Datasets provided for `spatstat`

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For `spatstat` version `3.6-3`

This document is an overview of the spatial datasets that are provided for 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*`)`. A nicer plot will often be produced by typing `example(`*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.

To list all the datasets in `spatstat`, you need to type `data(package="spatstat.data")`. This is because, for efficiency, the datasets are actually installed in a sub-package `spatstat.data`. This is the only time you should ever need to mention `spatstat.data` explicitly. When the `spatstat` package is loaded by the command `library(spatstat)`, the sub-package `spatstat.data` is automatically loaded.

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.data`.

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

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	·	
btb	bovine tuberculosis	type, year	·	
cells	biological cells	·	·	
chorley	cancers	case/control	·	
clmfires	forest fires	cause, size, date	elevation, orientation, slope, land use	
concrete	air bubbles in concrete	·	·	
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, heat, water	
hamster	hamster tumour cells	cell type	·	
humberside	child leukaemia	case/control	·	
hyytiala	mixed forest	species	·	
japanesepines	Japanese pines	·	·	
lansing	mixed forest	species	·	
longleaf	trees	diameter	·	
meningitis	disease cases	serotype	population density	
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	·	
shelling	artillery impacts	·	·	
simdat	simulated pattern	·	·	
sporophores	fungi	species	·	
spruces	trees	diameter	·	
stonetools	palaeolithic tools	type, depth	·	
swedishpines	trees	·	·	
urkiola	mixed forest	species	·	
vesicles	synaptic vesicles	·	zones	
waka	trees	diameter	·	

Auxiliary information

Additional information about a point pattern data set *name* may be stored in a separate list *name*.extra. Currently these are the auxiliary data sets:

Name	Contents
ants.extra	field and scrub subregions; additional map elements; plotting function
bei.extra	covariate images
chorley.extra	incinerator location; plotting function
gorillas.extra	covariate images
nbfires.extra	inscribed rectangle; border type labels
ponderosa.extra	data points of interest; plotting function
redwoodfull.extra	subregions; plotting function
shapley.extra	individual survey fields; plotting function
vesicles.extra	anatomical regions

Additionally, raw data files are available for the datasets amacrine, finpines, gorillas, vesicles and gorillas. See the help files for these datasets for information about the raw data files.

1.2 Other Spatial Data Types

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

name	description	class	format
austates	Australian states	tess	tessellation
cetaceans	marine survey	hyperframe	replicated 2D point patterns
chicago	crimes	lpp	point pattern on linear network
demohyper	simulated data	hyperframe	replicated 2D point patterns with covariates
dendrite	dendritic spines	lpp	point pattern on linear network
flu	virus proteins	hyperframe	replicated 2D point patterns
heather	heather mosaic	solist	binary image (three versions)
osteo	osteocyte lacunae	hyperframe	replicated 3D point patterns with covariates
pyramidal	pyramidal neurons	hyperframe	replicated 2D point patterns in 3 groups
residualspaper	data & code	list	2D point patterns, R function
simba	simulated data	hyperframe	replicated 2D point patterns in 2 groups
spiders	spider webs	lpp	point pattern on linear network
waterstriders	insects on water	solist	replicated 2D point patterns

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

Raw data files are available for the osteo dataset. See the help for osteo for information.

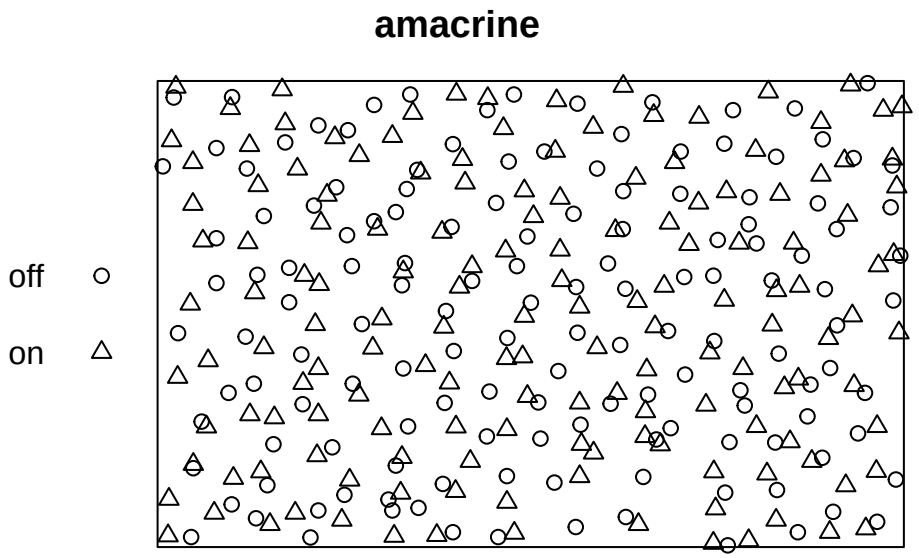
2 Information on each dataset

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".

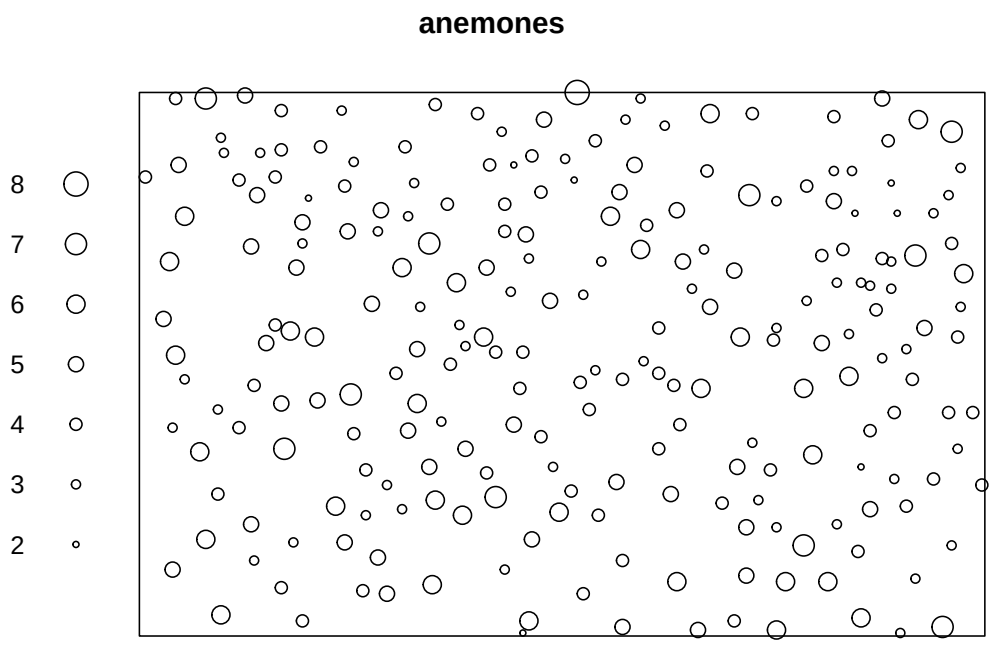
```
> plot(amacrine)
```



`anemones`: **Sea Anemones**

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

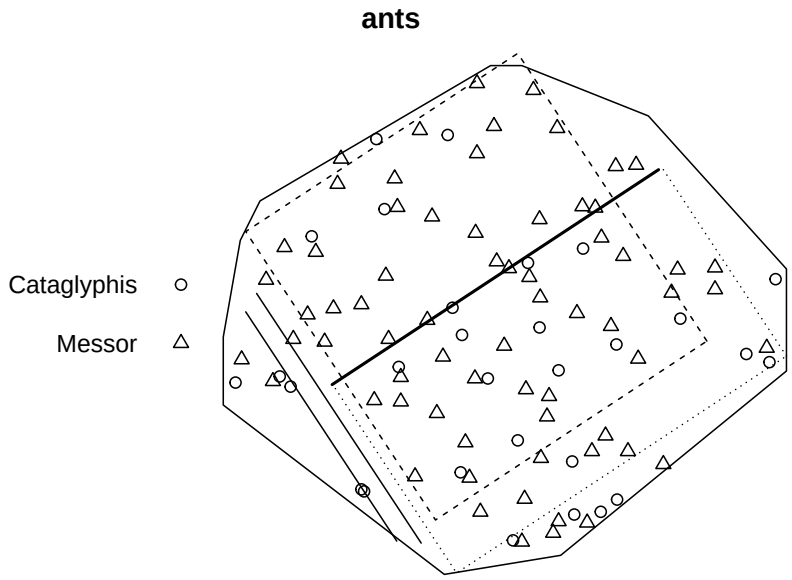
```
> plot(anemones, markscale=1)
```



`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).

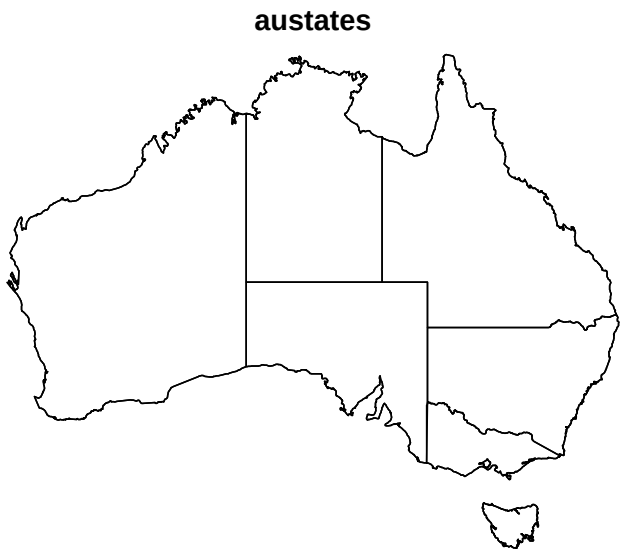
```
> ants.extra$plotit()
```



`austates`: **Australian states**

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

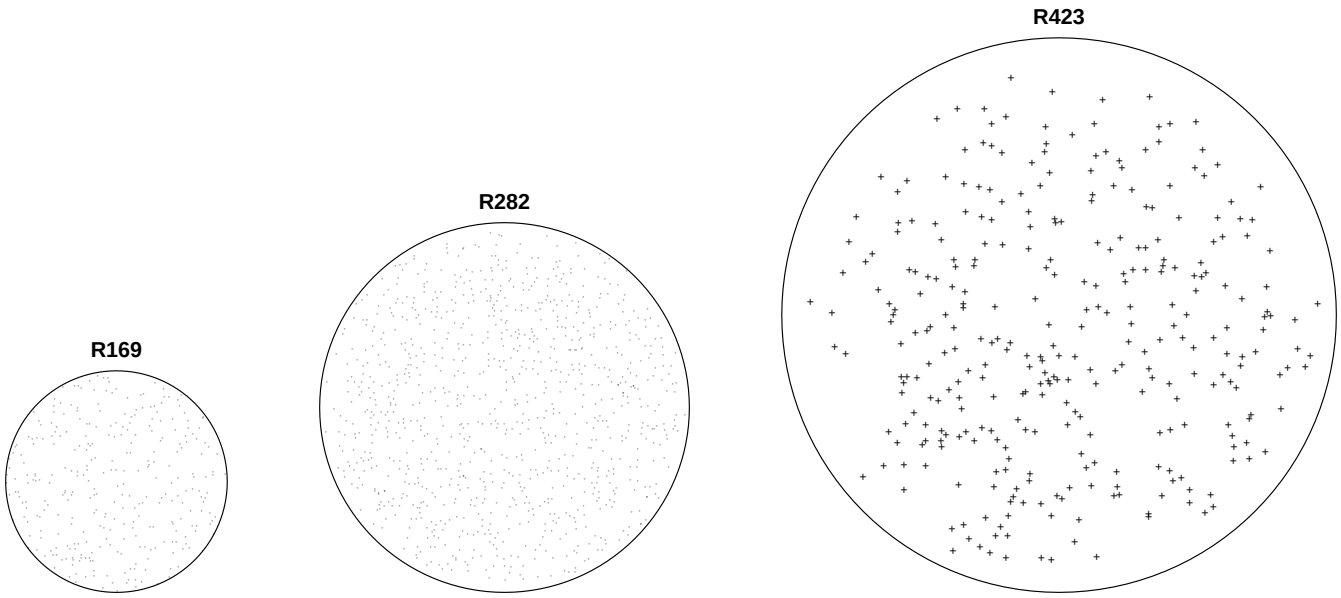
```
> plot(austates)
```



`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.

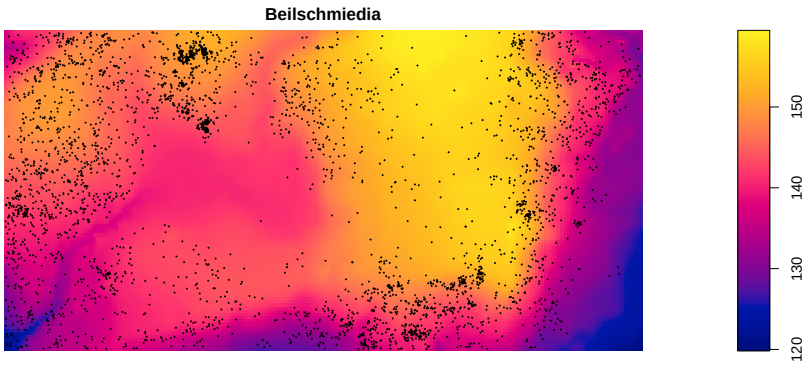
```
> plot(bdspots, equal.scales=TRUE, pch="+",
+      panel.args=function(i)list(cex=c(0.15, 0.2, 0.7)[i]))
```



`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)
```



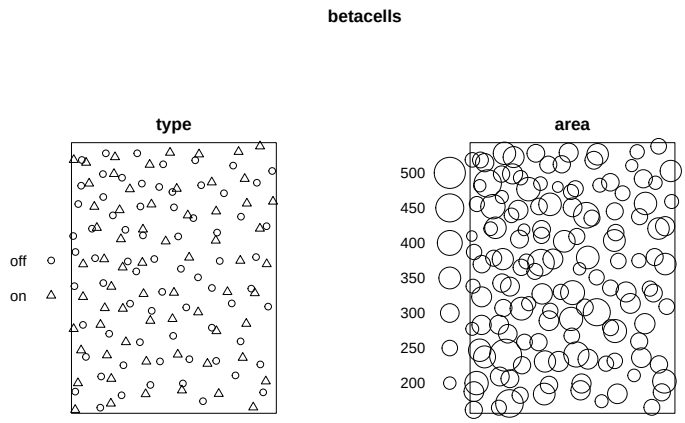
The following command gives a perspective display similar to the front cover of Baddeley, Rubak and Turner (2015):

```
> 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

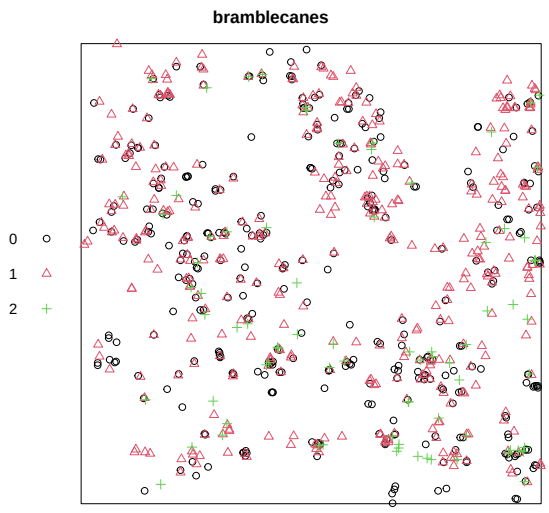
Locations of beta ganglion cells in cat retina, each cell classified as 'on' or 'off' and also labelled with the cell profile area.

```
> plot(betacells)
```



`bramblecanes`: Bramble canes

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



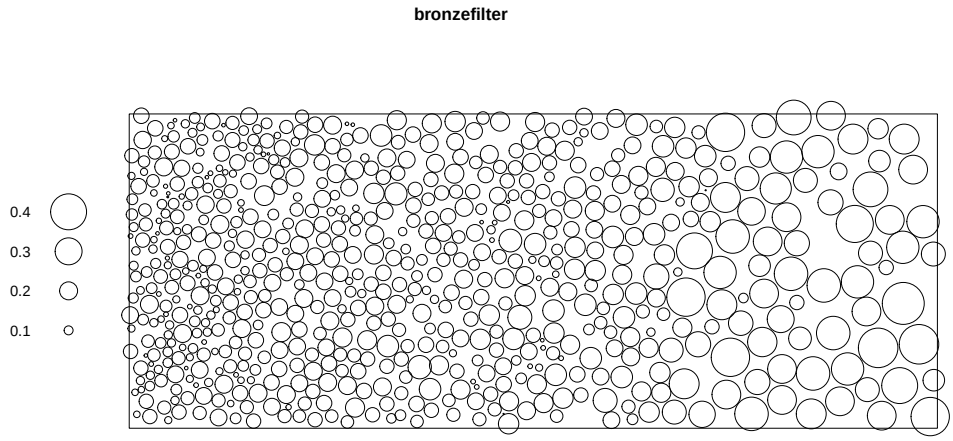
Try the following

```
> 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.

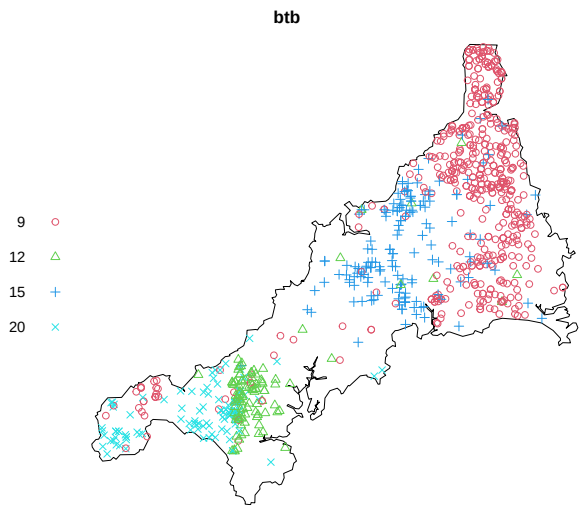
```
> plot(bronzefilter,markscale=2)
```



`btb`: bovine tuberculosis

Locations of farms where bovine tuberculosis was detected, marked by year of detection and spoligotype of tuberculosis.

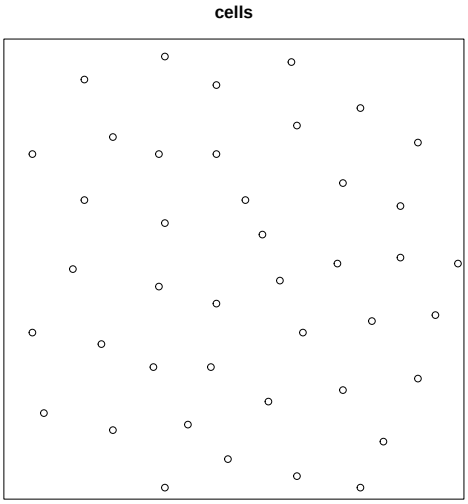
```
> plot(btb, which.marks="spoligotype", cols=2:5, chars=1:4)
```



`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.

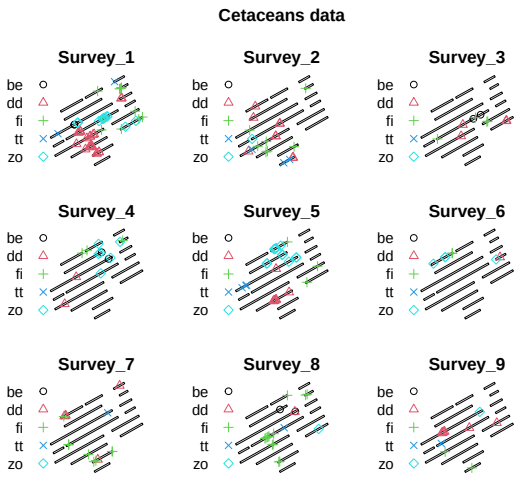
```
> plot(cells)
```



`cetaceans`: Survey of marine species

Recorded sightings of whales, dolphins and other marine species in a series of surveys. Replicated 2D marked point patterns.

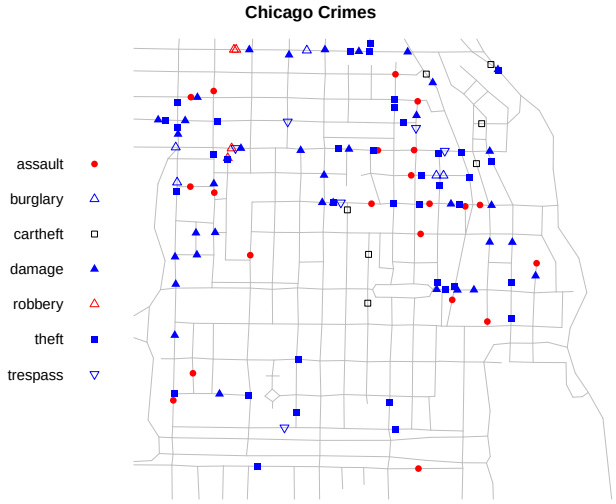
```
> plot(cetaceans.extra$patterns, main="Cetaceans data", cols=1:5, hsep=1)
```



`chicago`: Chicago crimes

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

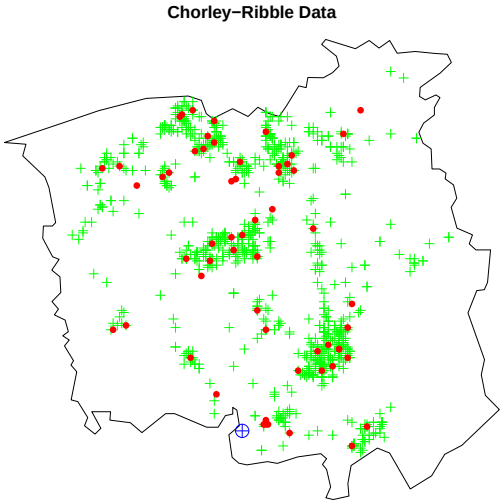
```
> plot(chicago, main="Chicago Crimes", col="grey",
+      cols=c("red", "blue", "black", "blue", "red", "blue", "blue"),
+      chars=c(16,2,22,17,24,15,6), leg.side="left", show.window=FALSE)
```



`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()
```

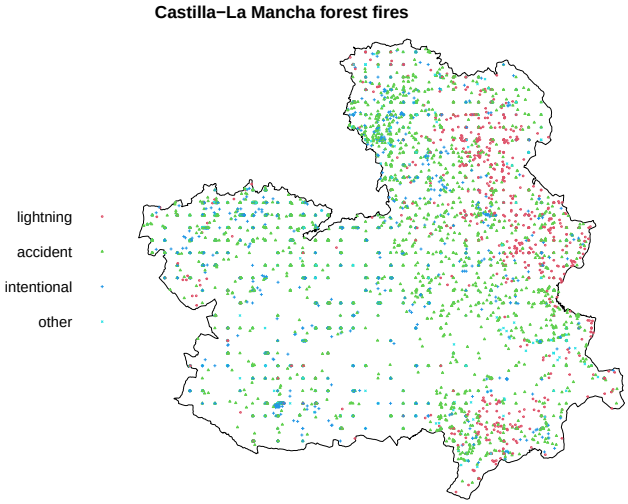


`clmfires`: Castilla-La Mancha Fires

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

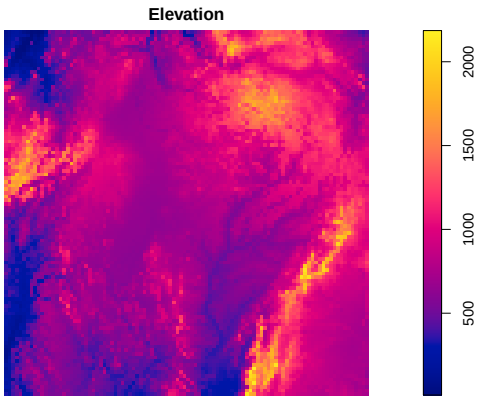
`cause`	cause of fire
`burnt.area`	total area burned, in hectares
`date`	date of fire
`julian.date`	date of fire in days since 1.1.1998

```
> 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`.

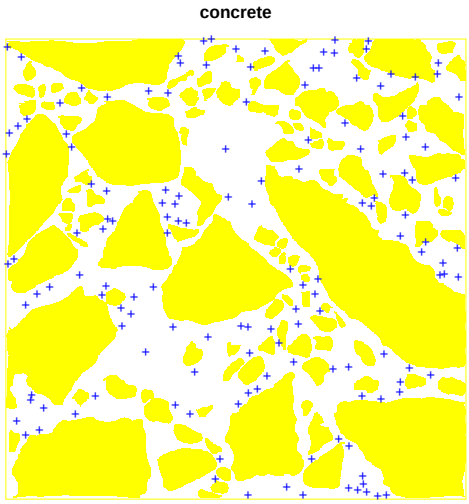
```
> plot(clmfires.extra$clmcov100$elevation, main="Elevation")
```



`concrete`: Air bubbles in concrete

Prof. Shin-ichi Igarashi's data: a point pattern of the locations of centroids of air bubbles seen in a cross-section of concrete. Air bubbles are present in the matrix of cement paste which surrounds the particles of aggregate. The outline of the aggregate, and the locations of the centroids of the bubble profiles, are recorded.

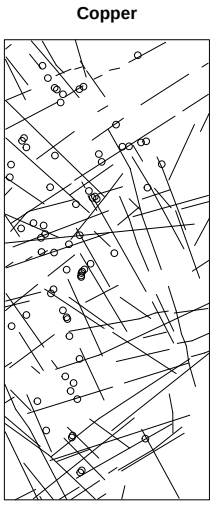
```
> plot(concrete,chars="+",cols="blue",col="yellow")
```



`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.

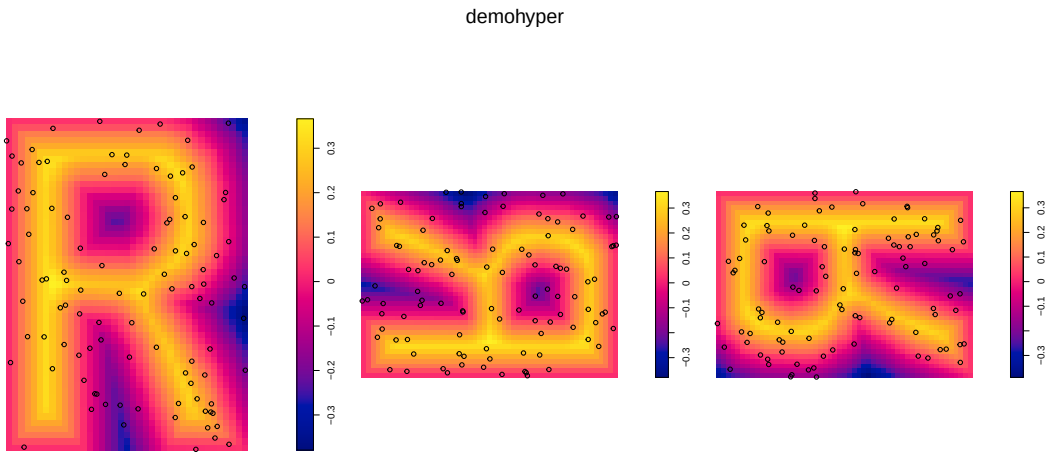
```
> plot(copper$Points, main="Copper")
> plot(copper$Lines, add=TRUE)
```



`demohyper`

A synthetic example of a `hyperframe` for demonstration purposes.

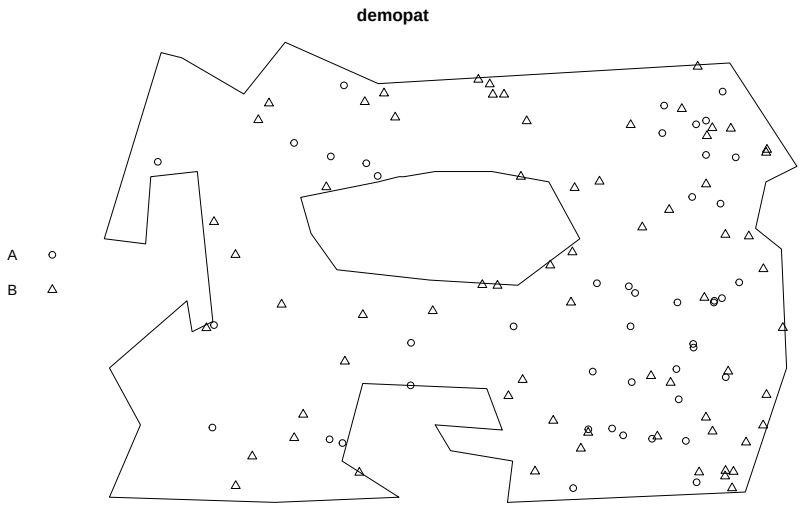
```
> plot(demohyper, quote({ plot(Image, main=""); plot(Points, add=TRUE) }),
+       parargs=list(mar=rep(1,4)))
```



`demopat`

A synthetic example of a point pattern for demonstration purposes.

```
> plot(demopat)
```

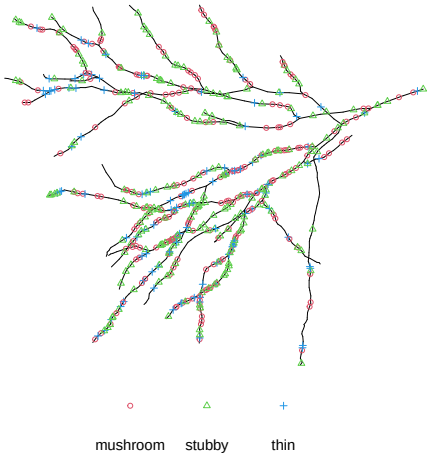


`dendrite`

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.

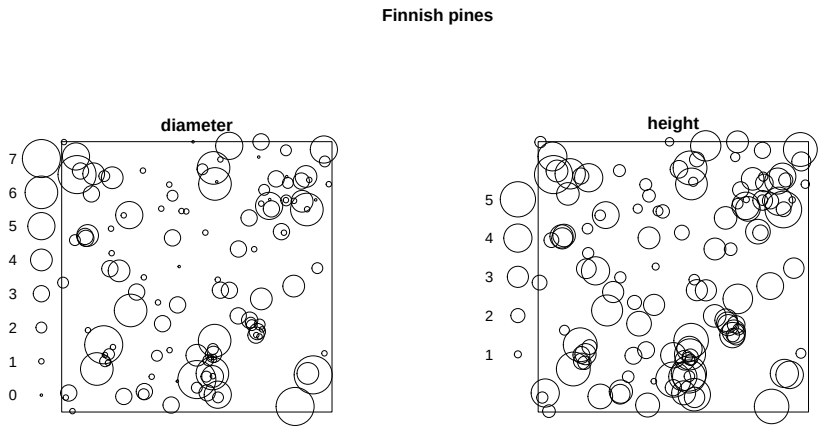
```
> plot(dendrite, leg.side="bottom", main="", cex=0.75, cols=2:4)
```



`finpines`: Finnish pine saplings

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

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

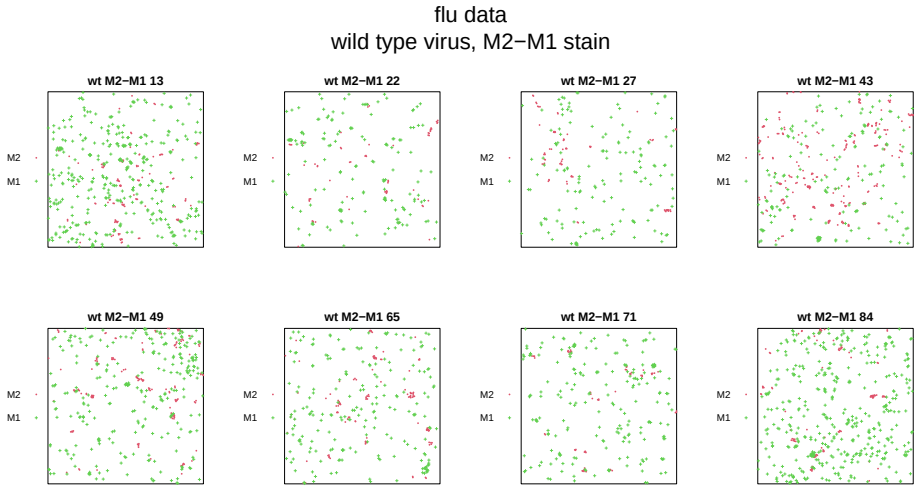


`flu`: Influenza virus proteins

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.

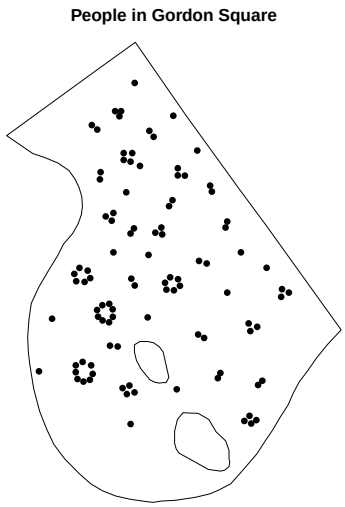
```
> wildM1 <- with(flu, virustype == "wt" & stain == "M2-M1")
> plot(flu[wildM1, 1, drop=TRUE],
+      main=c("flu data", "wild type virus, M2-M1 stain"),
+      chars=c(16,3), cex=0.4, cols=2:3)
```



`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)
```



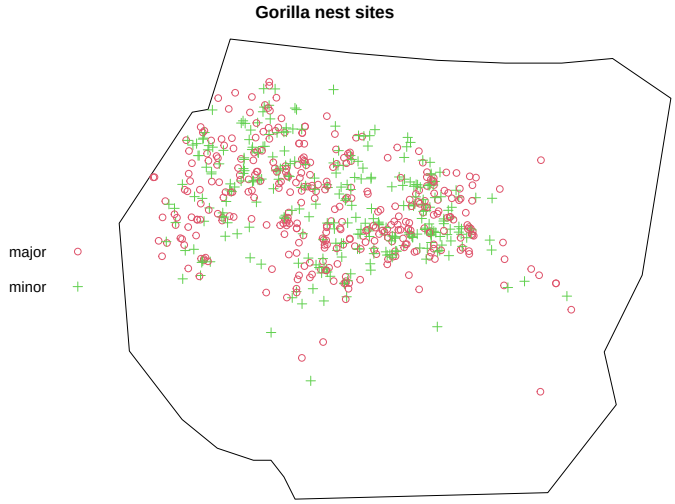
`gorillas`: Gorilla nesting sites

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")
```



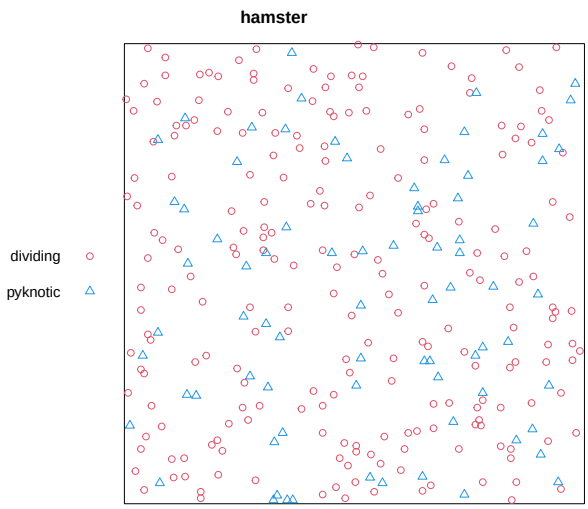
The `vegetation` covariate is also available as a raw ASCII format file,

```
> 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.

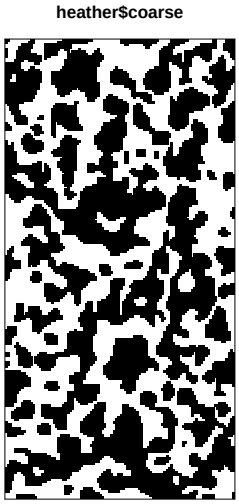
```
> plot(hamster, cols=c(2,4))
```



`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$coarse)
```



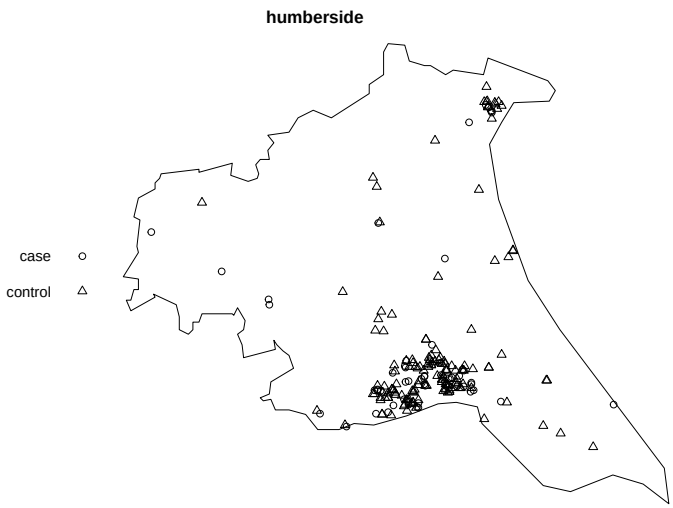
Type the following to see all three images:

```
> 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)
```

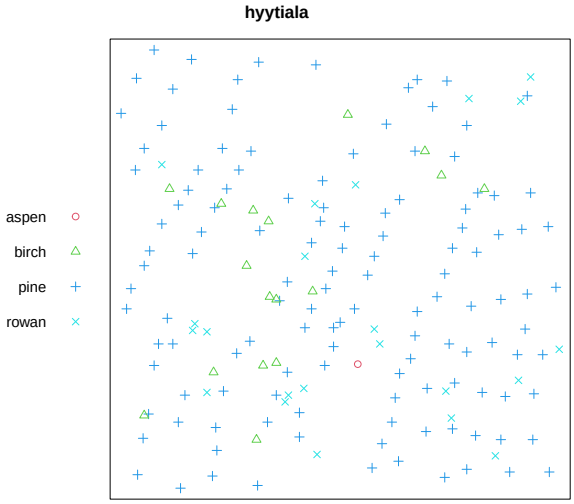


The dataset `humberside.convex` is an object of the same format, representing the same point pattern data, but contained in a larger, 5-sided convex polygon.

`hyytiala`: Mixed forest

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

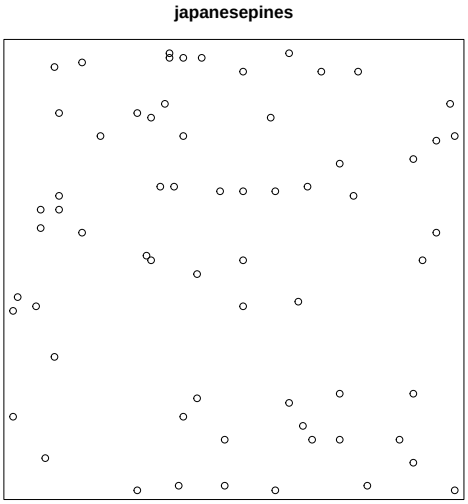
```
> plot(hyytiala, cols=2:5)
```



`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.

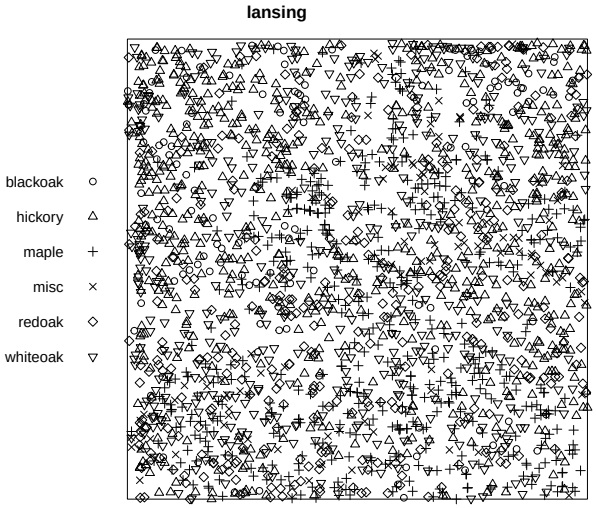
```
> plot(japanesepines)
```



`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)
```



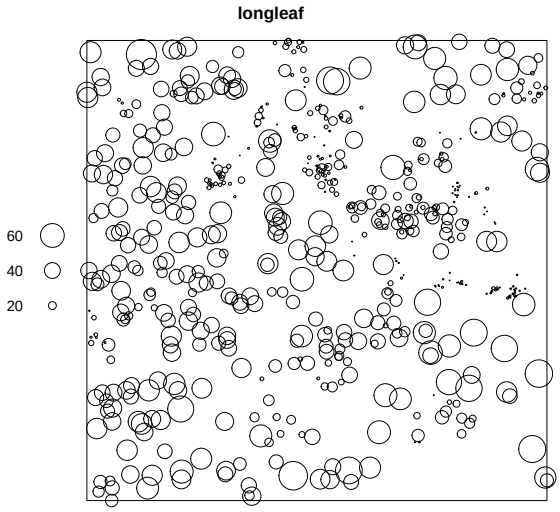
Type the following to see 6 plots, each showing the location of one of the types of points:

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

`longleaf`: Longleaf Pines

Locations and diameters of Longleaf pine trees.

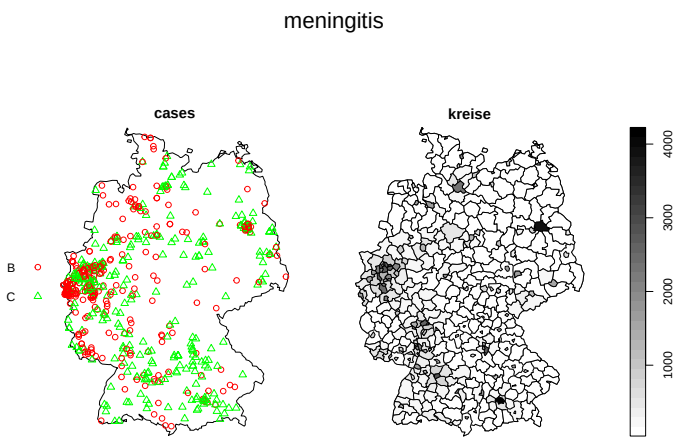
```
> plot(longleaf)
```



`meningitis`: Meningitis Cases

Spatial locations of cases of invasive meningitis in Germany, labelled by serotype. Auxiliary data gives average population density in each administrative district.

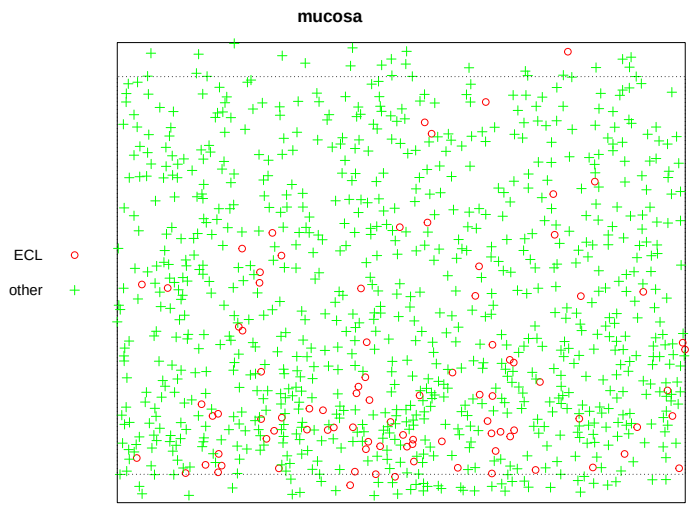
```
> pa <- function(i) {
+    if(i == 1) list(cols=c("red", "green")) else
+    list(do.col=TRUE, col=grey(seq(1,0,length=32)))
+ }
> plot(meningitis, panel.args=pa)
```



`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)
```



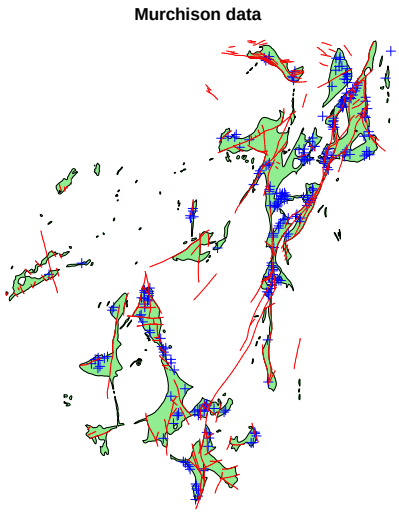
`murchison`: Murchison Gold Deposits

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.

Type the following to see the full Murchison dataset:

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

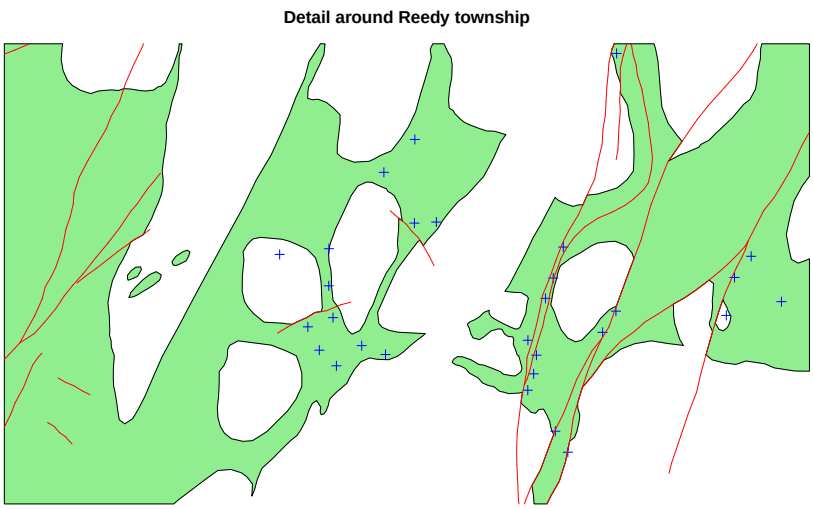


Some analysis of the data uses a rectangle close to the abandoned town of Reedy:

```
> reedy <- owin(c(580, 650) * 1000, c(6986, 7026) * 1000)
```

Here are the data in that area:

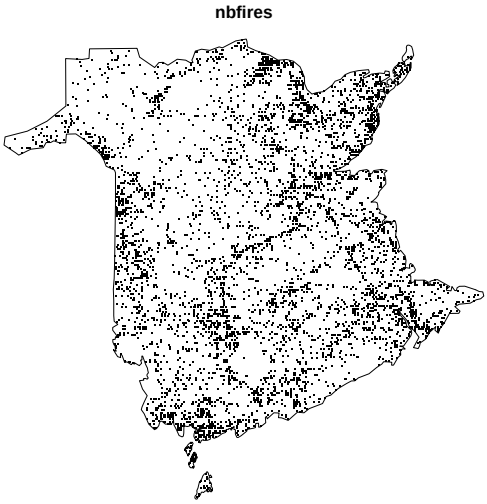
```
> plot(murchison$greenstone[reedy],
+      main="Detail around Reedy township",
+      col="lightgreen")
> plot(murchison$gold[reedy], add=TRUE, pch=3, col="blue")
> plot(murchison$faults[reedy], add=TRUE, col="red")
```



`nbfires`: New Brunswick Fires

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

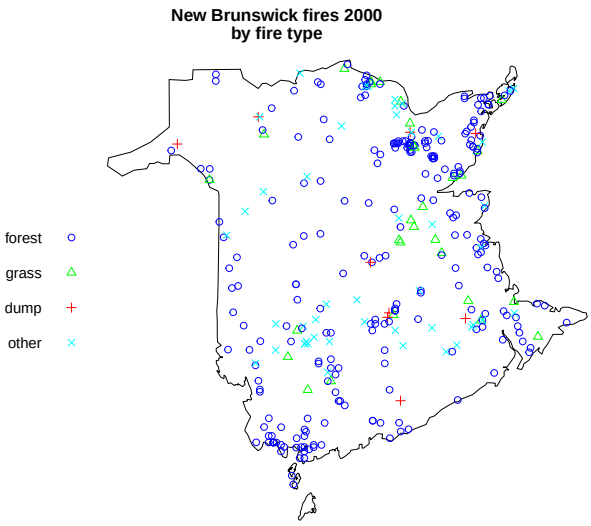
```
> plot(nbfires, use.marks=FALSE, pch=".")
```



The following command would show the data for each year in a separate panel:

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

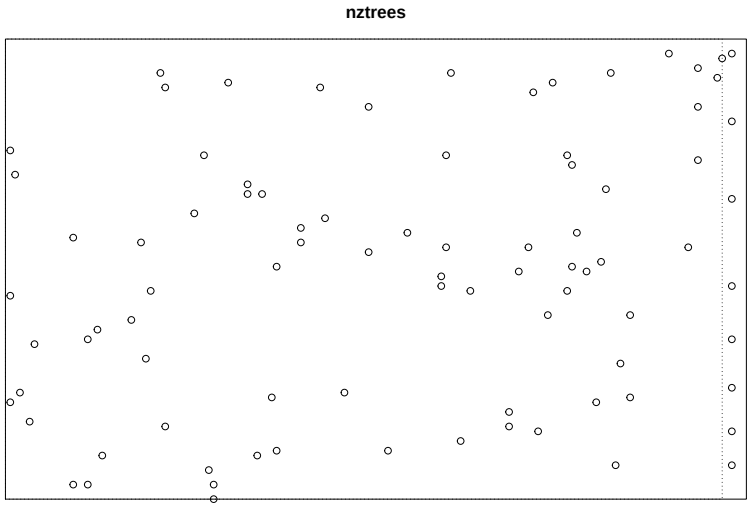
```
> par(mar=c(0,0,2,0))
> plot(split(nbfires)$"2000", which.marks="fire.type",
+      main=c("New Brunswick fires 2000", "by fire type"),
+      cols=c("blue", "green", "red", "cyan"),
+      leg.side="left")
```



`nztrees`: New Zealand Trees

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

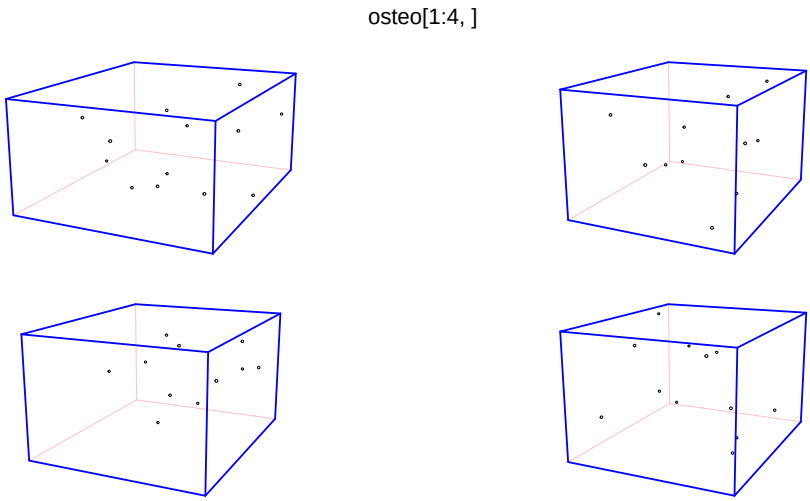
```
> plot(nztrees)
> plot(trim.rectangle(as.owin(nztrees), c(0,5), 0), add=TRUE, lty=3)
```



`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[1:4,], main.panel="", pch=21, bg='white')
```



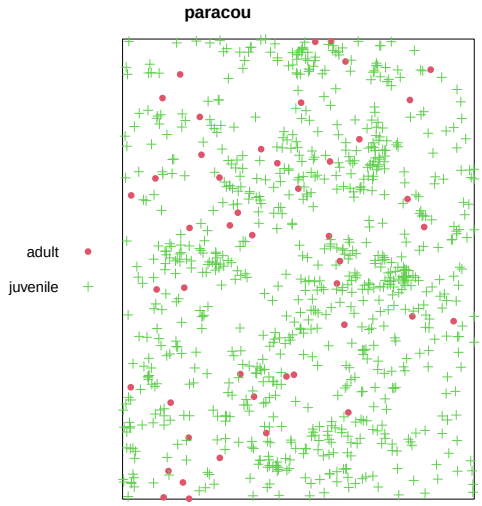
For demonstration and instruction purposes, the raw data from the 36th point pattern are available in a plain ascii file in the `spatstat` installation,

```
> 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.

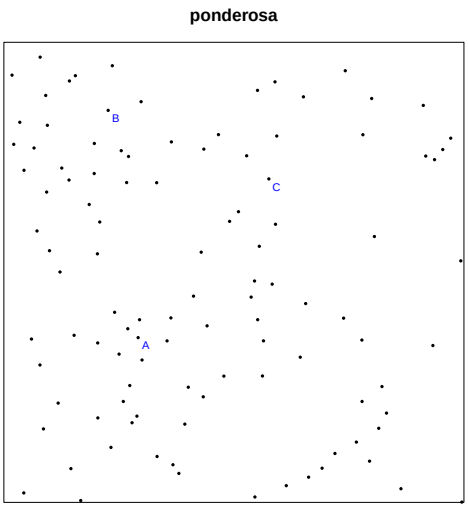
```
> plot(paracou, cols=2:3, chars=c(16,3))
```



`ponderosa`: Ponderosa Pines

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

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



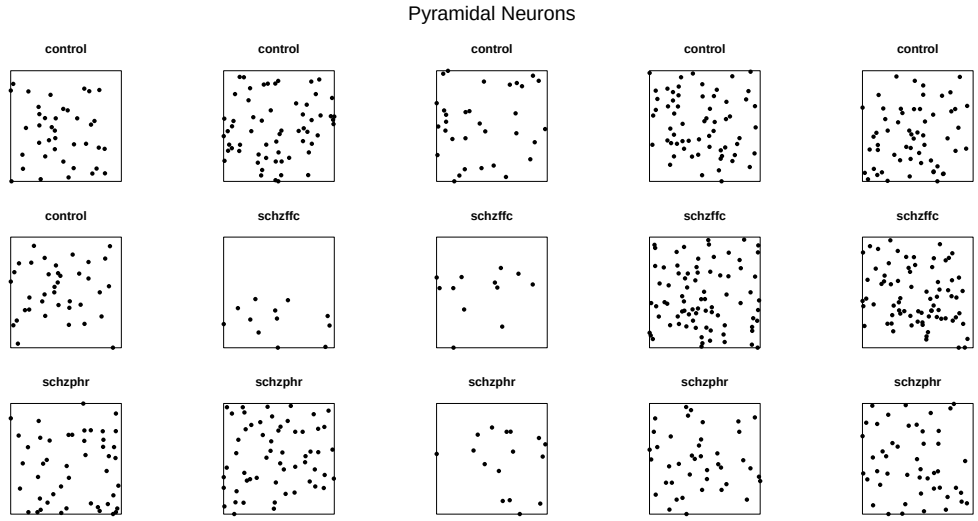
`pyramidal`: Pyramidal Neurons in Brain

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).

To reduce space, we show only the odd-numbered patterns:

```
> pyr <- pyramidal[c(FALSE,TRUE), ]

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



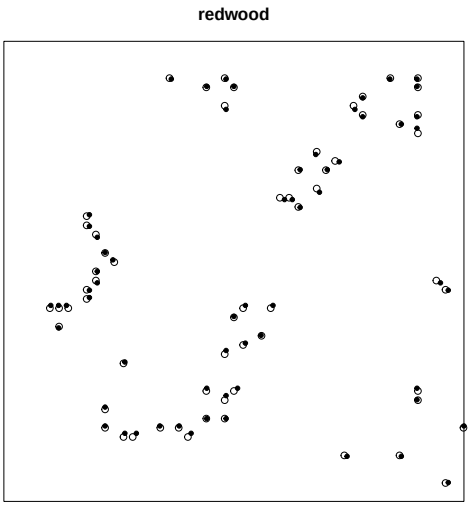
`redwood`, `redwood3`, `redwoodfull`: Redwood seedlings and saplings

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

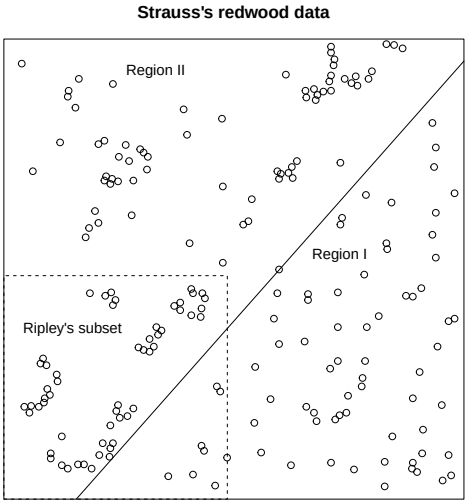
The `redwoodfull` dataset is the full data. It is spatially inhomogeneous in density and spacing of points.

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()
```



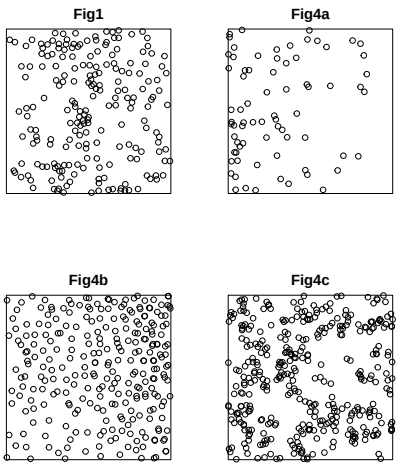
`residualspaper`: Data from residuals paper

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.

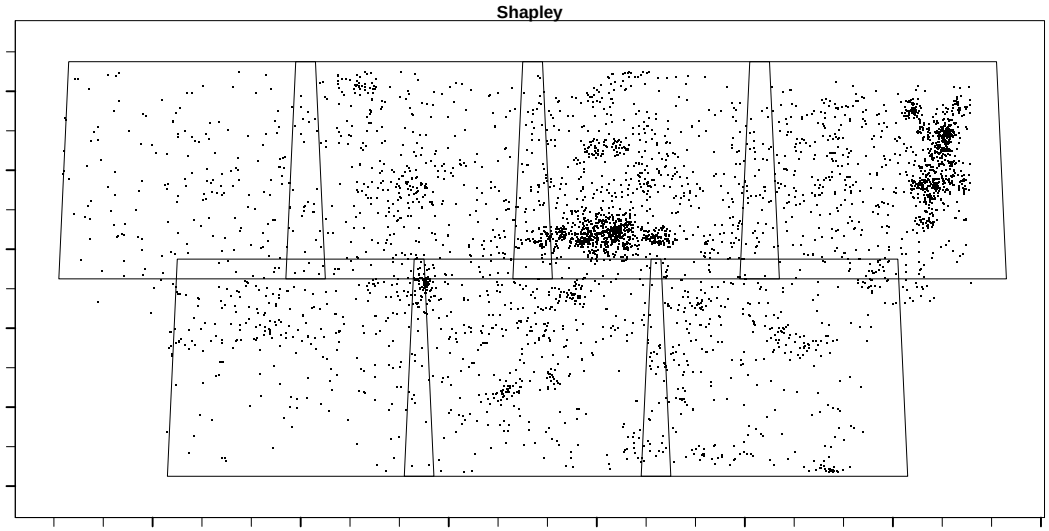
```
> plot(as.solist(residualspaper[c("Fig1", "Fig4a", "Fig4b", "Fig4c")]),
+      main="")
```



`shapley`: Shapley Galaxy Concentration

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

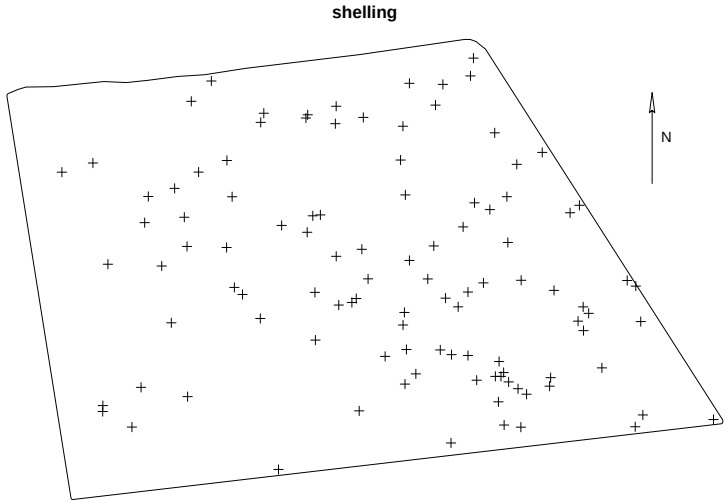
```
> shapley.extra$plotit(main="Shapley")
```



`shelling`: **Artillery shell impacts**

Spatial locations of artillery shell impacts in a field in Ukraine.

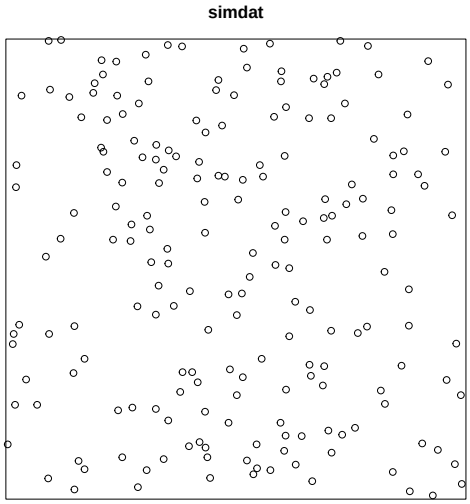
```
> plot(shelling, pch=3)
> plot(onearrow(830, 400, 830, 530, "N"), add=TRUE)
```



`simdat`: **Simulated data**

Another simulated dataset used for demonstration purposes.

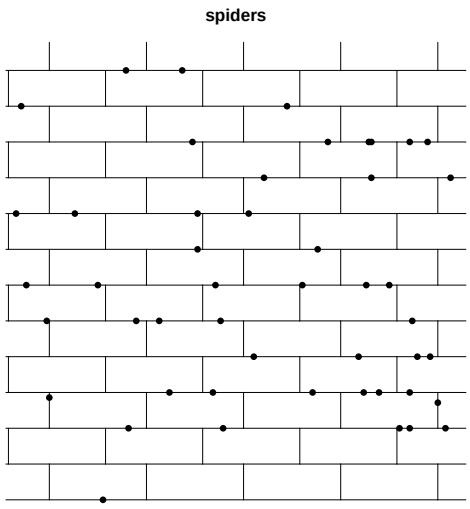
```
> plot(simdat)
```



`spiders`: Spider webs

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

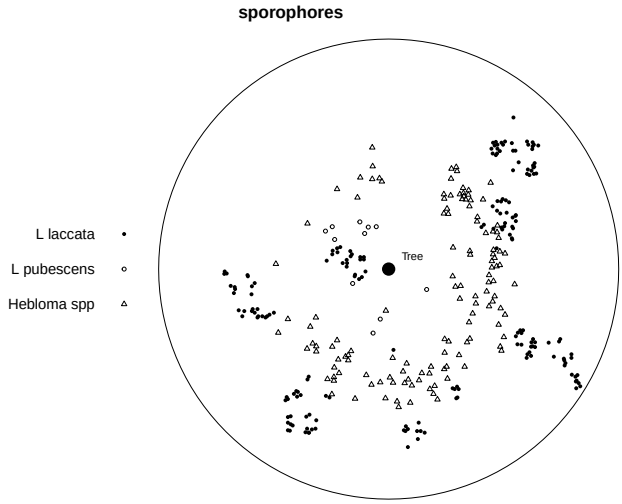
```
> plot(spiders, pch=16, show.window=FALSE)
```



`sporophores`: Sporophores

Sporophores of three species of fungi around a tree.

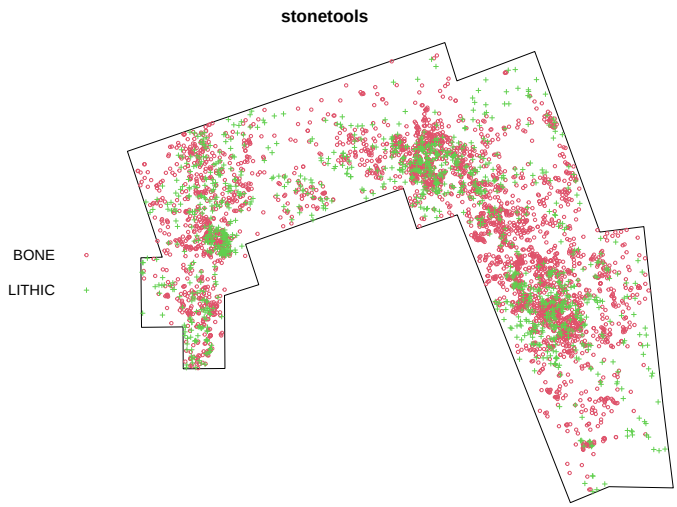
```
> plot(sporophores, chars=c(16,1,2), cex=0.6)
> points(0,0,pch=16, cex=2)
> text(15,8,"Tree", cex=0.75)
```



`stonetools`: Palaeolithic stone tools and bone fragments

Palaeolithic tools and bone fragments uncovered in an archaeological dig in Tanzania. Each find is marked by its type (either `BONE` or `LITHIC`) and by the height z (above a reference level) of the location in the soil where it was found.

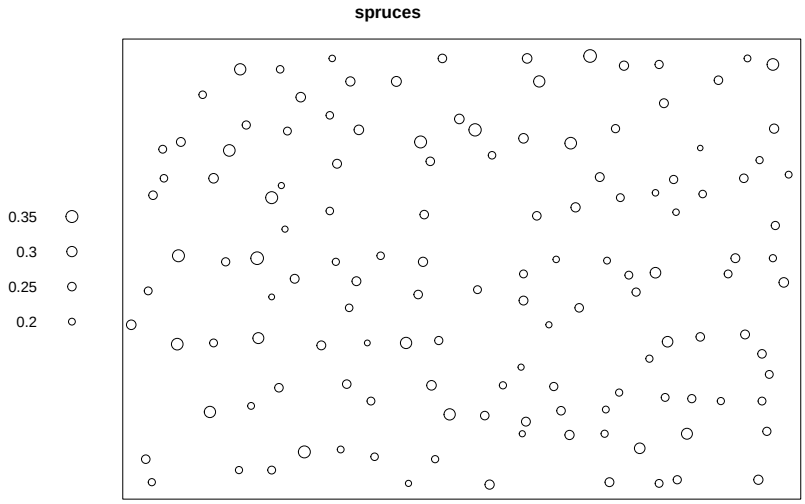
```
> plot(stonetools, which.marks=2, cols=c(2,3), chars=c(1,3), cex=0.5)
```



`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.

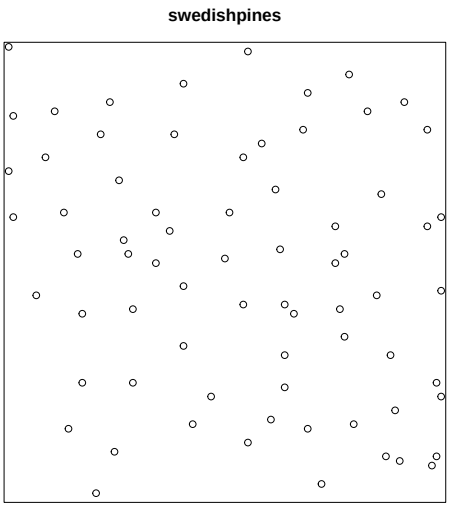
```
> plot(spruces, maxsize=min(nndist(spruces)))
```



`swedishpines`: Swedish Pines

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

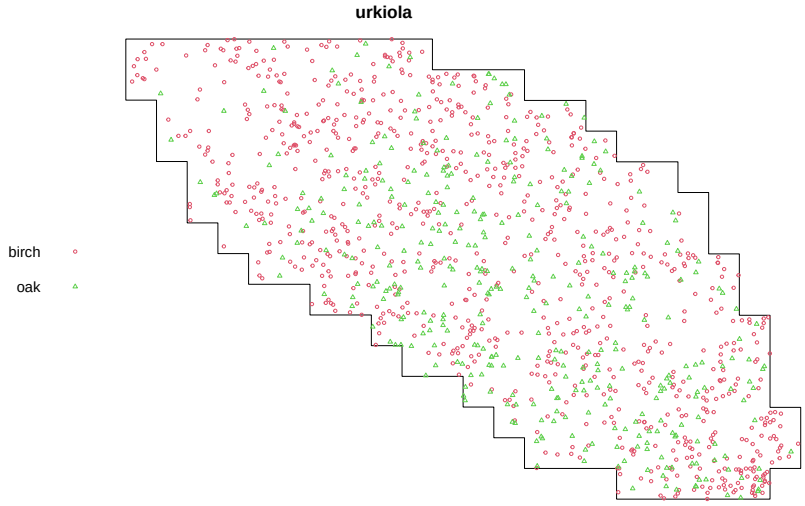
```
> plot(swedishpines)
```



`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.

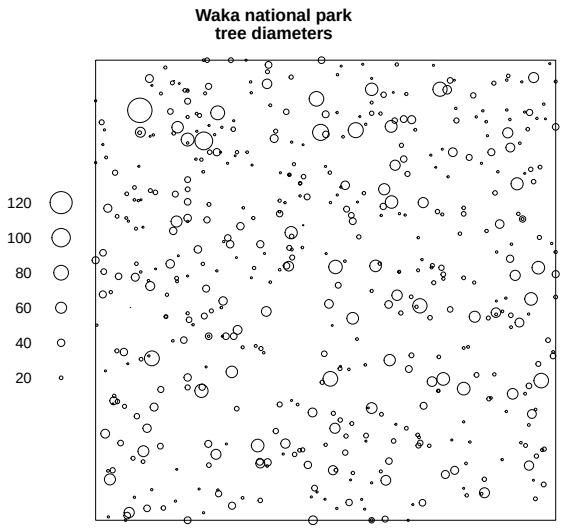
```
> plot(urkiola, cex=0.5, cols=2:3)
```



`waka`: trees in Waka National Park

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

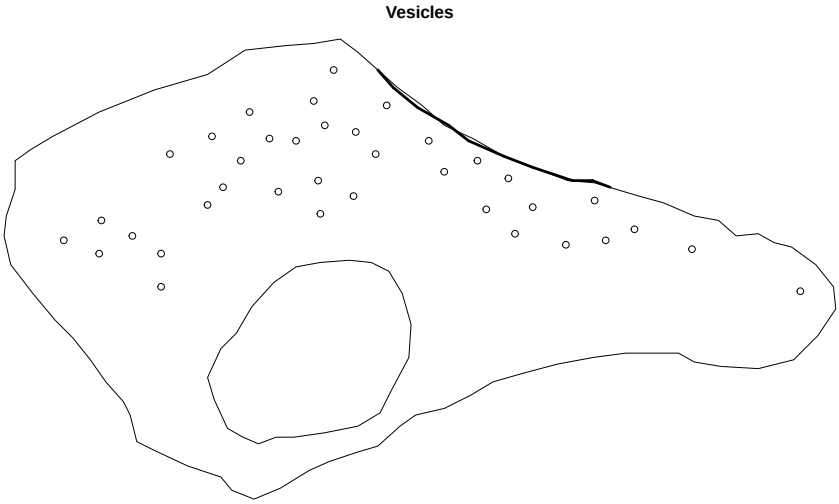
```
> par(mar=c(0,0,2,0))
> plot(waka, markscale=0.04, main=c("Waka national park", "tree diameters"))
```



`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

`presynapse`	outer polygonal boundary of presynapse
`mitochondria`	polygonal boundary of mitochondria
`mask`	binary mask representation of vesicles window
`activezone`	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:

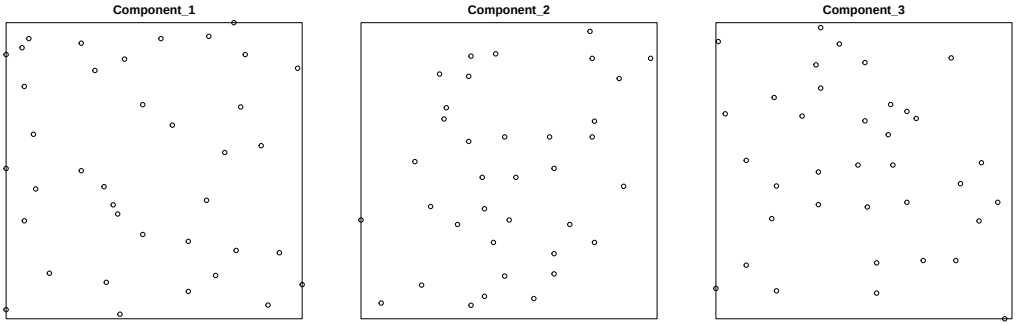
`vesicles.txt`	spatial locations of vesicles
`presynapse.txt`	vertices of `presynapse`
`mitochondria.txt`	vertices of `mitochondria`
`vesiclesimage.tif`	greyscale microscope image
`vesiclesmask.tif`	binary image of `mask`
`activezone.txt`	coordinates of `activezone`

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)
```

waterstriders