
```
> plot(split(lansing))
```



**longleaf: Longleaf Pines**

Locations and diameters of Longleaf pine trees.

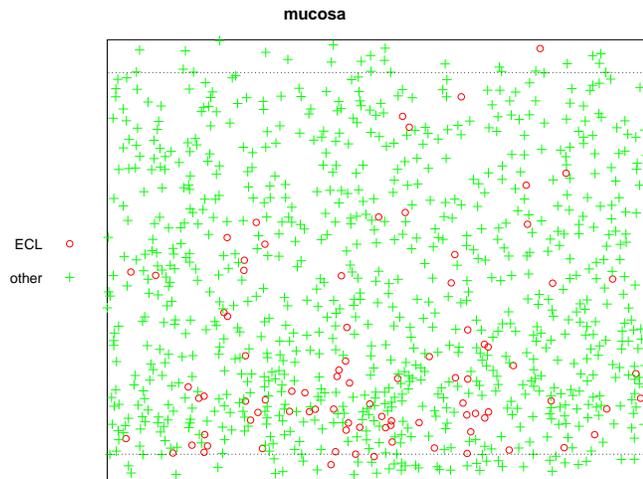
```
> plot(longleaf)
```



**mucosa: Gastric Mucosa Cells**

A bivariate inhomogeneous point pattern, giving the locations of the centres of two types of cells in a cross-section of the gastric mucosa of a rat.

```
> plot(mucosa, chars=c(1,3), cols=c("red", "green"))
> plot(mucosa.subwin, add=TRUE, lty=3)
```

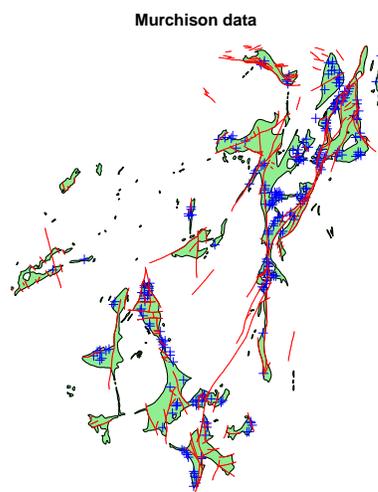


### murchison: Murchison Gold Deposits

Spatial locations of gold deposits and associated geological features in the Murchison area of Western Australia. A list of three elements:

- `gold`, the point pattern of gold deposits;
- `faults`, the line segment pattern of geological faults;
- `greenstone`, the subregion of greenstone outcrop.

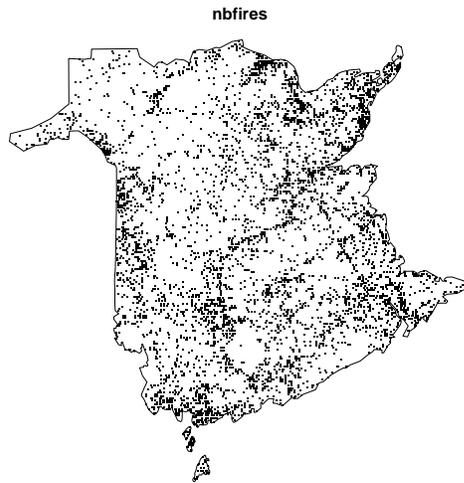
```
> plot(murchison$greenstone, main="Murchison data", col="lightgreen")
> plot(murchison$gold, add=TRUE, pch=3, col="blue")
> plot(murchison$faults, add=TRUE, col="red")
```



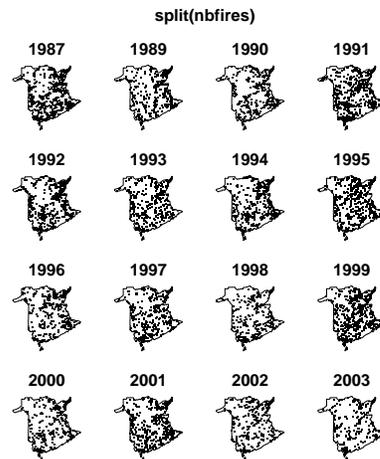
### nbfires: New Brunswick Fires

Fires in New Brunswick (Canada) with marks giving information about each fire.

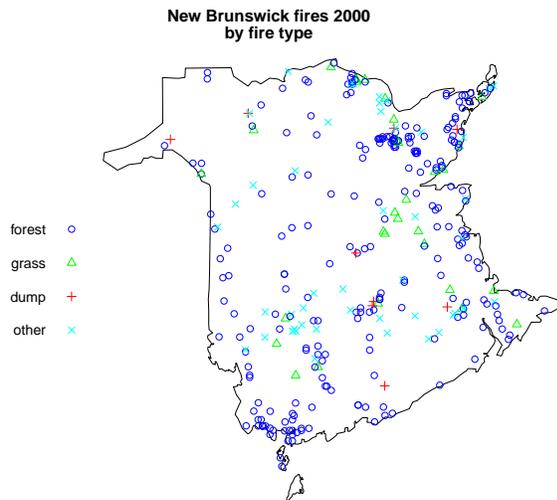
```
> plot(nbfires, use.marks=FALSE, pch=".")
```



```
> plot(split(nbfires), use.marks=FALSE, chars=".")
```



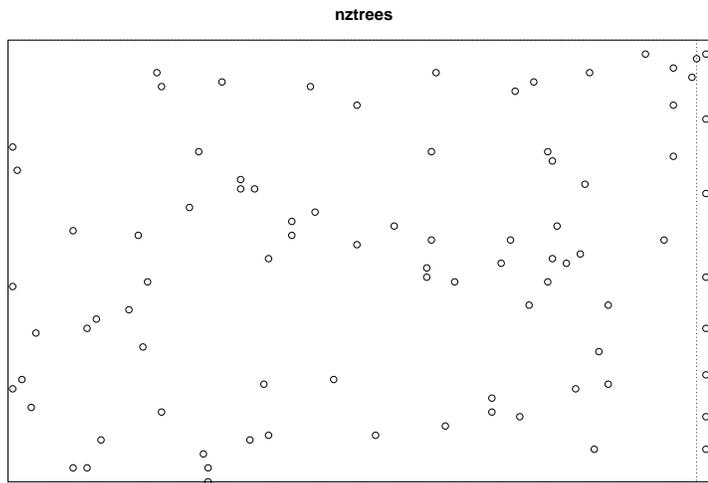
```
> par(mar=c(0,0,2,0))
> plot(split(nbfires)$"2000", which.marks="fire.type",
+       main=c("New Brunswick fires 2000", "by fire type"),
+       cols=c("blue", "green", "red", "cyan"),
+       leg.side="left")
```



### nztrees: New Zealand Trees

Locations of trees in a forest plot in New Zealand. Often used as a demonstration example.

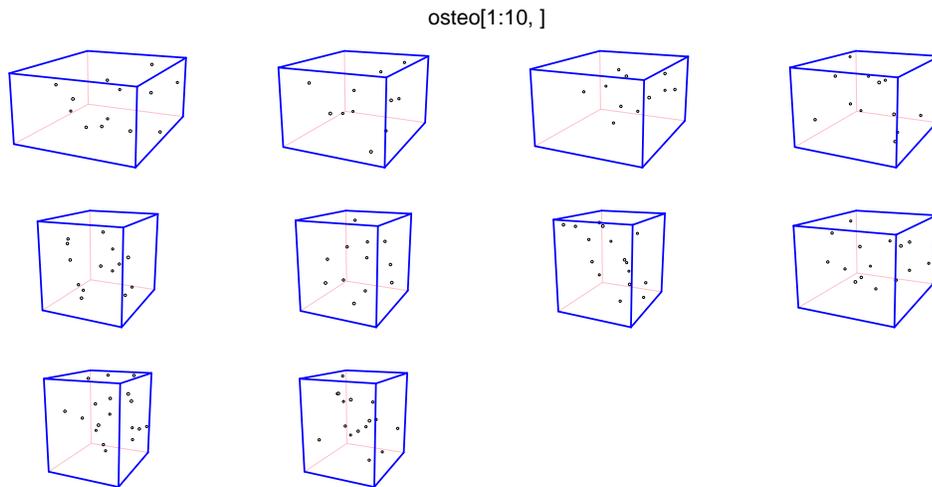
```
> plot(nztrees)
> plot(trim.rectangle(as.owin(nztrees), c(0,5), 0), add=TRUE, lty=3)
```



### osteo: Osteocyte Lacunae

Replicated three-dimensional point patterns: the three-dimensional locations of osteocyte lacunae observed in rectangular volumes of solid bone using a confocal microscope. A **hyperframe** containing 3D point patterns and explanatory variables.

```
> plot(osteo[1:10,], main.panel="", pch=21, bg='white')
```



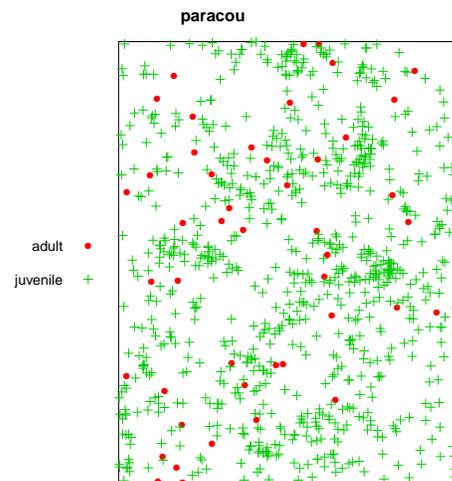
For demonstration and instruction purposes, the raw data from the 36th point pattern are available in a plain ascii file in the `spatstat` installation,

```
> system.file("rawdata/osteo/osteo36.txt", package="spatstat")
```

#### paracou: Kimboto trees

Point pattern of adult and juvenile Kimboto trees recorded at Paracou in French Guiana. A bivariate point pattern.

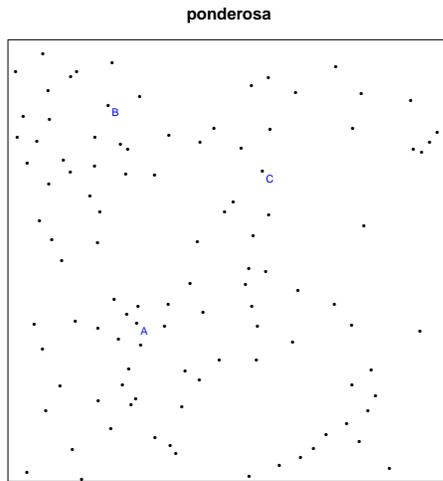
```
> plot(paracou, cols=2:3, chars=c(16,3))
```



#### ponderosa: Ponderosa Pines

Locations of Ponderosa Pine trees in a forest. Several special points are identified.

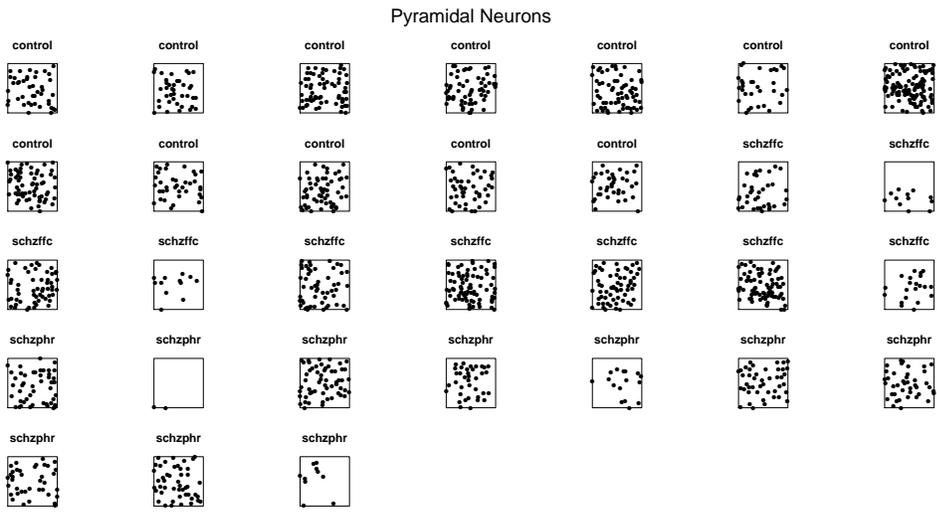
```
> ponderosa.extra$plotit()
```



### pyramidal: Pyramidal Neurons in Brain

Locations of pyramidal neurons in sections of human brain. There is one point pattern from each of 31 human subjects. The subjects are divided into three groups: controls (12 subjects), schizoaffective (9 subjects) and schizophrenic (10 subjects).

```
> pyr <- pyramidal
> pyr$grp <- abbreviate(pyramidal$group, minlength=7)
> plot(pyr, quote(plot(Neurons, pch=16, main=grp)), main="Pyramidal Neurons")
```



### redwood, redwood3, redwoodfull: Redwood seedlings and saplings

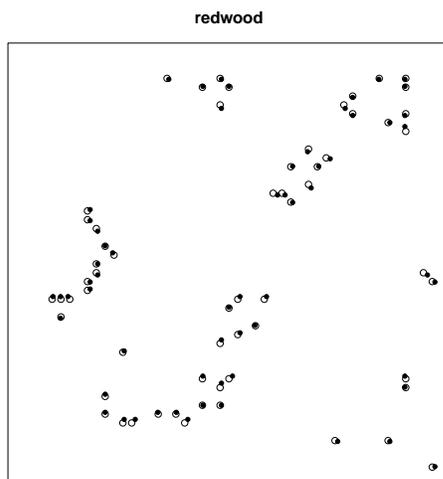
California Redwood seedlings and saplings in a forest. There are two versions of this dataset: `redwood` and `redwoodfull`.

The `redwoodfull` dataset is the full data. It is spatially inhomogeneous in density and spacing of points.

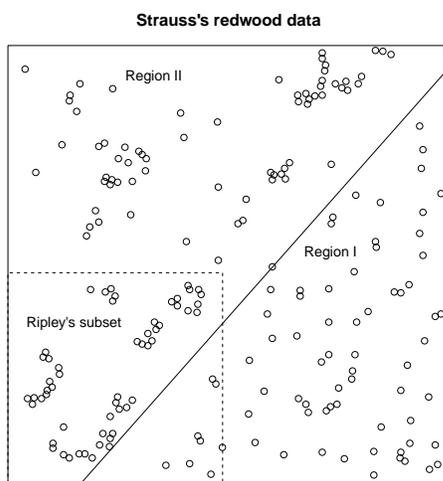
The `redwood` dataset is a subset of the full data, selected because it is apparently homogeneous, and has often been used as a demonstration example. This comes in two versions commonly used in

the literature: `redwood` (coordinates given to 2 decimal places) and `redwood3` (coordinates given to 3 decimal places).

```
> plot(redwood)
> plot(redwood3, add=TRUE, pch=20)
```



```
> redwoodfull.extra$plotit()
```



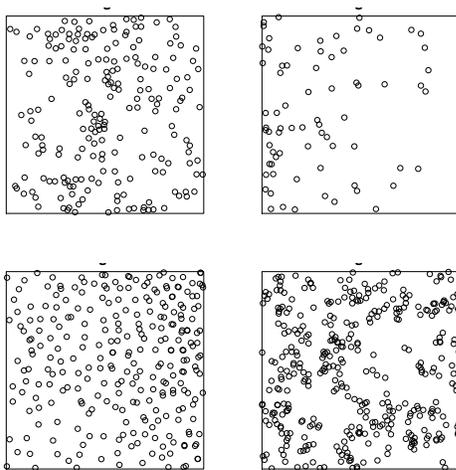
### residualspaper: Data from residuals paper

Contains the point patterns used as examples in

A. Baddeley, R. Turner, J. Møller and M. Hazelton (2005) Residual analysis for spatial point processes. *Journal of the Royal Statistical Society, Series B* **67**, 617–666

along with R code.

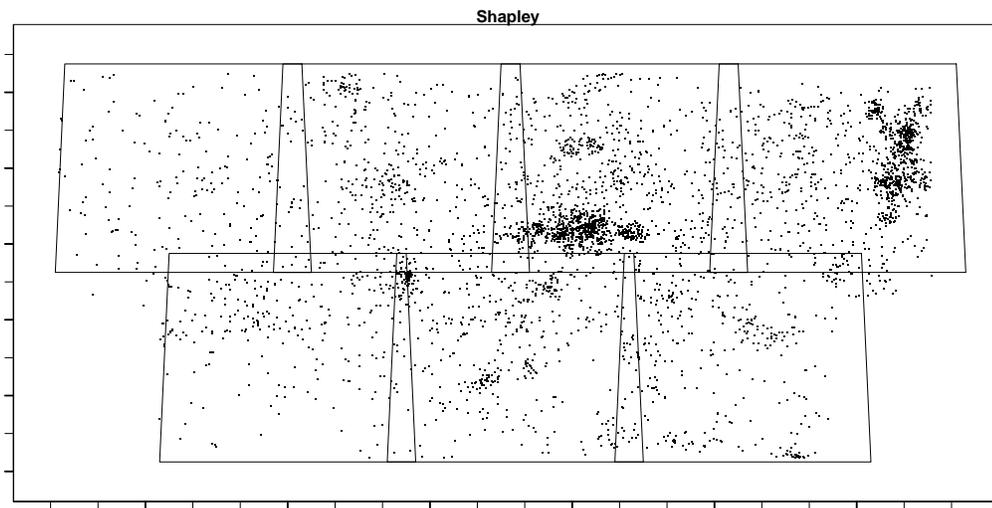
```
> plot(as.listof(residualspaper[c("Fig1", "Fig4a", "Fig4b", "Fig4c")] ),
+       main="")
```



**shapley: Shapley Galaxy Concentration**

Sky positions of 4215 galaxies in the Shapley Supercluster (mapped by radioastronomy).

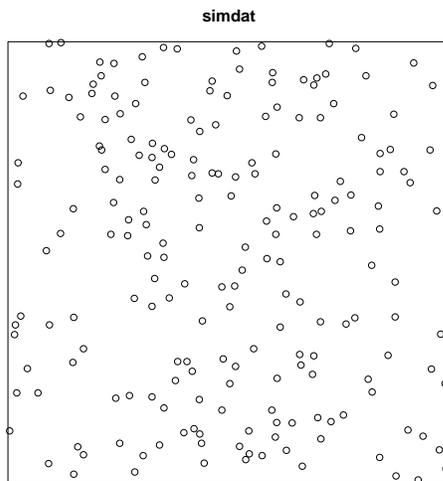
```
> shapley.extra$plotit(main="Shapley")
```



**simdat: Simulated data**

Another simulated dataset used for demonstration purposes.

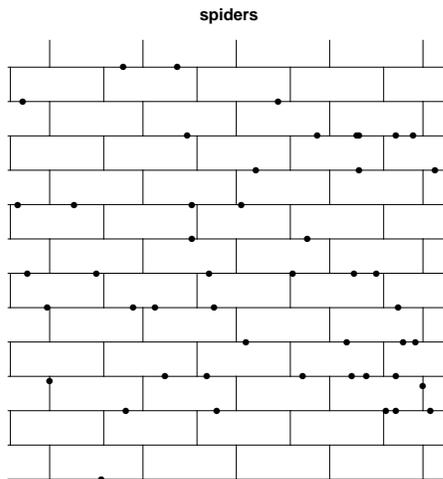
```
> plot(simdat)
```



**spiders: Spider webs**

Spider webs across the mortar lines of a brick wall. A point pattern on a linear network.

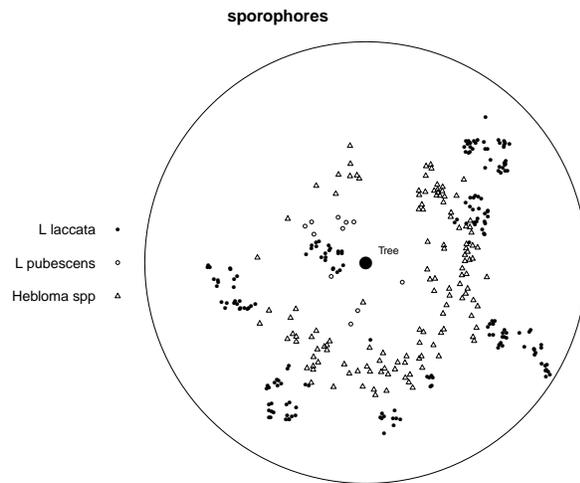
```
> plot(spiders, pch=16, show.window=FALSE)
```



**sporophores: Sporophores**

Sporophores of three species of fungi around a tree.

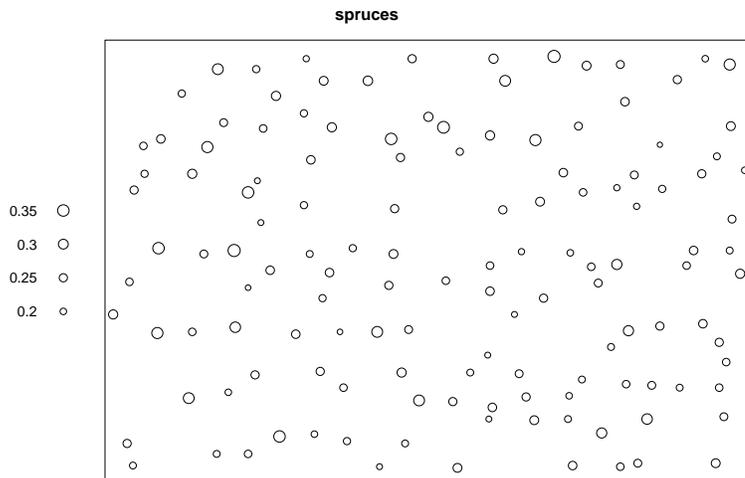
```
> plot(sporophores, chars=c(16,1,2), cex=0.6)
> points(0,0,pch=16, cex=2)
> text(15,8,"Tree", cex=0.75)
```



**spruces: Spruces in Saxony**

Locations of Norwegian spruce trees in a natural forest stand in Saxonia, Germany. Each tree is marked with its diameter at breast height.

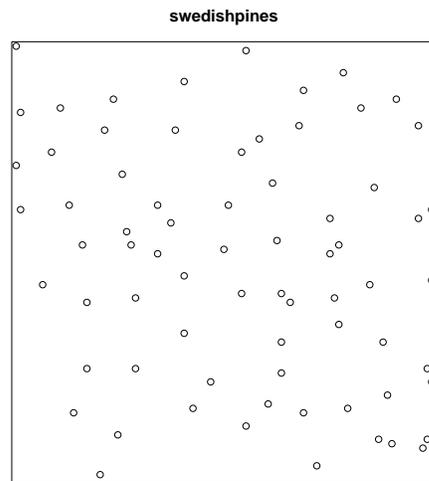
```
> plot(spruces, maxsize=min(nndist(spruces)))
```



**swedishpines: Swedish Pines**

Locations of pine saplings in a Swedish forest. Often used as a demonstration example.

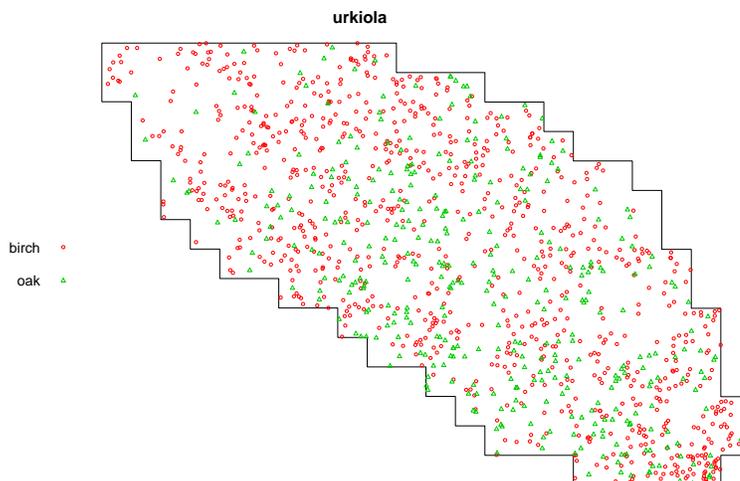
```
> plot(swedishpines)
```



### urkiola: trees in a wood

Locations of birch and oak trees in a secondary wood in Urkiola Natural Park (Basque country, northern Spain). Irregular window, bivariate point pattern.

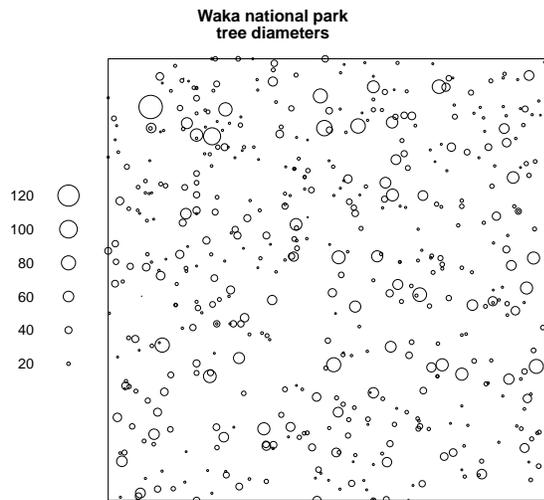
```
> plot(urkiola, cex=0.5, cols=2:3)
```



### waka: trees in Waka National Park

Spatial coordinates of each tree, marked by the tree diameter at breast height.

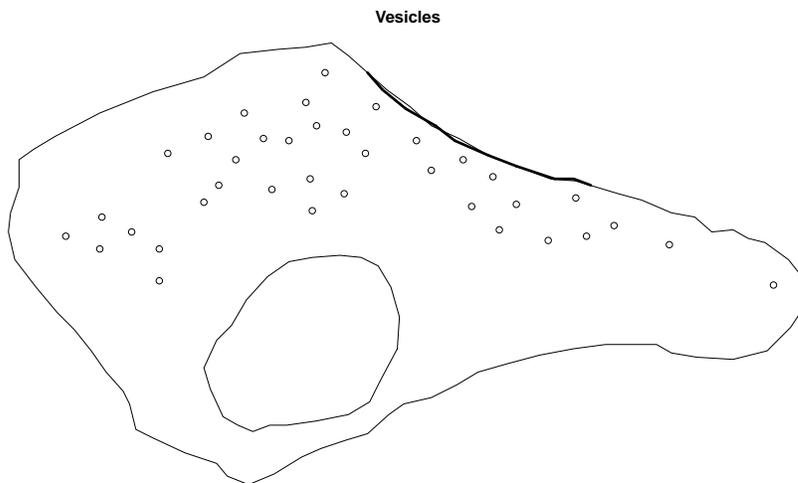
```
> par(mar=c(0,0,2,0))
> plot(waka, markscale=0.04, main=c("Waka national park", "tree diameters"))
```



### vesicles: synaptic vesicles

Point pattern of synaptic vesicles observed in rat brain tissue.

```
> v <- rotate(vesicles, pi/2)
> ve <- lapply(vesicles.extra, rotate, pi/2)
> plot(v, main="Vesicles")
> plot(ve$activezone, add=TRUE, lwd=3)
```



The auxiliary dataset `vesicles.extra` is a list with entries

|                           |  |
|---------------------------|--|
| <code>presynapse</code>   | outer polygonal boundary of presynapse             |
| <code>mitochondria</code> | polygonal boundary of mitochondria                 |
| <code>mask</code>         | binary mask representation of vesicles window      |
| <code>activezone</code>   | line segment pattern representing the active zone. |

For demonstration and training purposes, the raw data files for this dataset are also provided in the `spatstat` package installation:

vesicles.txt            spatial locations of vesicles  
presynapse.txt        vertices of presynapse  
mitochondria.txt     vertices of mitochondria  
vesiclesimage.tif    greyscale microscope image  
vesiclesmask.tif     binary image of mask  
activezone.txt        coordinates of activezone

The files are in the folder `rawdata/vesicles` in

the `spatstat` installation directory. The precise location of the files can be obtained using `system.file`, for example

```
> system.file("rawdata/vesicles/mitochondria.txt", package="spatstat")
```

### waterstriders: Insects on a pond

Three independent replications of a point pattern formed by insects on the surface of a pond.

```
> plot(waterstriders)
```

