

# Package ‘sp’

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**Title** Classes and Methods for Spatial Data

**Depends** R (>= 3.0.0), methods

**Imports** utils, stats, graphics, grDevices, lattice, grid

**Suggests** RColorBrewer, rgdal (>= 1.2-3), rgeos (>= 0.3-13), gstat, maptools, deldir

**Description** Classes and methods for spatial data; the classes document where the spatial location information resides, for 2D or 3D data. Utility functions are provided, e.g. for plotting data as maps, spatial selection, as well as methods for retrieving coordinates, for subsetting, print, summary, etc.

**License** GPL (>= 2)

**URL** <https://github.com/edzer/sp/> <https://edzer.github.io/sp/>

**BugReports** <https://github.com/edzer/sp/issues>

**Collate** bpy.colors.R AAA.R Class-CRS.R CRS-methods.R Class-Spatial.R Spatial-methods.R projected.R Class-SpatialPoints.R SpatialPoints-methods.R Class-SpatialPointsDataFrame.R SpatialPointsDataFrame-methods.R Class-SpatialMultiPoints.R SpatialMultiPoints-methods.R Class-SpatialMultiPointsDataFrame.R SpatialMultiPointsDataFrame-methods.R Class-GridTopology.R Class-SpatialGrid.R Class-SpatialGridDataFrame.R Class-SpatialLines.R SpatialLines-methods.R Class-SpatialLinesDataFrame.R SpatialLinesDataFrame-methods.R Class-SpatialPolygons.R Class-SpatialPolygonsDataFrame.R SpatialPolygons-methods.R SpatialPolygonsDataFrame-methods.R GridTopology-methods.R SpatialGrid-methods.R SpatialGridDataFrame-methods.R SpatialPolygons-internals.R point.in.polygon.R SpatialPolygons-displayMethods.R zerodist.R image.R stack.R bubble.R mapasp.R select.spatial.R gridded.R asciigrid.R spplot.R over.R spsample.R recenter.R dms.R gridlines.R spdist.R rbind.R flipSGDF.R chfids.R loadmeuse.R compassRose.R surfaceArea.R spOptions.R subset.R disaggregate.R sp\_spat1.R merge.R aggregate.R

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---

addAttrToGeom-methods *constructs SpatialXxxDataFrame from geometry and attributes*

---

**Description**

constructs SpatialXxxDataFrame from geometry and attributes

**Usage**

```
addAttrToGeom(x, y, match.ID, ...)
```

**Arguments**

x	geometry (locations) of the queries
y	data.frame object with attributes
match.ID	logical; if TRUE, the IDs of the geometry and of the data.frame are matched (possibly swapping records), and an error occurs when some IDs do not match
...	(optional) arguments passed to the constructor functions

**Value**

an object of class XxxDataFrame, where Xxx is the class of x

**Methods**

```
x = "SpatialPoints", y = "data.frame"  
x = "SpatialPixels", y = "data.frame"  
x = "SpatialGrid", y = "data.frame"  
x = "SpatialLines", y = "data.frame"  
x = "SpatialPolygons", y = "data.frame"
```

**Author(s)**

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

**See Also**

[over](#)

---

aggregate	<i>aggregation of spatial objects</i>
-----------	---------------------------------------

---

## Description

spatial aggregation of thematic information in spatial objects

## Usage

```
## S3 method for class 'Spatial'
aggregate(x, by = list(ID = rep(1, length(x))),
FUN, ..., dissolve = TRUE, areaWeighted = FALSE)
```

## Arguments

x	object deriving from <a href="#">Spatial</a> , with attributes
by	aggregation predicate; if by is a <a href="#">Spatial</a> object, the geometry by which attributes in x are aggregated; if by is a list, aggregation by attribute(s), see <a href="#">aggregate.data.frame</a>
FUN	aggregation function, e.g. <a href="#">mean</a> ; see details
...	arguments passed on to function FUN, unless <code>minDimension</code> is specified, which is passed on to function <a href="#">over</a>
dissolve	logical; should, when aggregating based on attributes, the resulting geometries be dissolved? Note that if x has class <code>SpatialPointsDataFrame</code> , this returns an object of class <code>SpatialMultiPointsDataFrame</code>
areaWeighted	logical; should the aggregation of x be weighted by the areas it intersects with each feature of by? See value.

## Details

FUN should be a function that takes as first argument a vector, and that returns a single number. The canonical examples are [mean](#) and [sum](#). Counting features is obtained when summing an attribute variable that has the value 1 everywhere.

## Value

The aggregation of attribute values of x either over the geometry of by by using [over](#) for spatial matching, or by attribute values, using aggregation function FUN.

If `areaWeighted` is TRUE, FUN is ignored and the area weighted mean is computed for numerical variables, or if all attributes are factors, the area dominant factor level (area mode) is returned. This will compute the [gIntersection](#) of x and by; see examples below.

If by is missing, aggregates over all features.

## Note

uses [over](#) to find spatial match if by is a [Spatial](#) object

**Author(s)**

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

**Examples**

```

data("meuse")
coordinates(meuse) <- ~x+y
data("meuse.grid")
coordinates(meuse.grid) <- ~x+y
gridded(meuse.grid) <- TRUE
i = cut(meuse.grid$dist, c(0,.25,.5,.75,1), include.lowest = TRUE)
j = sample(1:2, 3103,replace=TRUE)
## Not run:
if (require(rgeos)) {
# aggregation by spatial object:
ab = gUnaryUnion(as(meuse.grid, "SpatialPolygons"), meuse.grid$part.a)
x = aggregate(meuse["zinc"], ab, mean)
spplot(x)
# aggregation of multiple variables
x = aggregate(meuse[c("zinc", "copper")], ab, mean)
spplot(x)
# aggregation by attribute, then dissolve to polygon:
x = aggregate(meuse.grid["dist"], list(i=i), mean)
spplot(x["i"])
x = aggregate(meuse.grid["dist"], list(i=i,j=j), mean)
spplot(x["dist"], col.regions=bpy.colors())
spplot(x["i"], col.regions=bpy.colors(4))
spplot(x["j"], col.regions=bpy.colors())
}

## End(Not run)

x = aggregate(meuse.grid["dist"], list(i=i,j=j), mean, dissolve = FALSE)
spplot(x["j"], col.regions=bpy.colors())

if (require(gstat) && require(rgeos)) {
x = idw(log(zinc)~1, meuse, meuse.grid, debug.level=0)[1]
spplot(x[1],col.regions=bpy.colors())
i = cut(x$var1.pred, seq(4, 7.5, by=.5),
include.lowest = TRUE)
xa = aggregate(x["var1.pred"], list(i=i), mean)
spplot(xa[1],col.regions=bpy.colors(8))
}

if (require(rgeos)) {
# Area-weighted example, using two partly overlapping grids:

gt1 = SpatialGrid(GridTopology(c(0,0), c(1,1), c(4,4)))
gt2 = SpatialGrid(GridTopology(c(-1.25,-1.25), c(1,1), c(4,4)))

# convert both to polygons; give p1 attributes to aggregate
p1 = SpatialPolygonsDataFrame(as(gt1, "SpatialPolygons"),

```

```

data.frame(v = 1:16, w=5:20, x=factor(1:16)), match.ID = FALSE)
p2 = as(gt2, "SpatialPolygons")

# plot the scene:
plot(p1, xlim = c(-2,4), ylim = c(-2,4))
plot(p2, add = TRUE, border = 'red')
i = gIntersection(p1, p2, byid = TRUE)
plot(i, add=TRUE, density = 5, col = 'blue')
# plot IDs p2:
ids.p2 = sapply(p2@polygons, function(x) slot(x, name = "ID"))
text(coordinates(p2), ids.p2)
# plot IDs i:
ids.i = sapply(i@polygons, function(x) slot(x, name = "ID"))
text(coordinates(i), ids.i, cex = .8, col = 'blue')

# compute & plot area-weighted average; will warn for the factor
ret = aggregate(p1, p2, areaWeighted = TRUE)
splot(ret)

# all-factor attributes: compute area-dominant factor level:
ret = aggregate(p1["x"], p2, areaWeighted = TRUE)
splot(ret)
}

```

---

as.SpatialPolygons.GridTopology

*Make SpatialPolygons object from GridTopology object*

---

## Description

Converts grids of regular rectangles into a SpatialPolygons object, which can be transformed to a different projection or datum with spTransform in package rgdal. The function is not suitable for high-resolution grids. The ordering of the grid cells is as in coordinates() of the same object, and is reported by IDvaluesGridTopology.

## Usage

```

as.SpatialPolygons.GridTopology(grd, proj4string = CRS(as.character(NA)))
IDvaluesGridTopology(obj)
as.SpatialPolygons.SpatialPixels(obj)
IDvaluesSpatialPixels(obj)
HexPoints2SpatialPolygons(hex, dx)

```

## Arguments

grd	GridTopology object
proj4string	object of class <a href="#">CRS-class</a>
obj	SpatialPixels object

hex	SpatialPoints object with points that are generated by hexagonal sampling; see <a href="#">spsample</a>
dx	spacing of two horizontally adjacent points; if missing, this will be computed from the points

**Value**

as.SpatialPolygons.GridTopology and as.SpatialPolygons.SpatialPixels return a SpatialPolygons object; IDvaluesGridTopology and IDvaluesSpatialPixels return a character vector with the object grid indices.

**See Also**

[GridTopology](#), [SpatialPixels](#), [SpatialPolygons](#) spTransform in package `rgdal`

**Examples**

```
library(lattice)
grd <- GridTopology(cellcentre.offset=c(-175,55), cellsize=c(10,10), cells.dim=c(4,4))
SpP_grd <- as.SpatialPolygons.GridTopology(grd)
plot(SpP_grd)
text(coordinates(SpP_grd), sapply(slot(SpP_grd, "polygons"), function(i) slot(i, "ID")), cex=0.5)
trdata <- data.frame(A=rep(c(1,2,3,4), 4), B=rep(c(1,2,3,4), each=4),
  row.names=sapply(slot(SpP_grd, "polygons"), function(i) slot(i, "ID")))
SpPDF <- SpatialPolygonsDataFrame(SpP_grd, trdata)
spplot(SpPDF)

data(meuse.grid)
gridded(meuse.grid)=~x+y
xx = spsample(meuse.grid, type="hexagonal", cellsize=200)
xxpl = HexPoints2SpatialPolygons(xx)
image(meuse.grid["dist"])
plot(xxpl, add = TRUE)
points(xx, cex = .5)
## Not run:
spplot(aggregate(as(meuse.grid[,1:3], "SpatialPolygonsDataFrame"), xxpl,
  areaWeighted=TRUE), main = "aggregated meuse.grid")

## End(Not run)
```

---

as.SpatialPolygons.PolygonsList

*Making SpatialPolygons objects*

---

**Description**

This function is used in making SpatialPolygons objects from other formats.



**Usage**

```
as.SpatialPolygons.PolygonsList(Sr1, proj4string=CRS(as.character(NA)))
```

**Arguments**

Sr1	A list of Polygons objects
proj4string	Object of class "CRS"; holding a valid proj4 string

**Value**

The functions return a SpatialPolygons object

**Author(s)**

Roger Bivand

**Examples**

```
grd <- GridTopology(c(1,1), c(1,1), c(10,10))
polys <- as.SpatialPolygons.GridTopology(grd)
plot(polys)
text(coordinates(polys), labels=sapply(slot(polys, "polygons"), function(i) slot(i, "ID")), cex=0.6)
```

---

bbox-methods

*retrieve bbox from spatial data*

---

### Description

retrieves spatial bounding box from spatial data

### Usage

```
bbox(obj)
```

### Arguments

**obj** object deriving from class "Spatial", or one of classes: "Line", "Lines", "Polygon" or "Polygons", or ANY, which requires obj to be an array with at least two columns

### Value

two-column matrix; the first column has the minimum, the second the maximum values; rows represent the spatial dimensions

### Methods

**obj = "Spatial"** object deriving from class "Spatial"

**obj = "ANY"** an array with at least two columns

**obj = "Line"** object deriving from class "Line"

**obj = "Lines"** object deriving from class "Lines"

**obj = "Polygon"** object deriving from class "Polygon"

**obj = "Polygons"** object deriving from class "Polygons"

**Examples**

```
# just 9 points on a grid:
x <- c(1,1,1,2,2,2,3,3,3)
y <- c(1,2,3,1,2,3,1,2,3)
xy <- cbind(x,y)
S <- SpatialPoints(xy)
bbox(S)

# data.frame
data(meuse.grid)
coordinates(meuse.grid) <- ~x+y
gridded(meuse.grid) <- TRUE
bbox(meuse.grid)
```

---

bpy.colors	<i>blue-pink-yellow color scheme, which also prints well on black/white printers</i>
------------	--

---

**Description**

Create a vector of ‘n’ “contiguous” colors.

**Usage**

```
bpy.colors(n = 100, cutoff.tails = 0.1, alpha = 1.0)
```

**Arguments**

n	number of colors ( $\geq 1$ ) to be in the palette
cutoff.tails	tail fraction to be cut off on each side. If 0, this palette runs from black to white; by cutting off the tails, it runs from blue to yellow, which looks nicer.
alpha	numeric; alpha transparency, 0 is fully transparent, 1 is opaque.

**Value**

A character vector, ‘cv’, of color names. This can be used either to create a user-defined color palette for subsequent graphics by ‘palette(cv)’, a ‘col=’ specification in graphics functions or in ‘par’.

**Note**

This color map prints well on black-and-white printers.

**Author(s)**

unknown; the palette was posted to gnuplot-info a few decades ago; R implementation Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

**See Also**

[rainbow](#), [cm.colors](#)

**Examples**

```
bpy.colors(10)
p <- expand.grid(x=1:30,y=1:30)
p$z <- p$x + p$y
coordinates(p) <- c("x", "y")
gridded(p) <- TRUE
image(p, col = bpy.colors(100), asp = 1)
# require(lattice)
# trellis.par.set("regions", list(col=bpy.colors())) # make this default palette
```

---

bubble

*Create a bubble plot of spatial data*

---

**Description**

Create a bubble plot of spatial data, with options for bicolour residual plots (xyplot wrapper)

**Usage**

```
bubble(obj, zcol = 1, ..., fill = TRUE, maxsize = 3, do.sqrt = TRUE, pch,
col = c("#d01c8b", "#4dac26"), key.entries = quantile(data[,zcol]), main,
identify = FALSE, labels = row.names(data.frame(obj)), key.space = "right",
scales = list(draw = FALSE), xlab = NULL, ylab = NULL, panel = panel.bubble,
sp.layout = NULL,
xlim = bbexpand(bbox(obj)[1,], 0.04),
ylim = bbexpand(bbox(obj)[2,], 0.04))
```

**Arguments**

obj	object of, or extending, class <code>SpatialPointsDataFrame</code> or <code>SpatialGridDataFrame</code> , see <a href="#">coordinates</a> or <a href="#">SpatialPointsDataFrame</a> ; the object knows about its spatial coordinates
zcol	z-variable column name, or column number after removing spatial coordinates from <code>x@data</code> : 1 refers to the first non-coordinate column
fill	logical; if TRUE, filled circles are plotted ( <code>pch = 16</code> ), else open circles ( <code>pch = 1</code> ); the <code>pch</code> argument overrides this
maxsize	cex value for largest circle
do.sqrt	logical; if TRUE the plotting symbol area ( $\text{sqrt}(\text{diameter})$ ) is proportional to the value of the z-variable; if FALSE, the symbol size (diameter) is proportional to the z-variable
pch	plotting character

<code>col</code>	colours to be used; numeric vector of size two: first value is for negative values, second for positive values. Default colors: 5-class PiYG from colorbrewer.org.
<code>key.entries</code>	the values that will be plotted in the key; by default the five quantiles min, q.25, median q.75, max
<code>main</code>	main plotting title
<code>identify</code>	logical; if true, regular plot is called instead of <code>xyplot</code> , and followed by a call to <code>identify()</code> .
<code>labels</code>	labels argument passed to plot if <code>identify</code> is TRUE
<code>...</code>	arguments, passed to <code>xyplot</code> , or plot if identification is required.
<code>key.space</code>	location of the key
<code>scales</code>	scales argument as passed to <a href="#">xyplot</a>
<code>xlab</code>	x-axis label
<code>ylab</code>	y-axis label
<code>panel</code>	panel function used
<code>sp.layout</code>	possible layout items; see <a href="#">spplot</a>
<code>xlim</code>	x axis limit
<code>ylim</code>	y axis limit

### Value

returns (or plots) the bubble plot; if `identify` is TRUE, returns the indexes (row numbers) of identified points.

### Author(s)

Edzer Pebesma

### See Also

[xyplot](#), [mapasp](#), [identify](#)

### Examples

```
data(meuse)
coordinates(meuse) <- c("x", "y") # promote to SpatialPointsDataFrame
bubble(meuse, "cadmium", maxsize = 2.5, main = "cadmium concentrations (ppm)",
       key.entries = 2^(-1:4))
bubble(meuse, "zinc", main = "zinc concentrations (ppm)",
       key.entries = 100 * 2^(0:4))
```

char2dms

*Convert character vector to DMS-class object***Description**

These two helper functions convert character vectors and decimal degree vectors to the DMS-class representation of degrees, minutes, and decimal seconds. "DMS" objects cannot contain NAs.

**Usage**

```
char2dms(from, chd = "d", chm = "'", chs = "\\")
dd2dms(dd, NS = FALSE)
```

**Arguments**

from	character vector of degree, minute, decimal second data
chd	degree character terminator
chm	minute character terminator
chs	second character terminator
dd	numeric vector of decimal degrees
NS	logical, TRUE for north/south decimal degrees, FALSE for east/west decimal degrees

**Details**

In char2dms, the input data vector should use a regular format, such as that used in the PROJ.4 library, with a trailing capital (NSWE) indicating compass direction.

**Value**

Both functions return a "DMS" object.

**Methods**

**from = "DMS", to = "numeric"** coerce a "DMS" object to a "numeric" vector

**from = "DMS", to = "character"** coerce a "DMS" object to a "character" vector (the as.character.DMS S3 method is also available)

**Author(s)**

Roger Bivand <Roger.Bivand@nhh.no>

**See Also**

[DMS-class](#)

**Examples**

```
data(state)
str(state.center$y)
stateN <- dd2dms(state.center$y, NS=TRUE)
str(attributes(stateN))
ch.stateN <- as.character(stateN)
str(ch.stateN)
stateNa <- char2dms(ch.stateN)
str(attributes(stateNa))
ch.stateN <- as(stateN, "character")
str(ch.stateN)
stateNa <- char2dms(ch.stateN)
str(attributes(stateNa))
```

---

compassRose

*Display a compass rose.*

---

**Description**

Displays a basic compass rose, usually to orient a map.

**Usage**

```
compassRose(x,y,rot=0,cex=1)
```

**Arguments**

x,y	The position of the center of the compass rose in user units.
rot	Rotation for the compass rose in degrees. See Details.
cex	The character expansion to use in the display.

**Details**

'compassRose' displays a conventional compass rose at the position requested. The size of the compass rose is determined by the character expansion, as the central "rose" is calculated relative to the character size. Rotation is in degrees counterclockwise.

**Value**

nil

**Author(s)**

Jim Lemon

---

coordinates	<i>set spatial coordinates to create a Spatial object, or retrieve spatial coordinates from a Spatial object</i>
-------------	--

---

### Description

set spatial coordinates to create a Spatial object, or retrieve spatial coordinates from a Spatial object

### Usage

```
coordinates(obj, ...)
coordinates(object) <- value
```

### Arguments

obj	object deriving from class "Spatial"
object	object of class "data.frame"
value	spatial coordinates; either a matrix, list, or data frame with numeric data, or column names, column number or a reference: a formula (in the form of e.g. $\sim x+y$ ), column numbers (e.g. $c(1, 2)$ ) or column names (e.g. $c("x", "y")$ ) specifying which columns in object are the spatial coordinates. If the coordinates are part of object, giving the reference does not duplicate them, giving their value does duplicate them in the resulting structure.
...	additional arguments that may be used by particular methods

### Value

usually an object of class SpatialPointsDataFrame; if the coordinates set cover the full set of variables in object, an object of class SpatialPoints is returned

### Examples

```
# data.frame
data(meuse.grid)
coordinates(meuse.grid) <- ~x+y
gridded(meuse.grid) <- TRUE
class(meuse.grid)
bbox(meuse.grid)

data(meuse)
meuse.xy = meuse[c("x", "y")]
coordinates(meuse.xy) <- ~x+y
class(meuse.xy)
```



---

coordinates-methods     *retrieve (or set) spatial coordinates*

---

### Description

retrieve (or set) spatial coordinates from (for) spatial data

### Methods

**obj = "list"** list with (at least) two numeric components of equal length

**obj = "data.frame"** data.frame with at least two numeric components

**obj = "matrix"** numeric matrix with at least two columns

**obj = "SpatialPoints"** object of, or deriving from, SpatialPoints

**obj = "SpatialPointsDataFrame"** object of, or deriving from, SpatialPointsDataFrame

**obj = "SpatialPolygons"** object of, or deriving from, SpatialPolygons

**obj = "SpatialPolygonsDataFrame"** object of, or deriving from, SpatialPolygonsDataFrame

**obj = "Line"** object of class Line; returned value is matrix

**obj = "Lines"** object of class Lines; returned value is list of matrices

**obj = "SpatialLines"** object of, or deriving from, SpatialLines; returned value is list of lists of matrices

**obj = "GridTopology"** object of, or deriving from, GridTopology

**obj = "GridTopology"** object of, or deriving from, GridTopology

**obj = "SpatialPixels"** object of, or deriving from, SpatialPixels

**obj = "SpatialPixelsDataFrame"** object of, or deriving from, SpatialPixelsDataFrame

**obj = "SpatialGrid"** object of, or deriving from, SpatialGrid

**obj = "SpatialGridDataFrame"** object of, or deriving from, SpatialGridDataFrame

### Methods for "coordinates<-"

**object = "data.frame", value="ANY"** promote data.frame to object of class [SpatialPointsDataFrame-class](#), by specifying coordinates; see [coordinates](#)

---

coordnames-methods      *retrieve or assign coordinate names for classes in sp*

---

### Description

retrieve or assign coordinate names for classes in **sp**

### Methods for coordnames

**x = "SpatialPoints"** retrieves coordinate names

**x = "SpatialLines"** retrieves coordinate names

**x = "Lines"** retrieves coordinate names

**x = "Line"** retrieves coordinate names

**x = "SpatialPolygons"** retrieves coordinate names

**x = "Polygons"** retrieves coordinate names

**x = "Polygon"** retrieves coordinate names

### Methods for "coordnames<-"

**x = "SpatialPoints", value = "character"** replace coordinate names

**x = "SpatialLines", value = "character"** replace coordinate names

**x = "Lines", value = "character"** replace coordinate names

**x = "Line", value = "character"** replace coordinate names

**x = "SpatialPolygons", value = "character"** replace coordinate names

**x = "GridTopology", value = "character"** replace coordinate names

**x = "SpatialGrid", value = "character"** replace coordinate names

**x = "SpatialPixels", value = "character"** replace coordinate names

---

CRS-class

*Class "CRS" of coordinate reference system arguments*

---

### Description

Interface class to the PROJ projection and transformation system. The class is defined as an empty stub accepting value NA in the sp package. The initiation function may call the PROJ library through **rgdal** to verify the argument set against those known in the library, returning error messages where necessary. If the "CRS" object is instantiated using CRS() with **rgdal** using PROJ >= 6 and GDAL >= 3, the object may also have a WKT2 (2019) string carried as a comment. The arguments for a Proj.4 string must be entered exactly as in the Proj.4 documentation, in particular there cannot be any white space in +<key>=<value> strings, and successive such strings can only be separated by blanks. Note that only "+proj=longlat +ellps=WGS84" is accepted for geographical coordinates, which must be ordered (eastings, northings); the "+ellps=" definition must be given (or expanded internally from a given "+datum=" value) for recent versions of the Proj.4 library, and should be set to an appropriate value.

**Usage**

```
CRS(projargs, doCheckCRSArgs=TRUE, SRS_string=NULL, get_source_if_boundcrs=TRUE)
identicalCRS(x,y)
```

**Arguments**

projargs	A character string of projection arguments; the arguments must be entered exactly as in the PROJ.4 documentation; if the projection is unknown, use as <code>.character(NA)</code> , it may be missing or an empty string of zero length and will then set to the missing value. With <b>rgdal</b> built with PROJ $\geq 6$ and GDAL $\geq 3$ , the <code>+init=</code> key may only be used with value <code>epsg:&lt;code&gt;</code> . From <b>sp</b> version 1.4-4, the string associated with the <code>SRS_string</code> argument may be entered as-is and will be set as <code>SRS_string</code> if the <code>projargs</code> argument does not begin with a <code>+</code> (suggested by Mikko Vihtakari).
doCheckCRSArgs	default TRUE, must be set to FALSE by package developers including CRS in an S4 class definition to avoid uncontrollable loading of the <b>rgdal</b> namespace
SRS_string	default NULL, only used when <b>rgdal</b> is built with PROJ $\geq 6$ and GDAL $\geq 3$ ; a valid WKT string or SRS definition such as "EPSG:4326" or "ESRI:102761"
get_source_if_boundcrs	(from <b>rgdal</b> 1.5-17, default TRUE) The presence of the <code>+towgs84=</code> key in a Proj4 string <code>projargs=</code> argument value may promote the output WKT2 CRS to BOUNDCRS for PROJ $\geq 6$ and GDAL $\geq 3$ , which is a coordinate operation from the input datum to WGS84. This is often unfortunate, so a PROJ function is called through <b>rgdal</b> to retrieve the underlying source definition.
x	object having a <code>proj4string</code> method, or if y is missing, list with objects that have a <code>proj4string</code> method
y	object of class <code>Spatial</code> , or having a <code>proj4string</code> method

**Value**

CRS returns on success an object of class `CRS`. `identicalCRS` returns a logical, indicating whether x and y have identical CRS, or if y is missing whether all objects in list x have identical CRS.

**Objects from the Class**

Objects can be created by calls of the form `CRS("projargs")`, where "projargs" is a valid string of PROJ.4 arguments. If the argument is a zero-length string or a character NA, the object records NA. If the "CRS" object is instantiated using `CRS()` with **rgdal** using PROJ  $\geq 6$  and GDAL  $\geq 3$ , the object may also have a WKT2 (2019) string carried as a comment. The initiation function may call the PROJ library through **rgdal** to verify the argument set against those known in the library, returning error messages where necessary. The function `CRSArgs()` can be used to show the expanded Proj.4 string used by the PROJ library.

**Slots**

`projargs`: Object of class "character": projection arguments; the arguments must be entered exactly as in the PROJ.4 documentation, in particular there cannot be any white space in `+<arg>=<value>` strings, and successive such strings can only be separated by blanks.

## Methods

**show** signature(object = "CRS"): print projection arguments in object

**wkt** signature(object = "CRS"): return WKT comment on object

**rebuild\_CRS** rebuild a CRS object, usually used to add a WKT comment with PROJ  $\geq$  6 and GDAL  $\geq$  3

## Note

Lists of projections may be seen by using the programs installed with the PROJ.4 library, in particular `proj` and `cs2cs`; with the latter, `-lp` lists projections, `-le` ellipsoids, `-lu` units, and `-ld` datum(s) known to the installed software (available in **rgdal** using `projInfo`). These are added to in successive releases, so tracking the website or compiling and installing the most recent revisions will give the greatest choice. Finding the very important datum transformation parameters to be given with the `+towgs84` tag is a further challenge, and is essential when the datums used in data to be used together differ. Tracing projection arguments is easier now than before the mass ownership of GPS receivers raised the issue of matching coordinates from different argument sets (GPS output and paper map, for example). See [GridsDatums](#), [make\\_EPSG](#) and [showEPSG](#) for help in finding CRS definitions.

The 4.9.1 release of the PROJ library omitted a small file of defaults, leading to reports of “major axis or radius = 0 or not given” errors. From 0.9-3, **rgdal** checks for the presence of this file (`proj_def.dat`), and if not found, and under similar conditions to those used by PROJ.4, adds “`+ellps=WGS84`” to the input string being checked by `checkCRSArgs`. The “`+no_defs`” tag ignores the file of defaults, and the default work-around implemented to get around this problem; strings including “`init`” and “`datum`” tags also trigger the avoidance of the work-around. Now messages are issued when a candidate CRS is checked; they may be suppressed using `suppressMessages`.

From release 6 of the PROJ library, when used in building **rgdal** with GDAL  $\geq$  3, the `+datum=` key in the Proj.4 string CRS representation is deprecated, and the `+towgs84=` and `+nadgrids=` keys may be deprecated soon. For this reason, **sp**, **rgdal** and **sf** are starting to use WKT2 (2019) string representations. In **sp**, the “CRS” object in itself remains unchanged, but the content of its “`projargs`” slot may be degraded. To work around the degradation, a comment is added around the “CRS” object containing a WKT2 (2019) string when **rgdal** is available and built with PROJ  $\geq$  6 and GDAL  $\geq$  3.

## Author(s)

Roger Bivand <Roger.Bivand@nhh.no>

## References

<https://github.com/OSGeo/PROJ>

## Examples

```
CRS()
CRS("")
CRS(as.character(NA))
CRS("+proj=longlat +datum=WGS84")
run <- FALSE
```

```

run <- require(rgdal)
if (run) {
  print(CRSargs(CRS("+proj=longlat +datum=NAD27")))
}
if (run) {
  print(CRSargs(CRS("+init=epsg:4267")))
}
if (run) {
  print(CRSargs(CRS("+init=epsg:26978")))
}
if (run) {
  print(CRSargs(CRS(paste("+proj=sterea +lat_0=52.15616055555555",
    "+lon_0=5.387638888888889 +k=0.999908 +x_0=155000 +y_0=463000 +ellps=bessel",
    " +towgs84=565.237,50.0087,465.658,-0.406857,0.350733,-1.87035,4.0812 +units=m"))))
}
if (run) {
  print(CRSargs(CRS("+init=epsg:28992")))
}
if (run) {
  o <- try(CRS(SRS_string="ESRI:102760"))
  if (!inherits(o, "try-error")) print(CRSargs(o))
}
if (run) {
  o <- try(CRS("EPSG:4326"))
  if (!inherits(o, "try-error")) print(CRSargs(o))
}
if (run) {
  o <- try(CRS("ESRI:102760"))
  if (!inherits(o, "try-error")) print(CRSargs(o))
}
if (run) {
  o <- new("Spatial")
  proj4string(o) <- CRS("+init=epsg:27700")
}
if (run && !is.null(comment(slot(o, "proj4string")))) {
  cat(wkt(o), sep="\n")
  cat(wkt(slot(o, "proj4string")), sep="\n")
}

```

---

degAxis

*axis with degrees*


---

### Description

draw axes on a plot using degree symbols in numbers

### Usage

```
degAxis(side, at, labels, ...)
```

**Arguments**

side	integer; see <a href="#">axis</a>
at	numeric; if missing, <a href="#">axTicks</a> is called for nice values; see <a href="#">axis</a>
labels	character; if omitted labels are constructed with degree symbols, ending in N/S/E/W; in case of negative degrees, sign is reversed and S or W is added; see <a href="#">axis</a>
...	passed to the actual <a href="#">axis</a> call

**Value**

axis is plotted on current graph

**Note**

decimal degrees are used if variation is small, instead of minutes and seconds

**Examples**

```
xy = cbind(x = 2 * runif(100) - 1, y = 2 * runif(100) - 1)
plot(SpatialPoints(xy, proj4string = CRS("+proj=longlat +ellps=WGS84")), xlim=c(-1,1), ylim=c(-1,1))
degAxis(1)
degAxis(2, at = c(-1,-0.5,0,0.5,1))
#
```

---

dimensions-methods      *retrieve spatial dimensions from spatial data*

---

**Description**

retrieves spatial dimensions box from spatial data

**Usage**

```
dimensions(obj)
```

**Arguments**

obj                    object deriving from class "Spatial"

**Value**

two-column matrix; the first column has the minimum, the second the maximum values; rows represent the spatial dimensions

**Methods**

**obj = "Spatial"** object deriving from class "Spatial"

## Examples

```
# just 9 points on a grid:
x <- c(1,1,1,2,2,2,3,3,3)
y <- c(1,2,3,1,2,3,1,2,3)
xy <- cbind(x,y)
S <- SpatialPoints(xy)
dimensions(S)

# data.frame
data(meuse.grid)
coordinates(meuse.grid) <- ~x+y
gridded(meuse.grid) <- TRUE
dimensions(meuse.grid)
```

---

disaggregate-methods    *disaggregate SpatialLines, SpatialLinesDataFrame, SpatialPolygons, or SpatialPolygonsDataFrame objects*

---

## Description

disaggregate `SpatialLines`, `SpatialLinesDataFrame`, `SpatialPolygons`, or `SpatialPolygonsDataFrame` objects, using functions from `rgeos` to handle polygon hole nesting

## Usage

```
disaggregate(x, ...)
```

## Arguments

x	object of class <code>SpatialLines</code> or <code>SpatialPolygons</code>
...	ignored

## Value

object of class `SpatialLines` or `SpatialPolygons`, where groups of `Line` or `Polygon` are disaggregated to one `Line` per `Lines`, or one `Polygon` per `Polygons`, respectively.

## Author(s)

Robert Hijmans, Edzer Pebesma

**Examples**

```

Sr1 = Polygon(cbind(c(2,4,4,1,2),c(2,3,5,4,2)), hole = FALSE)
Sr2 = Polygon(cbind(c(5,4,2,5),c(2,3,2,2)), hole = FALSE)
Sr3 = Polygon(cbind(c(4,4,5,10,4),c(5,3,2,5,5)), hole = FALSE)
Sr4 = Polygon(cbind(c(5,6,6,5,5),c(4,4,3,3,4)), hole = TRUE)

Srs1 = Polygons(list(Sr1, Sr2), "s1/2")
Srs3 = Polygons(list(Sr3, Sr4), "s3/4")
sp = SpatialPolygons(list(Srs1,Srs3), 1:2)
length(sp) ## [1] 2
length(disaggregate(sp)) ## [1] 3

l1 = cbind(c(1,2,3),c(3,2,2))
l1a = cbind(l1[,1]+.05,l1[,2]+.05)
l2 = cbind(c(1,2,3),c(1,1.5,1))
S11 = Line(l1)
S11a = Line(l1a)
S12 = Line(l2)
S1 = Lines(list(S11, S11a), ID="a")
S2 = Lines(list(S12), ID="b")
s1 = SpatialLines(list(S1,S2))
length(s1)
length(disaggregate(s1))

```

---

DMS-class

*Class "DMS" for degree, minute, decimal second values*


---

**Description**

The class provides a container for coordinates stored as degree, minute, decimal second values.

**Objects from the Class**

Objects can be created by calls of the form `new("DMS", ...)`, converted from decimal degrees using `dd2dms()`, or converted from character strings using `char2dms()`.

**Slots**

**WS:** Object of class "logical" TRUE if input value negative  
**deg:** Object of class "numeric" degrees  
**min:** Object of class "numeric" minutes  
**sec:** Object of class "numeric" decimal seconds  
**NS:** Object of class "logical" TRUE if input value is a Northing

**Methods**

**coerce** signature(from = "DMS", to = "numeric"): convert to decimal degrees  
**show** signature(object = "DMS"): print data values



**Author(s)**

Roger Bivand <Roger.Bivand@nhh.no>

**See Also**

[char2dms](#), [dd2dms](#)

**Examples**

```
data(state)
dd2dms(state.center$x)
dd2dms(state.center$y, NS=TRUE)
as.numeric(dd2dms(state.center$y))
as(dd2dms(state.center$y, NS=TRUE), "numeric")
as.numeric.DMS(dd2dms(state.center$y))
state.center$y
```

---

flip

*rearrange data in SpatialPointsDataFrame or SpatialGridDataFrame for plotting with spplot (levelplot/xyplot wrapper)*

---

**Description**

rearrange SpatialPointsDataFrame for plotting with spplot or levelplot

**Usage**

```
flipHorizontal(x)
flipVertical(x)
```

**Arguments**

x                    object of class SpatialGridDataFrame

**Value**

object of class SpatialGridDataFrame, with pixels flipped horizontally or vertically. Note that the spatial structure is destroyed (or at least: drastically changed).

**Author(s)**

Michael Sumner

## Examples

```
data(meuse.grid) # data frame
gridded(meuse.grid) = c("x", "y") # promotes to
fullgrid(meuse.grid) = TRUE
d = meuse.grid["dist"]
image(d, axes=TRUE)
image(flipHorizontal(d), axes=TRUE)
image(flipVertical(d), axes=TRUE)
```

---

geometry-methods	<i>Methods for retrieving the geometry from a composite (geometry + attributes) object</i>
------------------	--

---

## Description

geometry retrieves the SpatialXxx object from a SpatialXxxDataFrame object, with Xxx Lines, Points, Polygons, Grid, or Pixels. geometry<- converts a data.frame into a Spatial object.

## Usage

```
geometry(obj)
geometry(obj) <- value
```

## Arguments

obj	in case of assignment, a data.frame, else an object of class Spatial
value	object of class Spatial

## Methods

```
obj = "Spatial"
obj = "SpatialPointsDataFrame"
obj = "SpatialMultiPointsDataFrame"
obj = "SpatialPolygonsDataFrame"
obj = "SpatialPixelsDataFrame"
obj = "SpatialGridDataFrame"
obj = "SpatialLinesDataFrame"
```

## Author(s)

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

**Examples**

```

data(meuse)
m = meuse
coordinates(m) = meuse[, c("x", "y")]
pts = geometry(m)
class(pts)
geometry(meuse) = pts
class(meuse)
identical(m, meuse) # TRUE

```

---

gridded-methods

*specify spatial data as being gridded, or find out whether they are*


---

**Description**

returns logical (TRUE or FALSE) telling whether the object is gridded or not; in assignment promotes a non-gridded structure to a gridded one, or demotes a gridded structure back to a non-structured one.

**Usage**

```

gridded(obj)
gridded(obj) <- value
fullgrid(obj)
fullgrid(obj) <- value
gridparameters(obj)

```

**Arguments**

obj	object deriving from class "Spatial" (for gridded), or object of class <a href="#">SpatialGridDataFrame-class</a> (for fullgrid and gridparameters)
value	logical replacement values, TRUE or FALSE

**Value**

if obj derives from class Spatial, gridded(object) will tell whether it is has topology on a regular grid; if assigned TRUE, if the object derives from SpatialPoints and has gridded topology, grid topology will be added to object, and the class of the object will be promoted to [SpatialGrid-class](#) or [SpatialGridDataFrame-class](#)

fullgrid returns a logical, telling whether the grid is full and ordered (i.e., in full matrix form), or whether it is not full or unordered (i.e. a list of points that happen to lie on a grid. If assigned, the way the points are stored may be changed. Changing a set of points to full matrix form and back may change the original order of the points, and will remove duplicate points if they were present.

gridparameters returns, if obj inherits from SpatialGridDataFrame its grid parameters, else it returns numeric(0). The returned value is a data.frame with three columns, named cellcentre.offset ("lower left cell centre coordinates"), cellsize, and cells.dim (cell dimension); the rows correspond to the spatial dimensions.

**Methods**

**obj = "Spatial"** object deriving from class "Spatial"

**Examples**

```
# just 9 points on a grid:
x <- c(1,1,1,2,2,2,3,3,3)
y <- c(1,2,3,1,2,3,1,2,3)
xy <- cbind(x,y)
S <- SpatialPoints(xy)
class(S)
plot(S)
gridded(S) <- TRUE
gridded(S)
class(S)
summary(S)
plot(S)
gridded(S) <- FALSE
gridded(S)
class(S)

# data.frame
data(meuse.grid)
coordinates(meuse.grid) <- ~x+y
gridded(meuse.grid) <- TRUE
plot(meuse.grid) # not much good
summary(meuse.grid)
```

---

gridIndex2nb

*create neighbourhood (nb) object from grid geometry*

---

**Description**

create neighbourhood (nb) object from grid geometry

**Usage**

```
gridIndex2nb(obj, maxdist = sqrt(2), fullMat = TRUE, ...)
```

**Arguments**

obj	object of class <a href="#">SpatialGrid</a> or <a href="#">SpatialPixels</a>
maxdist	maximum distance to be considered (inclusive), expressed in number of grid cell (sqrt(2) results in queen neighbours)
fullMat	use <a href="#">dist</a> to compute distances from grid (row/col) indices; FALSE avoids forming the full distance matrix, at a large performance cost
...	arguments passed on to <a href="#">dist</a>

**Value**

Object of class nb, which is a list.

The nb object follows the convention of nb objects in package spdep; it is a list with each list element corresponding to a grid cell or pixel; the list element contains the indices of neighbours defined as cells less than maxdist away, measured in cell unit (N/S/E/W neighbour has distance 1).

**Note**

Unequal grid cell size is ignored; grid cell row/col indices are taken to be the coordinates from which distances are computed.

**Author(s)**

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

**See Also**

plot.nb in package spdep

---

gridlines

*Create N-S and E-W grid lines over a geographic region*

---

**Description**

Create N-S and E-W grid lines over a geographic region; create and plot corresponding labels

**Usage**

```
gridlines(x, easts = pretty(bbox(x)[1,]), norths = pretty(bbox(x)[2,]),
  ndiscr = 100)
gridat(x, easts = pretty(bbox(x)[1,]), norths = pretty(bbox(x)[2,]),
  offset = 0.5, side = "WS")
## S3 method for class 'SpatialLines'
labels(object, labelCRS, side = 1:2, ...)
## S3 method for class 'SpatialPointsDataFrame'
text(x, ...)
```

**Arguments**

x	object deriving from class <a href="#">Spatial-class</a>
easts	numeric; east-west values for vertical lines
norths	numeric; north-south values for horizontal lines
ndiscr	integer; number of points used to discretize the line, could be set to 2, unless the grid is (re)projected
offset	offset value to be returned, see <a href="#">text</a>

object	<a href="#">SpatialLines-class</a> object, as returned by <code>gridlines</code>
labelCRS	the CRS in which the grid lines were drawn and labels should be printed; if missing, the CRS from object is taken
side	for labels: integer, indicating side(s) at which gridlines labels will be drawn: 1=below (S), 2=left (W), 3=above (N), and 4=right (E); for <code>gridat</code> : default “WS”, if “EN” labels placed on the top and right borders
...	for labels: ignored; for text: arguments passed on to <a href="#">text</a> , see below for example use of <code>adj</code>

### Value

`gridlines` returns an object of class [SpatialLines-class](#), with lines as specified; the return object inherits the projection information of `x`; `gridat` returns a [SpatialPointsDataFrame](#) with points at the west and south ends of the grid lines created by `gridlines`, with degree labels.

The `labels` method for [SpatialLines](#) objects returns a [SpatialPointsDataFrame-class](#) object with the parameters needed to print labels below and left of the gridlines. The locations for the labels are those of `proj4string(object)` the labels also unless `labelCRS` is given, in which case they are in that CRS. This object is prepared to be plotted with `text`:

The `text` method for [SpatialPointsDataFrame](#) puts text labels on its coordinates, and takes care of attributes `pos`, `labels`, `srt` and `offset`; see [text](#).

### Author(s)

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>, using example code of Roger Bivand.

### See Also

[spTransform](#); `llgridlines` in `rgdal` (recent versions) for plotting long-lat grid over projected data

### Examples

```
data(meuse)
coordinates(meuse) = ~x+y
plot(meuse)
plot(gridlines(meuse), add = TRUE)
text(labels(gridlines(meuse)))
title("default gridlines within Meuse bounding box")

proj4string(meuse) <- CRS("+init=epsg:28992")
crs.longlat <- CRS("+init=epsg:4326")
if (require(rgdal, quietly=TRUE)) {
  meuse_ll <- spTransform(meuse, crs.longlat)
  grd <- gridlines(meuse_ll)
  grd_x <- spTransform(grd, CRS("+init=epsg:28992"))

  # labels South and West:
  plot(meuse)
  plot(grd_x, add=TRUE, lty=2)
  grdat_ll <- gridat(meuse_ll)
```

```

grdat_x <- spTransform(grdat_ll, CRS("+init=epsg:28992"))
text(grdat_x)

# labels North and East:
plot(meuse)
plot(grd_x, add=TRUE, lty=2)
grdat_ll <- gridat(meuse_ll, side="EN")
grdat_x <- spTransform(grdat_ll, CRS("+init=epsg:28992"))
text(grdat_x)

# now using labels:
plot(meuse)
plot(grd_x, add=TRUE, lty=2)
text(labels(grd_x, crs.longlat))

# demonstrate axis labels with angle, both sides:
sp = SpatialPoints(rbind(c(-101,9), c(-101,55), c(-19,9), c(-19,55)), crs.longlat)
laea = CRS("+proj=laea +lat_0=30 +lon_0=-40")
sp.l = spTransform(sp, laea)
plot(sp.l, expandBB = c(0, 0.05, 0, .05))
gl = spTransform(gridlines(sp), laea)
plot(gl, add = TRUE)
text(labels(gl, crs.longlat))
text(labels(gl, crs.longlat, side = 3:4), col = 'red')
title("curved text label demo")

# polar:
pts=SpatialPoints(rbind(c(-180,-70),c(0,-70),c(180,-89),c(180,-70)), crs.longlat)
polar = CRS("+init=epsg:3031")
gl = spTransform(gridlines(pts, easts = seq(-180,180,20), ndiscr = 100), polar)
plot(spTransform(pts, polar), expandBB = c(.05,0,.05,0))
lines(gl)
l = labels(gl, crs.longlat, side = 3)
l$pos = NULL # pos is too simple, use adj:
text(l, adj = c(0.5, -0.5))
l = labels(gl, crs.longlat, side = 4)
l$srt = 0 # otherwise they end up upside-down
text(l)
title("grid line labels on polar projection, epsg 3031")
}
## Not run:
if (require(maps)) demo(polar) # adds the map of the antarctic

## End(Not run)

```

---

GridTopology-class      *Class "GridTopology"*

---

## Description

class for defining a rectangular grid of arbitrary dimension

### Objects from the Class

Objects are created by using e.g.

```
GridTopology(c(0,0), c(1,1), c(5,5))
```

see [SpatialGrid](#)

### Slots

`cellcentre.offset`: numeric; vector with the smallest centroid coordinates for each dimension; coordinates refer to the cell centre

`cellsize`: numeric; vector with the cell size in each dimension

`cells.dim`: integer; vector with number of cells in each dimension

### Methods

**coordinates** signature(`x = "SpatialGrid"`): calculates coordinates for each point on the grid

**summary** signature(`object = "SpatialGrid"`): summarize object

**coerce** signature(`from = "GridTopology"`, `to = "data.frame"`): convert to data.frame with columns `cellcentre.offset`, `cellsize` and `cells.dim`

### Author(s)

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

### See Also

[SpatialGridDataFrame-class](#), [SpatialGrid-class](#)

### Examples

```
x = GridTopology(c(0,0), c(1,1), c(5,5))
class(x)
x
summary(x)
coordinates(x)
y = SpatialGrid(grid = x)
class(y)
y
```



---

```
image.SpatialGridDataFrame
```

*Image or contour method for gridded spatial data; convert to and from image data structure*

---

## Description

Create image for gridded data in SpatialGridDataFrame or SpatialPixelsDataFrame objects.

## Usage

```
## S3 method for class 'SpatialGridDataFrame'
image(x, attr = 1, xcol = 1, ycol = 2,
      col = heat.colors(12), red=NULL, green=NULL, blue=NULL,
      axes = FALSE, xlim = NULL,
      ylim = NULL, add = FALSE, ..., asp = NA, setParUsrBB=FALSE,
      interpolate = FALSE, angle = 0,
      useRasterImage = !(.Platform$GUI[1] == "Rgui" &&
        getIdentification() == "R Console") && missing(breaks), breaks,
      zlim = range(as.numeric(x[[attr]])[is.finite(x[[attr]])]))
## S3 method for class 'SpatialPixelsDataFrame'
image(x, ...)
## S3 method for class 'SpatialPixels'
image(x, ...)
## S3 method for class 'SpatialGridDataFrame'
contour(x, attr = 1, xcol = 1, ycol = 2,
        col = 1, add = FALSE, xlim = NULL, ylim = NULL, axes = FALSE,
        ..., setParUsrBB = FALSE)
## S3 method for class 'SpatialPixelsDataFrame'
contour(x, ...)
as.image.SpatialGridDataFrame(x, xcol = 1, ycol = 2, attr = 1)
image2Grid(im, p4 = as.character(NA), digits=10)
```

## Arguments

x	object of class <a href="#">SpatialGridDataFrame</a>
attr	column of attribute variable; this may be the column name in the data.frame of data (as.data.frame(data)), or a column number
xcol	column number of x-coordinate, in the coordinate matrix
ycol	column number of y-coordinate, in the coordinate matrix
col	a vector of colors
red,green,blue	columns names or numbers given instead of the attr argument when the data represent an image encoded in three colour bands on the 0-255 integer scale; all three columns must be given in this case, and the attribute values will be constructed using function <code>rgb</code>

<code>axes</code>	logical; should coordinate axes be drawn?
<code>xlim</code>	x-axis limits
<code>ylim</code>	y-axis limits
<code>zlim</code>	data limits for plotting the (raster, attribute) values
<code>add</code>	logical; if FALSE, the image is added to the plot layout setup by <code>plot(as(x, "Spatial"), axes=axes, xlim=..., ylim=..., zlim=...)</code> ; if TRUE, the image is added to the existing plot.
<code>...</code>	arguments passed to <code>image</code> , see examples
<code>asp</code>	aspect ratio to be used for plot
<code>setParUsrBB</code>	default FALSE, see <a href="#">Spatial-class</a> for further details
<code>useRasterImage</code>	if TRUE, use <code>rasterImage</code> to render the image if available; for legacy rendering set FALSE; should be FALSE on Windows SDI installations
<code>breaks</code>	class breaks for coloured values
<code>interpolate</code>	default FALSE, a logical vector (or scalar) indicating whether to apply linear interpolation to the image when drawing, see <code>rasterImage</code>
<code>angle</code>	default 0, angle of rotation (in degrees, anti-clockwise from positive x-axis, about the bottom-left corner), see <code>rasterImage</code>
<code>im</code>	list with components named x, y, and z, as used for <code>image</code>
<code>proj4</code>	CRS object, proj4 string
<code>digits</code>	default 10, number of significant digits to use for checking equal row/column spacing

**Value**

`as.image.SpatialGridDataFrame` returns the list with elements `x` and `y`, containing the coordinates of the cell centres of a matrix `z`, containing the attribute values in matrix form as needed by `image`.

**Note**

Providing `xcol` and `ycol` attributes seems obsolete, and it is for 2D data, but it may provide opportunities for plotting certain slices in 3D data. I haven't given this much thought yet.

`filled.contour` seems to misinterpret the coordinate values, if we take the `image.default` manual page as the reference.

**Author(s)**

Edzer Pebesma

**See Also**

`image.default`, [SpatialGridDataFrame-class](#), `levelplot` in package `lattice`. Function `image.plot` in package `fields` can be used to make a legend for an image, see an example in <https://stat.ethz.ch/pipermail/r-sig-geo/2007-June/002143.html>

**Examples**

```

data(meuse.grid)
coordinates(meuse.grid) = c("x", "y") # promote to SpatialPointsDataFrame
gridded(meuse.grid) = TRUE             # promote to SpatialGridDataFrame
data(meuse)
coordinates(meuse) = c("x", "y")
image(meuse.grid["dist"], main = "Distance to river Meuse")
points(coordinates(meuse), pch = "+")
image(meuse.grid["dist"], main = "Distance to river Meuse",
      useRasterImage=TRUE)
points(coordinates(meuse), pch = "+")

# color scale:
layout(cbind(1,2), c(4,1),1)
image(meuse.grid["dist"])
imageScale(meuse.grid$dist, axis.pos=4, add.axis=FALSE)
axis(4,at=c(0,.2,.4,.8), las=2)

data(Rlogo)
d = dim(Rlogo)
cellsize = abs(c(gt[2],gt[6]))
cells.dim = c(d[1], d[2]) # c(d[2],d[1])
cellcentre.offset = c(x = gt[1] + 0.5 * cellsize[1], y = gt[4] - (d[2] - 0.5) * abs(cellsize[2]))
grid = GridTopology(cellcentre.offset, cellsize, cells.dim)
df = as.vector(Rlogo[,1])
for (band in 2:d[3]) df = cbind(df, as.vector(Rlogo[,band]))
df = as.data.frame(df)
names(df) = paste("band", 1:d[3], sep="")
Rlogo <- SpatialGridDataFrame(grid = grid, data = df)
summary(Rlogo)
image(Rlogo, red="band1", green="band2", blue="band3")
image(Rlogo, red="band1", green="band2", blue="band3",
      useRasterImage=FALSE)
is.na(Rlogo$band1) <- Rlogo$band1 == 255
is.na(Rlogo$band2) <- Rlogo$band2 == 255
is.na(Rlogo$band3) <- Rlogo$band3 == 255
Rlogo$i7 <- 7
image(Rlogo, "i7")
image(Rlogo, red="band1", green="band2", blue="band3", add=TRUE)

```

is.projected

*Sets or retrieves projection attributes on classes extending Spatial-Data*

**Description**

Sets or retrieves projection attributes on classes extending SpatialData; set or retrieve option value for error or warning on exceedance of geographical coordinate range, set or retrieve option value for exceedance tolerance of geographical coordinate range. Note that only “+proj=longlat +ellps=WGS84” is accepted for geographical coordinates, which must be ordered (eastings, northings); the “+ellps=”

definition must be given (or expanded internally from a given “+datum=” value) for recent versions of the PROJ library, and should be set to an appropriate value.

From release 6 of the PROJ library, when used in building **rgdal** with GDAL  $\geq 3$ , the +datum= key in the Proj.4 string CRS representation is deprecated, and the +towgs84= and +nadgrids= keys may be deprecated soon. For this reason, **sp**, **rgdal** and **sf** are starting to use WKT2 (2019) string representations. In **sp**, the “CRS” object in itself remains unchanged, but the content of its “proj4args” slot may be degraded. To work around the degradation, a comment is added around the “CRS” object containing a WKT2 (2019) string when **rgdal** is available and built with PROJ  $\geq 6$  and GDAL  $\geq 3$ . The wkt() accessor function returns the WKT2 (2019) string comment belonging to the “CRS” object.

### Usage

```
is.projected(obj)
proj4string(obj)
proj4string(obj) <- value
wkt(obj)
get_ll_warn()
get_ll_TOL()
get_ReplCRS_warn()
set_ll_warn(value)
set_ll_TOL(value)
set_ReplCRS_warn(value)
```

### Arguments

obj	An object of class or extending <a href="#">Spatial-class</a>
value	For proj4string CRS object, containing a valid proj4 string; attempts to assign an object containing “longlat” to data extending beyond longitude [-180, 360] or latitude [-90, 90] will be stopped. For set_ll_warn a single logical value, if FALSE (default) error on range exceedance, if TRUE, warning. For set_ll_TOL the value of the power of .Machine\$double.eps (default 0.25) to use as tolerance in testing range exceedance. set_ReplCRS_warn may be used to turn off warnings issued when changing object CRS with the proj4string replacement method (by setting value=FALSE).

### Details

proj4 strings are operative through CRAN package **rgdal**. For strings defined as “longlat”, the minimum longitude should be -180, the maximum longitude 360, the minimum latitude -90, and the maximum latitude 90. Note that the proj4string replacement method does not project spatial data - for this use spTransform methods in the **rgdal** package.

### Value

is.projected returns a logical that may be NA; proj4string returns a character vector of length 1.

**Author(s)**

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

**See Also**

[CRS](#)

**Examples**

```
o <- new("Spatial")
proj4string(o) <- CRS("+init=epsg:27700")
if (!is.null(comment(slot(o, "proj4string")))) {
  cat(strsplit(wkt(o), "\n")[[1]], sep="\n")
  cat(strsplit(wkt(slot(o, "proj4string")), "\n")[[1]], sep="\n")
}
is.projected(CRS("+proj=longlat"))
is.projected(CRS("+proj=geocent"))
is.projected(CRS("+proj=geocent +units=km"))
```

---

Line

*create objects of class Line or Lines*

---

**Description**

create objects of class Line or Lines from coordinates

**Usage**

```
Line(coords)
Lines(slinelist, ID)
```

**Arguments**

coords	2-column numeric matrix with coordinates for a single line
slinelist	list with elements of class <a href="#">Line-class</a>
ID	a single word unique character identifier, character vector of length one

**Value**

Line returns an object of class [Line-class](#); Lines returns an object of class [Lines-class](#)

**See Also**

[SpatialLines-class](#)

## Examples

```
# from the sp vignette:
l1 = cbind(c(1,2,3),c(3,2,2))
l1a = cbind(l1[,1]+.05,l1[,2]+.05)
l2 = cbind(c(1,2,3),c(1,1.5,1))
S11 = Line(l1)
S11a = Line(l1a)
S12 = Line(l2)
S1 = Lines(list(S11, S11a), ID="a")
S2 = Lines(list(S12), ID="b")
```

---

Line-class

Class "Line"

---

## Description

class for line objects

## Objects from the Class

Objects can be created by calls of the form `new("Line", ...)`, or (preferred) by calls to the function [Line](#)

## Slots

`coords`: Object of class "matrix", containing the line coordinates

## Methods

**coordinates** signature(`obj = "Line"`): retrieve coordinates from line

**lines** signature(`x = "Line"`): add lines to a plot

## Author(s)

Roger Bivand, Edzer Pebesma

## See Also

[Lines-class](#), [SpatialLines-class](#)

---

Lines-class	Class "Lines"
-------------	---------------

---

**Description**

class for sets of line objects

**Arguments**

SL, Lines      an Lines object

**Objects from the Class**

Objects can be created by calls to the function [Line](#)

**Slots**

Lines: Object of class "list", containing elements of class [Line-class](#)

ID: "character" vector of length one, with unique identifier string

**Methods**

**coordinates** signature(obj = "Line"): retrieve coordinates from lines; returns list with matrices

**lines** signature(x = "Line"): add lines to a plot

**Author(s)**

Roger Bivand, Edzer Pebesma

**See Also**

[Lines-class](#), [SpatialLines-class](#)

---

loadMeuse	<i>deprecated function to load the Meuse data set</i>
-----------	---

---

**Description**

deprecated function to load the Meuse data set

**Usage**

```
loadMeuse()
```

**Value**

none; it prints a warning to run demo(meuse)

**See Also**

[meuse](#), [meuse.grid](#)

**Examples**

```
demo(meuse)
```

---

mapasp	<i>Calculate aspect ratio for plotting geographic maps; create nice degree axis labels</i>
--------	--

---

**Description**

Calculate aspect ratio for plotting geographic maps; create nice degree axis labels

**Usage**

```
mapasp(data, xlim, ylim)
degreeLabelsEW(x)
degreeLabelsNS(x)
```

**Arguments**

data	object of class or extending <code>Spatial</code>
xlim	the xlim argument passed (or derived from bounding box)
ylim	the ylim argument passed (or derived from bounding box)
x	numeric; values at which tics and marks will be generated

**Value**

mapasp is used for the aspect argument in lattice plots and `splot`;  
 let  $x = dy/dx$ , with  $dy$  and  $dx$  the y- and x-size of the map.  
 let  $s = 1/\cos((My * \pi)/180)$  with  $My$  the y coordinate of the middle of the map (the mean of ylim)  
 for latlong (longlat) data, mapasp returns  $s * x$ . for other data, mapasp returns "iso".

**Note**

the values for x are typically obtained from [axTicks](#)

**See Also**

[levelplot](#) in package `lattice`



---

merge	<i>Merge a Spatial* object having attributes with a data.frame</i>
-------	--

---

### Description

Merge a Spatial object having a data.frame (i.e. merging of non-spatial attributes).

### Usage

```
## S4 method for signature 'Spatial,data.frame'  
merge(x, y, by = intersect(names(x), names(y)),  
      by.x = by, by.y = by, all.x = TRUE, suffixes = c(".x", ".y"),  
      incomparables = NULL, duplicateGeoms = FALSE, ...)
```

### Arguments

x	object deriving from <a href="#">Spatial</a>
y	object of class data.frame, or any other class that can be coerced to a data.frame with as.data.frame
by, by.x, by.y	specifications of the common columns. See 'Details' in (base) <a href="#">merge</a> .
all.x	logical; if TRUE, then the returned object will have all rows of x, even those that has no matching row in y. These rows will have NAs in those columns that are usually filled with values from y
suffixes	character(2) specifying the suffixes to be used for making non-by names() unique.
incomparables	values which cannot be matched. See <a href="#">match</a> .
duplicateGeoms	logical; if TRUE geometries in x are duplicated if there are multiple matches between records in x and y
...	arguments to be passed to or from methods.

### Value

a Spatial\* object

### Author(s)

Robert J. Hijmans

### See Also

[merge](#)

meuse

*Meuse river data set***Description**

This data set gives locations and topsoil heavy metal concentrations, along with a number of soil and landscape variables at the observation locations, collected in a flood plain of the river Meuse, near the village of Stein (NL). Heavy metal concentrations are from composite samples of an area of approximately 15 m x 15 m.

**Usage**

```
data(meuse)
```

**Format**

This data frame contains the following columns:

**x** a numeric vector; Easting (m) in Rijksdriehoek (RDH) (Netherlands topographical) map coordinates

**y** a numeric vector; Northing (m) in RDH coordinates

**cadmium** topsoil cadmium concentration, mg kg<sup>-1</sup> soil ("ppm"); zero cadmium values in the original data set have been shifted to 0.2 (half the lowest non-zero value)

**copper** topsoil copper concentration, mg kg<sup>-1</sup> soil ("ppm")

**lead** topsoil lead concentration, mg kg<sup>-1</sup> soil ("ppm")

**zinc** topsoil zinc concentration, mg kg<sup>-1</sup> soil ("ppm")

**elev** relative elevation above local river bed, m

**dist** distance to the Meuse; obtained from the nearest cell in [meuse.grid](#), which in turn was derived by a spread (spatial distance) GIS operation, horizontal precision 20 metres; then normalized to  $[0,1]$

**om** organic matter, kg (100 kg)<sup>-1</sup> soil (percent)

**ffreq** flooding frequency class: 1 = once in two years; 2 = once in ten years; 3 = one in 50 years

**soil** soil type according to the 1:50 000 soil map of the Netherlands. 1 = Rd10A (Calcareous weakly-developed meadow soils, light sandy clay); 2 = Rd90C/VII (Non-calcareous weakly-developed meadow soils, heavy sandy clay to light clay); 3 = Bkd26/VII (Red Brick soil, fine-sandy, silty light clay)

**lime** lime class: 0 = absent, 1 = present by field test with 5% HCl

**landuse** landuse class: Aa Agriculture/unspecified = , Ab = Agr/sugar beetsm, Ag = Agr/small grains, Ah = Agr/??, Am = Agr/maize, B = woods, Bw = trees in pasture, DEN = ??, Fh = tall fruit trees, Fl = low fruit trees; Fw = fruit trees in pasture, Ga = home gardens, SPO = sport field, STA = stable yard, Tv = ?? , W = pasture

**dist.m** distance to river Meuse in metres, as obtained during the field survey

**Note**

row.names refer to the original sample number.

Soil units were mapped with a minimum delination width of 150 m, and so somewhat generalize the landscape.

Approximate equivalent World Reference Base 2002 for Soil Resources names are: Rd10A Gleyic Fluvisols; Rd90C Haplic Fluvisols; Bkd26 Haplic Luvisols. Units Rd90C and Bkd26 have winter groundwater > 80cm, summer > 120cm depth.

**Author(s)**

Field data were collected by Ruud van Rijn and Mathieu Rikken; compiled for R by Edzer Pebesma; description extended by David Rossiter

**References**

M G J Rikken and R P G Van Rijn, 1993. Soil pollution with heavy metals - an inquiry into spatial variation, cost of mapping and the risk evaluation of copper, cadmium, lead and zinc in the floodplains of the Meuse west of Stein, the Netherlands. Doctoraalveldwerkverslag, Dept. of Physical Geography, Utrecht University

P.A. Burrough, R.A. McDonnell, 1998. Principles of Geographical Information Systems. Oxford University Press.

Stichting voor Bodemkartering (STIBOKA), 1970. Bodemkaart van Nederland : Blad 59 Peer, Blad 60 West en 60 Oost Sittard: schaal 1 : 50 000. Wageningen, STIBOKA.

<http://www.gstat.org/>

**Examples**

```
data(meuse)
summary(meuse)
coordinates(meuse) <- ~x+y
proj4string(meuse) <- CRS("+init=epsg:28992")
```

---

meuse.grid

*Prediction Grid for Meuse Data Set*

---

**Description**

The meuse.grid data frame has 3103 rows and 7 columns; a grid with 40 m x 40 m spacing that covers the Meuse study area (see [meuse](#))

**Usage**

```
data(meuse.grid)
```

**Format**

This data frame contains the following columns:

**x** a numeric vector; x-coordinate (see [meuse](#))

**y** a numeric vector; y-coordinate (see [meuse](#))

**dist** distance to the Meuse river; obtained by a spread (spatial distance) GIS operation, from border of river; normalized to  $[0,1]$

**ffreq** flooding frequency class, for definitions see this item in [meuse](#); it is not known how this map was generated

**part.a** arbitrary division of the area in two areas, a and b

**part.b** see `part.a`

**soil** soil type, for definitions see this item in [meuse](#); it is questionable whether these data come from a real soil map, they do not match the published 1:50 000 map

**Details**

x and y are in RD New, the Dutch topographical map coordinate system. Roger Bivand projected this to UTM in the R-Grass interface package.

**Source**

<http://www.gstat.org/>

**References**

See the [meuse](#) documentation

**Examples**

```
data(meuse.grid)
coordinates(meuse.grid) = ~x+y
proj4string(meuse.grid) <- CRS("+init=epsg:28992")
gridded(meuse.grid) = TRUE
spplot(meuse.grid)
```

---

meuse.grid\_ll

*Prediction Grid for Meuse Data Set, geographical coordinates*

---

**Description**

The object contains the meuse.grid data as a SpatialPointsDataFrame after transformation to WGS84 and geographical coordinates.

**Usage**

```
data(meuse.grid_ll)
```

**Format**

The format is: Formal class 'SpatialPointsDataFrame' [package "sp"].

**Source**

See the [meuse](#) documentation

**Examples**

```
data(meuse.grid_ll)
```

---

meuse.riv

*River Meuse outline*

---

**Description**

The `meuse.riv` data consists of an outline of the Meuse river in the area a few kilometers around the [meuse](#) data set.

The `meuse.area` polygon has an outline of [meuse.grid](#). See example below how it can be created from [meuse.grid](#).

**Usage**

```
data(meuse.riv)
data(meuse.area)
```

**Format**

`meuse.riv`: two-column data.frame containing 176 coordinates.

`meuse.area`: two-column matrix with coordinates of outline.

**Details**

`x` and `y` are in RDM, the Dutch topographical map coordinate system. See examples of `spTransform` in the `rgdal` package for projection parameters.

**References**

See the [meuse](#) documentation

**Examples**

```

data(meuse.riv)
plot(meuse.riv, type = "l", asp = 1)
data(meuse.grid)
coordinates(meuse.grid) = c("x", "y")
gridded(meuse.grid) = TRUE
image(meuse.grid, "dist", add = TRUE)
data(meuse)
coordinates(meuse) = c("x", "y")
meuse.sr = SpatialPolygons(list(Polygons(list(Polygon(meuse.riv)), "meuse.riv")))
spplot(meuse.grid, col.regions=bpy.colors(), main = "meuse.grid",
  sp.layout=list(
list("sp.polygons", meuse.sr),
list("sp.points", meuse, pch="+", col="black")
)
)
spplot(meuse, "zinc", col.regions=bpy.colors(), main = "zinc, ppm",
  cuts = c(100,200,400,700,1200,2000), key.space = "right",
  sp.layout= list("sp.polygons", meuse.sr, fill = "lightblue")
)

# creating meuse.area from meuse.grid:
if (require(rgeos)) {
  meuse.area = gUnaryUnion(as(meuse.grid, "SpatialPolygons"))
plot(meuse.area)
}

```

---

over-methods

*consistent spatial overlay for points, grids and polygons*


---

**Description**

consistent spatial overlay for points, grids and polygons: at the spatial locations of object x retrieves the indexes or attributes from spatial object y

**Usage**

```

over(x, y, returnList = FALSE, fn = NULL, ...)
x %over% y

```

**Arguments**

x	geometry (locations) of the queries
y	layer from which the geometries or attributes are queried
returnList	logical; see value
fn	(optional) a function; see value

... arguments passed on to function `fn`, except for the special argument `minDimension`: minimal dimension for an intersection to be counted; -1 takes any intersection, and does not order; 0 takes any intersection but will order according to dimensionality of the intersections (if `returnList` is TRUE, 1 (2) selects intersections with dimension 1, meaning lines (2, meaning areas); see vignette("over") for details

## Value

If `y` is only geometry an object of length `length(x)`. If `returnList` is FALSE, a vector with the (first) index of `y` for each geometry (point, grid cell centre, polygon or lines) matching `x`. if `returnList` is TRUE, a list of length `length(x)`, with list element `i` the vector of all indices of the geometries in `y` that correspond to the  $i$ -th geometry in `x`.

If `y` has attribute data, attribute data are returned. `returnList` is FALSE, a `data.frame` with number of rows equal to `length(x)` is returned, if it is TRUE a list with `length(x)` elements is returned, with a list element the `data.frame` elements of all geometries in `y` that correspond to that element of `x`.

In case the `rgeos` over methods are used, matching is done by `gRelate`, which uses DE-9IM (<https://en.wikipedia.org/wiki/DE-9IM>). From the string returned, characters 1, 2, 4 and 5 are used, indicating the dimension of the overlap of the inner and boundary of each `x` geometry with the inner and boundary of each `y` geometry. The order in which matched `y` geometries are returned is determined by the dimension of the overlap (2: area overlap, 1: line in common, 0: point in common), and then by the position in the string (1, 2, 4, 5, meaning points in polygons are preferred over points on polygon boundaries).

## Methods

- `x = "SpatialPoints", y = "SpatialPolygons"`** returns a numeric vector of length equal to the number of points; the number is the index (number) of the polygon of `y` in which a point falls; NA denotes the point does not fall in a polygon; if a point falls in multiple polygons, the last polygon is recorded.
- `x = "SpatialPointsDataFrame", y = "SpatialPolygons"`** equal to the previous method, except that an argument `fn=xxx` is allowed, e.g. `fn = mean` which will then report a `data.frame` with the mean attribute values of the `x` points falling in each polygon (set) of `y`
- `x = "SpatialPoints", y = "SpatialPolygonsDataFrame"`** returns a `data.frame` of the second argument with row entries corresponding to the first argument
- `x = "SpatialPolygons", y = "SpatialPoints"`** returns the polygon index of points in `y`; if `x` is a `SpatialPolygonsDataFrame`, a `data.frame` with rows from `x` corresponding to points in `y` is returned.
- `x = "SpatialGridDataFrame", y = "SpatialPoints"`** returns object of class `SpatialPointsDataFrame` with grid attribute values `x` at spatial point locations `y`; NA for NA grid cells or points outside grid, and NA values on NA grid cells.
- `x = "SpatialGrid", y = "SpatialPoints"`** returns grid values `x` at spatial point locations `y`; NA for NA grid cells or points outside the grid
- `x = "SpatialPixelsDataFrame", y = "SpatialPoints"`** returns grid values `x` at spatial point locations `y`; NA for NA grid cells or points outside the grid

```

x = "SpatialPixels", y = "SpatialPoints" returns grid values x at spatial point locations y; NA for
  NA grid cells or points outside the grid
x = "SpatialPoints", y = "SpatialGrid" xx
x = "SpatialPoints", y = "SpatialGridDataFrame" xx
x = "SpatialPoints", y = "SpatialPixels" xx
x = "SpatialPoints", y = "SpatialPixelsDataFrame" xx
x = "SpatialPolygons", y = "SpatialGridDataFrame" xx

```

### Note

over can be seen as a left outer join in SQL; the match is a spatial intersection.

points on a polygon boundary and points corresponding to a polygon vertex are considered to be inside the polygon.

These methods assume that pixels and grid cells are never overlapping; for objects of class SpatialPixels this is not guaranteed.

over methods that involve SpatialLines objects, or pairs of SpatialPolygons require package rgeos, and use [gIntersects](#).

### Author(s)

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

### See Also

vignette("over") for examples and figures; [point.in.polygon](#), package [gIntersects](#)

### Examples

```

r1 = cbind(c(180114, 180553, 181127, 181477, 181294, 181007, 180409,
180162, 180114), c(332349, 332057, 332342, 333250, 333558, 333676,
332618, 332413, 332349))
r2 = cbind(c(180042, 180545, 180553, 180314, 179955, 179142, 179437,
179524, 179979, 180042), c(332373, 332026, 331426, 330889, 330683,
331133, 331623, 332152, 332357, 332373))
r3 = cbind(c(179110, 179907, 180433, 180712, 180752, 180329, 179875,
179668, 179572, 179269, 178879, 178600, 178544, 179046, 179110),
c(331086, 330620, 330494, 330265, 330075, 330233, 330336, 330004,
329783, 329665, 329720, 329933, 330478, 331062, 331086))
r4 = cbind(c(180304, 180403, 179632, 179420, 180304),
c(332791, 333204, 333635, 333058, 332791))

sr1=Polygons(list(Polygon(r1)), "r1")
sr2=Polygons(list(Polygon(r2)), "r2")
sr3=Polygons(list(Polygon(r3)), "r3")
sr4=Polygons(list(Polygon(r4)), "r4")
sr=SpatialPolygons(list(sr1, sr2, sr3, sr4))
srdf=SpatialPolygonsDataFrame(sr, data.frame(cbind(1:4, 5:2),
row.names=c("r1", "r2", "r3", "r4")))

```



```

data(meuse)
coordinates(meuse) = ~x+y

plot(meuse)
polygon(r1)
polygon(r2)
polygon(r3)
polygon(r4)
# retrieve mean heavy metal concentrations per polygon:
over(sr, meuse[,1:4], fn = mean)

# return the number of points in each polygon:
sapply(over(sr, geometry(meuse), returnList = TRUE), length)

data(meuse.grid)
coordinates(meuse.grid) = ~x+y
gridded(meuse.grid) = TRUE

over(sr, geometry(meuse))
over(sr, meuse)
over(sr, geometry(meuse), returnList = TRUE)
over(sr, meuse, returnList = TRUE)

over(meuse, sr)
over(meuse, srdf)

# same thing, with grid:
over(sr, meuse.grid)
over(sr, meuse.grid, fn = mean)
over(sr, meuse.grid, returnList = TRUE)

over(meuse.grid, sr)
over(meuse.grid, srdf, fn = mean)
over(as(meuse.grid, "SpatialPoints"), sr)
over(as(meuse.grid, "SpatialPoints"), srdf)

```

---

panel.splot

*panel and panel utility functions for splot*


---

## Description

panel functions for splot functions, and functions that can be useful within these panel functions

## Usage

```

splot.key(sp.layout, rows = 1, cols = 1)
SpatialPolygonsRescale(obj, offset, scale = 1, fill = "black", col = "black",
plot.grid = TRUE, ...)
sp.lines(obj, col = 1, ...)
sp.points(obj, pch = 3, ...)

```

```

sp.polygons(obj, col = 1, fill = "transparent", ...)
sp.grid(obj, col = 1, alpha = 1, ..., at = pretty(obj[[1]]), col.regions = col)
sp.text(loc, txt, ...)
sp.panel.layout(lst, p.number, ...)
bbexpand(x, fraction)

```

### Arguments

sp.layout	list; see <a href="#">splot</a> for definition
rows	integer; panel row(s) for which the layout should be drawn
cols	integer; panel column(s) for which the layout should be drawn
obj	object of class <a href="#">SpatialPolygons-class</a> for <code>SpatialPolygonsRescale</code> ; of class <a href="#">SpatialLines-class</a> , <a href="#">Lines-class</a> or <a href="#">Line-class</a> for <code>sp.lines</code> of a class that has a <a href="#">coordinates-methods</a> for <code>sp.points</code> ; of class <a href="#">SpatialPolygons-class</a> for <code>sp.polygons</code> . When <code>obj</code> is character, the actual object is retrieved by <code>get(obj)</code> before its class is evaluated.
offset	offset for shifting a Polygons object
scale	scale for rescaling
fill	fill color
col	line color
plot.grid	logical; plot through grid functions (TRUE), or through traditional graphics functions (FALSE)
pch	plotting character
at	numeric; values at which colour breaks should occur
col.regions	colours to fill the grid cells, defaults to <code>col</code>
loc	numeric vector of two elements
txt	text to be plotted
alpha	alpha (transparency) level
lst	<code>sp.layout</code> argument, see <a href="#">splot</a>
p.number	panel number; in a panel, <code>panel.number()</code> should be passed to this argument
x	length two numeric vector, containing a range
fraction	fraction to expand the range by
...	arguments passed to the underlying panel, lattice or grid functions

### Note

The panel functions of [splot](#), `panel.gridplot` for grids, `panel.pointsplot` for points, or `panel.polygonsplot` for lines or polygons can be called with arguments `(x,y,...)`. Customizing `splot` plots can be done by extending the panel function, or by supplying an `sp.layout` argument; see the documentation for [splot](#). Inside these panel functions, `sp.panel.layout` is called to deal with plotting the items in a `sp.layout` object.

`SpatialPolygonsRescale` scales and shifts an object of class [SpatialPolygons-class](#); this is useful e.g. for scale bars, or other layout items.

sp.lines, sp.points, sp.polygons and sp.text plot lines, points, polygons or text in a panel.

spplot.key draws the sp.layout object at given rows/cols.

sp.pagefn can be passed as a page argument, and will call function spplot.key for the last panel drawn on a page.

### Author(s)

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

### References

<https://edzer.github.io/sp/> has a graph gallery with examples with R code.

### See Also

[spplot](#), [spplot-methods](#)

---

point.in.polygon      *do point(s) fall in a given polygon?*

---

### Description

verifies for one or more points whether they fall in a given polygon

### Usage

```
point.in.polygon(point.x, point.y, pol.x, pol.y, mode.checked=FALSE)
```

### Arguments

point.x	numerical array of x-coordinates of points
point.y	numerical array of y-coordinates of points
pol.x	numerical array of x-coordinates of polygon
pol.y	numerical array of y-coordinates of polygon
mode.checked	default FALSE, used internally to save time when all the other argument are known to be of storage mode double

### Value

integer array; values are: 0: point is strictly exterior to pol; 1: point is strictly interior to pol; 2: point lies on the relative interior of an edge of pol; 3: point is a vertex of pol.

### References

Uses the C function InPoly(). InPoly is Copyright (c) 1998 by Joseph O'Rourke. It may be freely redistributed in its entirety provided that this copyright notice is not removed.

**Examples**

```
# open polygon:
point.in.polygon(1:10,1:10,c(3,5,5,3),c(3,3,5,5))
# closed polygon:
point.in.polygon(1:10,rep(4,10),c(3,5,5,3,3),c(3,3,5,5,3))
```

---

Polygon-class

*Class "Polygon"*

---

**Description**

class for spatial polygon

**Objects from the Class**

Objects can be created by calls to the function Polygon

**Slots**

ringDir: Object of class "integer"; the ring direction of the ring (polygon) coordinates, holes are expected to be anti-clockwise

labpt: Object of class "numeric"; an x, y coordinate pair forming the label point of the polygon

area: Object of class "numeric"; the planar area of the polygon, does not respect projection as objects of this class have no projection defined

hole: Object of class "logical"; does the polygon seem to be a hole

coords: Object of class "matrix"; coordinates of the polygon; first point should equal the last point

**Extends**

Class "Line", directly.

**Methods**

No methods defined with class "Polygon" in the signature.

**Author(s)**

Roger Bivand

**See Also**

[Polygons-class](#), [SpatialPolygons-class](#)

---

polygons	<i>sets spatial coordinates to create spatial data, or retrieves spatial coordinates</i>
----------	--

---

**Description**

sets spatial coordinates to create spatial data, or retrieves spatial coordinates

**Usage**

```
polygons(obj)
polygons(object) <- value
```

**Arguments**

obj	object of class "SpatialPolygons" or "SpatialPolygonsDataFrame"
object	object of class "data.frame"
value	object of class "SpatialPolygons"

**Value**

polygons returns the SpatialPolygons of obj; polygons<- promotes a data.frame to a SpatialPolygonsDataFrame object

**Examples**

```
grd <- GridTopology(c(1,1), c(1,1), c(10,10))
polys <- as.SpatialPolygons.GridTopology(grd)
centroids <- coordinates(polys)
x <- centroids[,1]
y <- centroids[,2]
z <- 1.4 + 0.1*x + 0.2*y + 0.002*x*x
df <- data.frame(x=x, y=y, z=z, row.names=row.names(polys))
polygons(df) <- polys
class(df)
summary(df)
```

---

Polygons-class	<i>Class "Polygons"</i>
----------------	-------------------------

---

**Description**

Collection of objects of class "Polygon"

**Objects from the Class**

Objects can be created by calls to the function Polygons

**Slots**

- Polygons:** Object of class "list"; list with objects of class [Polygon-class](#)
- plotOrder:** Object of class "integer"; order in which the Polygon objects should be plotted, currently by order of decreasing size
- labpt:** Object of class "numeric"; pair of x, y coordinates giving a label point, the label point of the largest polygon component
- ID:** Object of class "character"; unique identifier string
- area:** Object of class "numeric"; the gross total planar area of the Polygon list but not double-counting holes (changed from 0.9-58 - islands are summed, holes are ignored rather than subtracted); these values are used to make sure that polygons of a smaller area are plotted after polygons of a larger area, does not respect projection as objects of this class have no projection defined

**Methods**

No methods defined with class "Polygons" in the signature.

**Note**

By default, single polygons (where Polygons is a list of length one) are not expected to be holes, but in multiple polygons, hole definitions for member polygons can be set. Polygon objects belonging to an Polygons object should either not overlap one-other, or should be fully included (as lakes or islands in lakes). They should not be self-intersecting. Checking of hole FALSE/TRUE status for Polygons objects is included in the maptools package using functions in the rgeos package, function `checkPolygonsHoles()`.

**Author(s)**

Roger Bivand

---

polygons-methods

*Retrieve polygons from SpatialPolygonsDataFrame object*

---

**Description**

Retrieve polygons from SpatialPolygonsDataFrame object

**Methods for polygons**

**obj = "SpatialPolygons"** object of, or deriving from, SpatialPolygons

**obj = "SpatialPolygonsDataFrame"** object of, or deriving from, SpatialPolygonsDataFrame

**Methods for "polygons<-"**

**object = "data.frame", value="SpatialPolygons"** promote data.frame to object of class [SpatialPolygonsDataFrame-class](#), by specifying polygons

---

read.asciigrid	<i>read/write to/from (ESRI) asciigrid format</i>
----------------	---

---

**Description**

read/write to/from ESRI asciigrid format

**Usage**

```
read.asciigrid(fname, as.image = FALSE, plot.image = FALSE, colname = fname,
  proj4string = CRS(as.character(NA)))
write.asciigrid(x, fname, attr = 1, na.value = -9999, ...)
```

**Arguments**

fname	file name
as.image	logical; if FALSE, a list is returned, ready to be shown with the image command; if FALSE an object of class <a href="#">SpatialGridDataFrame-class</a> is returned
plot.image	logical; if TRUE, an image of the map is plotted
colname	alternative name for data column if not file name
proj4string	A CRS object setting the projection arguments of the Spatial Grid returned
x	object of class <a href="#">SpatialGridDataFrame</a>
attr	attribute column; if missing, the first column is taken; a name or a column number may be given
na.value	numeric; value given to missing valued cells in the resulting map
...	arguments passed to <a href="#">write.table</a> , which is used to write the numeric data

**Value**

read.asciigrid returns the grid map read; either as an object of class [SpatialGridDataFrame-class](#) or, if as.image is TRUE, as list with components x, y and z.

**Author(s)**

Edzer Pebesma

**See Also**

[as.image.SpatialGridDataFrame](#), [image](#)

**Examples**

```
x <- read.asciigrid(system.file("external/test.ag", package="sp")[1])
class(x)
image(x)
```

**Description**

Methods for function `recenter` in package `sp` to shift or re-center geographical coordinates for a Pacific view. All longitudes  $< 0$  are added to 360, to avoid for instance parts of Alaska being represented on the far left and right of a plot because they have values straddling 180 degrees. In general, using a projected coordinate reference system is to be preferred, but this method permits a geographical coordinate reference system to be used. This idea was suggested by Greg Snow, and corresponds to the two world representations in the `maps` package.

**Methods**

**obj = "SpatialPolygons"** recenter a SpatialPolygons object

**obj = "Polygons"** recenter a Polygons object

**obj = "Polygon"** recenter an Polygon object

**obj = "SpatialLines"** recenter a SpatialLines object

**obj = "Lines"** recenter a Lines object

**obj = "Line"** recenter an Line object

**Examples**

```
crds <- matrix(c(179, -179, -179, 179, 50, 50, 52, 52), ncol=2)
SL <- SpatialLines(list(Lines(list(Line(crds)), "1")),
  CRS("+proj=longlat +ellps=WGS84"))
bbox(SL)
SLr <- recenter(SL)
bbox(SLr)
rcrds <- rbind(crds, crds[1,])
SpP <- SpatialPolygons(list(Polygons(list(Polygon(rcrds)), ID="r1")),
  proj4string=CRS("+proj=longlat +ellps=WGS84"))
bbox(SpP)
SpPr <- recenter(SpP)
bbox(SpPr)
opar <- par(mfrow=c(1,2))
plot(SpP)
plot(SpPr)
par(opar)
crds <- matrix(c(-1, 1, 1, -1, 50, 50, 52, 52), ncol=2)
SL <- SpatialLines(list(Lines(list(Line(crds)), "1")),
  CRS("+proj=longlat +ellps=WGS84"))
bbox(SL)
SLr <- recenter(SL)
bbox(SLr)
rcrds <- rbind(crds, crds[1,])
SpP <- SpatialPolygons(list(Polygons(list(Polygon(rcrds)), ID="r1")),
```



```

proj4string=CRS("+proj=longlat +ellps=WGS84"))
bbox(SpP)
SpPr <- recenter(SpP)
bbox(SpPr)
opar <- par(mfrow=c(1,2))
plot(SpP)
plot(SpPr)
par(opar)

```

---

Rlogo

*Rlogo jpeg image*


---

### Description

Rlogo jpeg image data as imported by `getRasterData` in the `rgdal` package

### Usage

```
data(Rlogo)
```

### Format

The format is: int [1:101, 1:77, 1:3] 255 255 255 255 255 255 255 255 255 255 ...

### Examples

```

## Not run:
library(rgdal)
logo <- system.file("pictures/Rlogo.jpg", package="rgdal")[1]
x <- GDAL.open(logo)
gt = .Call('RGDAL_GetGeoTransform', x, PACKAGE="rgdal")
data <- getRasterData(x)
GDAL.close(x)

## End(Not run)
data(Rlogo)
d = dim(Rlogo)
cellsize = abs(c(gt[2],gt[6]))
cells.dim = c(d[1], d[2]) # c(d[2],d[1])
cellcentre.offset = c(x = gt[1] + 0.5 * cellsize[1], y = gt[4] - (d[2] - 0.5) * abs(cellsize[2]))
grid = GridTopology(cellcentre.offset, cellsize, cells.dim)
df = as.vector(Rlogo[,1])
for (band in 2:d[3]) df = cbind(df, as.vector(Rlogo[,band]))
df = as.data.frame(df)
names(df) = paste("band", 1:d[3], sep="")
Rlogo <- SpatialGridDataFrame(grid = grid, data = df)
summary(Rlogo)
splot(Rlogo, zcol=1:3, names.attr=c("red","green","blue"),
col.regions=grey(0:100/100),
main="example of three-layer (RGB) raster image", as.table=TRUE)

```

---

select.spatial            *select points spatially*

---

### Description

select a number of points by digitizing the area they fall in

### Usage

```
select.spatial(data, digitize = TRUE, pch = "+", rownames = FALSE)
```

### Arguments

data	data object of class, or extending SpatialPoints; this object knows about its x and y coordinate
digitize	logical; if TRUE, points in a digitized polygon are selected; if FALSE, points identified by mouse clicks are selected
pch	plotting character used for points
rownames	logical; if FALSE, row (coordinate) numbers are returned; if TRUE and data contains a data.frame part, row.names for selected points in the data.frame are returned.

### Value

if rownames == FALSE, array with either indexes (row numbers) of points inside the digitized polygon; if rownames == TRUE, character array with corresponding row names in the data.frame part

### See Also

[point.in.polygon](#), [locator](#), [SpatialPoints-class](#), [SpatialPointsDataFrame-class](#)

### Examples

```
data(meuse)
## the following command requires user interaction: left mouse
## selects points, right mouse ends digitizing
data(meuse)
coordinates(meuse) = c("x", "y")
# select.spatial(meuse)
```

---

sp *A package providing classes and methods for spatial data: points, lines, polygons and grids*

---

## Description

This package provides S4 classes for importing, manipulating and exporting spatial data in R, and for methods including print/show, plot, subset, [, [[, \$, names, dim, summary, and a number of methods specific to spatial data handling.

## Introduction

Several spatial statistical packages have been around for a long while, but no organized set of classes for spatial data has yet been devised. Many of the spatial packages make their own assumptions, or use their own class definitions for spatial data, making it inconvenient to move from one package to another. This package tries to provide a solid set of classes for many different types of spatial data. The idea is that spatial statistical packages will either support these classes (i.e., directly read and write them) or will provide conversion to them, so that we have a base class set with which any package can exchange. This way, many-to-many conversions can be replaced with one-to-many conversions, provided either in this package or the spatial packages. Wherever possible conversion (coercion) functions are automatic, or provided by sp.

External packages that depend on sp will provide importing and exporting from and to external GIS formats, e.g. through GDAL, OGR or shapelib.

In addition, this package tries to provide convenient methods to print, summarize and plot such spatial data.

## Dimensions

In principal, geographical data are two-dimensional, on a flat surface (a map) or on a sphere (the earth). This package provides space for dealing with higher dimensional data where possible; this is e.g. very simple for points and grids, but hard to do for polygons. Plotting functions are devised primarily for two-dimensional data, or two-dimensional projections of higher dimensional data.

## Coordinate reference systems

Central to spatial data is that they have a coordinate reference system, which is coded in object of CRS class. Central to operations on different spatial data sets is that their coordinate reference system is compatible (i.e., identical).

This CRS can be a character string describing a reference system in a way understood by the PROJ.4 projection library, or a (character) missing value. An interface to the PROJ.4 library is available only if the R package rgdal is present.

## Class structure

All spatial classes derive from a basic class `Spatial`, which only provides a bounding box and a CRS. This class has no useful instances, but useful derived classes.

SpatialPoints extends Spatial and has coordinates. The method `coordinates` extracts the numeric matrix with coordinates from an object of class SpatialPoints, or from other (possibly derived) classes that have points.

Objects of class SpatialGrid points on a regular grid. Either a full grid is stored or a partial grid (i.e., only the non-missing valued cells); calling `coordinates` on them will give the coordinates for the grid cells.

SpatialPoints, SpatialPixels and SpatialGrid can be of arbitrary dimension, although most of the effort is in making them work for two dimensional data.

SpatialLines provides lines, and SpatialPolygons provides polygons, i.e., lines that end where they start and do not intersect with itself. SpatialLines and SpatialPolygons only have two-dimensional data.

SpatialPointsDataFrame extends SpatialPoints with a data slot, having a data.frame with attribute data. Similarly, SpatialPixelsDataFrame, SpatialLinesDataFrame, SpatialPolygonsDataFrame extend the primary spatial information with attribute data.

## References

PROJ.4: <https://github.com/OSGeo/PROJ>

GDAL and OGR: <https://gdal.org/>.

## Authors

sp is a collaborative effort of Edzer Pebesma, Roger Bivand, Barry Rowlingson and Virgilio Gómez-Rubio.

---

sp-deprecated

*Deprecated functions in sp*

---

## Description

Deprecated functions is sp: `getSpP*`, `getPolygon*`, `getLines*` `getSL*`

## Note

For overlay the new implementation is found in the `over` method; this works slightly different and more consistent.

---

Spatial-class	<i>Class "Spatial"</i>
---------------	------------------------

---

### Description

An abstract class from which useful spatial classes are derived

### Usage

```
Spatial(bbox, proj4string = CRS(as.character(NA)))
## S3 method for class 'Spatial'
subset(x, subset, select, drop = FALSE, ...)
```

### Arguments

bbox	a bounding box matrix
proj4string	a CRS object
x	object of class Spatial
subset	see <a href="#">subset.data.frame</a>
select	see <a href="#">subset.data.frame</a>
drop	see <a href="#">subset.data.frame</a>
...	passed through

### Objects from the Class

are never to be generated; only derived classes can be meaningful

### Slots

**bbox:** Object of class "matrix"; 2-column matrix holding the minimum in first and maximum in second column for the x-coordinate (first row), y-coordinate (second row) and optionally, for points and grids only, further coordinates. The constructed Spatial object will be invalid if any bbox values are NA or infinite. The column names must be c("min", "max")

**proj4string:** Object of class "CRS". The name of this slot was chosen to reflect the use of Proj.4 strings to represent coordinate reference systems (CRS). The slot name will continue to be used, but as PROJ >= 6 and GDAL >= 3 are taken into use for reading files and for projection and transformation, the Proj.4 string CRS representation is being supplemented by a WKT2 (2019) representation. The reason for the modification is that important keys in the Proj.4 string representation are being deprecated in PROJ >= 6 and GDAL >= 3. Legacy "CRS" objects hold only a valid Proj.4 string, which can be used for unprojecting or reprojecting coordinates; it is initialised to NA. If the "CRS" object is instantiated using CRS() with **rgdal** using PROJ >= 6 and GDAL >= 3, the object may also have a WKT2 (2019) string carried as a comment. Non-NA strings may be checked for validity in the **rgdal** package, but attempts to assign a string containing "longlat" to data extending beyond longitude [-180, 360] or latitude [-90, 90] will be stopped or warned, use [set\\_ll\\_warn](#) to warn rather than stop, and [set\\_ll\\_TOL](#) to change the default tolerance for the range exceedance tests.

**Methods**

**bbox** signature(obj = "Spatial"): retrieves the bbox element

**dimensions** signature(obj = "Spatial"): retrieves the number of spatial dimensions spanned

**gridded** signature(obj = "Spatial"): logical, tells whether the data is on a regular spatial grid

**plot** signature(x = "Spatial", y = "missing"): plot method for spatial objects; does nothing but setting up a plotting region choosing a suitable aspect if not given(see below), colouring the plot background using either a bg= argument or par("bg"), and possibly drawing axes.

**summary** signature(object = "Spatial"): summarize object

**\$** retrieves attribute column

**\$<-** sets or replaces attribute column, or promote a geometry-only object to an object having an attribute

**rebuild\_CRS** rebuild a CRS object, usually used to add a WKT comment with PROJ >= 6 and GDAL >= 3

**plot method arguments**

The plot method for "Spatial" objects takes the following arguments:

**x** object of class Spatial

**xlim** default NULL; the x limits (x1, x2) of the plot

**ylim** default NULL; the y limits of the plot

**asp** default NA; the y/x aspect ratio

**axes** default FALSE; a logical value indicating whether both axes should be drawn

**bg** default par("bg"); colour to be used for the background of the device region

**xaxs** The style of axis interval calculation to be used for the x-axis

**yaxs** The style of axis interval calculation to be used for the y-axis

**lab** A numerical vector of the form c(x,y,len) which modifies the default way that axes are annotated

**setParUsrBB** default FALSE; set the par "usr" bounding box; see below

**bgMap** object of class ggmap, or returned by function RgoogleMaps::GetMap

**expandBB** numeric; factor to expand the plotting region default: bbox(x) with on each side (1=below, 2=left, 3=above and 4=right); defaults to c(0,0,0,0); setting xlim or ylim overrides this.

... passed through

**Warning**

this class is not useful in itself, but all spatial classes in this package derive from it

**Note**

The default aspect for map plots is 1; if however data are not projected (coordinates are longlat), the aspect is by default set to  $1/\cos(My * \pi)/180$  with My the y coordinate of the middle of the map (the mean of ylim, which defaults to the y range of bounding box).

The argument `setParUsrBB` may be used to pass the logical value TRUE to functions within `plot.Spatial`. When set to TRUE, `par("usr")` will be overwritten with `c(xlim,ylim)`, which defaults to the bounding box of the spatial object. This is only needed in the particular context of graphic output to a specified device with given width and height, to be matched to the spatial object, when using `par("xaxs")` and `par("yaxs")` in addition to `par(mar=c(0,0,0,0))`.

**Author(s)**

r-spatial team; Edzer Pebesma, <edzer.pebesma@uni-muenster.de> Roger Bivand, Barry Rowlingson, Virgilio Gómez-Rubio

**See Also**

[SpatialPoints-class](#), [SpatialGrid-class](#),  
[SpatialPointsDataFrame-class](#), [SpatialGridDataFrame-class](#)

**Examples**

```
o <- new("Spatial")
proj4string(o) <- CRS("+init=epsg:27700")
if (!is.null(comment(slot(o, "proj4string")))) {
  cat(strsplit(wkt(o), "\n")[[1]], sep="\n")
  cat(strsplit(wkt(slot(o, "proj4string")), "\n")[[1]], sep="\n")
}
```

---

SpatialGrid-class      *Class "SpatialGrid"*

---

**Description**

class for defining a full, rectangular grid of arbitrary dimension

**Objects from the Class**

Objects are created by using e.g.

`SpatialGrid(grid)`

with grid of class [GridTopology-class](#)

**Slots**

`grid` object of class [GridTopology-class](#), defining the grid topology (offset, cellsize, dim)

`bbox`: Object of class "matrix"; bounding box

`proj4string`: Object of class "CRS"; projection

**Extends**

Class "SpatialPoints" directly; Class "Spatial", by class "SpatialPoints".

**Methods**

**coordinates** signature(x = "SpatialGrid"): calculates coordinates for each point on the grid; coordinates are not stored in objects of class SpatialGrid

**summary** signature(object = "SpatialGrid"): summarize object

**plot** signature(x = "SpatialGrid"): plots cell centers

**"["** signature(x = "SpatialGrid"): select rows and columns

**Author(s)**

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

**See Also**

[SpatialGridDataFrame-class](#), [SpatialGrid](#)

**Examples**

```
x = GridTopology(c(0,0), c(1,1), c(5,5))
class(x)
x
summary(x)
coordinates(x)
y = SpatialGrid(grid = x)
class(y)
y
```

---

SpatialGridDataFrame-class

*Class "SpatialGridDataFrame"*

---

**Description**

Class for spatial attributes that have spatial locations on a (full) regular grid.

**Objects from the Class**

Objects can be created by calls of the form `as(x, "SpatialGridDataFrame")`, where `x` is of class [SpatialPixelsDataFrame-class](#), or by importing through `rgdal`. Ordered full grids are stored instead of unordered non-NA cells;



**Slots**

**grid**: see [GridTopology-class](#); grid parameters  
**bbox**: Object of class "matrix"; bounding box  
**proj4string**: Object of class "CRS"; projection  
**data**: Object of class data.frame, containing attribute data

**Extends**

Class "SpatialGrid", directly. Class "Spatial", by class "SpatialGrid".

**Methods**

**coordinates** signature(x = "SpatialGridDataFrame"): retrieves (and calculates!) coordinates  
**[** signature(x = "SpatialGridDataFrame"): selects rows, columns, and attributes; returns an object of class SpatialGridDataFrame  
**as.matrix** signature(x = "SpatialGridDataFrame"): coerce to matrix; increasing col index corresponds to decreasing y coordinate, row index increases with coordinate index  
**as.array** signature(x = "SpatialGridDataFrame"): coerce to array; increasing array index for the second dimension corresponds to decreasing coordinates, all other coordinate dimensions increase with array index  
**cbind** signature(...): if arguments have identical topology, combine their attribute values

**Plot method arguments**

The plot methods for "SpatialPixelsDataFrame" or "SpatialGridDataFrame" objects take the following arguments:

**x** object of class [SpatialPixelsDataFrame](#) or [SpatialGridDataFrame](#)  
**...** arguments passed on to [image.SpatialGridDataFrame](#)  
**attr** integer or character, indicating the attribute variable to be plotted; default 1  
**col** color ramp to be used; default `bpy.colors(100)` for continuous, or `RColorBrewer::brewer.pal(nlevels(x[[1]]), "` for factor variables  
**breaks** for continuous attributes: values at which color breaks should take place  
**zlim** for continuous attributes: numeric of length 2, specifying the range of attribute values to be plotted; default to data range `range(as.numeric(x[[attr]])[is.finite(x[[attr]])])`  
**axes** logical: draw x and y axes? default FALSE  
**xaxs** character, default "i", see [par](#)  
**yaxs** character, default equal to `xaxs`, see [par](#)  
**at** numeric or NULL, values at which axis ticks and labels should be drawn; default NULL (use [pretty](#))  
**border** color, to be used for drawing grid lines; default NA (don't draw grid lines)  
**axis.pos** integer, 1-4; default 4, see [axis](#)  
**add.axis** logical: draw axis along scale? default TRUE

**what** what to draw: "image", "scale", or "both"; default "both"

**scale.size** size for the scale bar; use `lcm` to specify in absolute size, or a numeric value such as 1/6 to specify relative size; default `lcm(2.8)`

**scale.shrink** non-negative numeric indicating the amount to shrink the scale length, default 0

**scale.frac** for categorical attributes: numeric between 0 and 1, indicating the scale width, default 0.3

**scale.n** for categorical attributes: integer, indicating how many scale categories should fill a complete width; default 15

### Author(s)

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

### See Also

[SpatialGrid-class](#), which does not contain the attribute data, and [SpatialPixelsDataFrame-class](#) which holds possibly incomplete grids

Plotting gridded data with sp: <https://www.r-spatial.org/r/2016/03/08/plotting-spatial-grids.html>

### Examples

```
data(meuse.grid) # only the non-missing valued cells
coordinates(meuse.grid) = c("x", "y") # promote to SpatialPointsDataFrame
gridded(meuse.grid) <- TRUE # promote to SpatialPixelsDataFrame
x = as(meuse.grid, "SpatialGridDataFrame") # creates the full grid
x[["idist"]] = 1 - x[["dist"]] # assigns new attribute
image(x[["idist"]]) # note the single [ for attribute selection

# toy example:
df = data.frame(z = c(1:6,NA,8,9),
               xc = c(1,1,1,2,2,2,3,3,3),
               yc = c(rep(c(0, 1.5, 3),3)))
coordinates(df) = ~xc+yc
gridded(df) = TRUE
df = as(df, "SpatialGridDataFrame") # to full grid
image(df[["z"]])
# draw labels to verify:
cc = coordinates(df)
z=df[["z"]]
zc=as.character(z)
zc[is.na(zc)]=NA
text(cc[,1],cc[,2],zc)

# the following is weird, but illustrates the concept of row/col selection:
fullgrid(meuse.grid) = TRUE
image(meuse.grid)
image(meuse.grid[20:70, 10:70, "dist"], add = TRUE, col = bpy.colors())

# as.matrix, as.array
```

```
sgdim = c(3,4)
SG = SpatialGrid(GridTopology(rep(0,2), rep(10,2), sgdim))
SGDF = SpatialGridDataFrame(SG, data.frame(val = 1:12))
as.array(SGDF)
as.matrix(SGDF)
as(SGDF, "array")
```

---

SpatialLines                      *create objects of class SpatialLines or SpatialLinesDataFrame*

---

### Description

create objects of class SpatialLines or SpatialLinesDataFrame from lists of Lines objects and data.frames; extract list of Lines from a SpatialLines object

### Usage

```
SpatialLines(LinesList, proj4string = CRS(as.character(NA)))
SpatialLinesDataFrame(sl, data, match.ID = TRUE)
as.SpatialLines.SLDF(SLDF)
getSpatialLinesMidPoints(SL)
LineLength(cc, longlat = FALSE, sum = TRUE)
LinesLength(Ls, longlat = FALSE)
SpatialLinesLengths(SL, longlat)
```

### Arguments

LinesList	list with objects of class <a href="#">Lines-class</a>
proj4string	Object of class "CRS"; holding a valid proj4 string
sl, SL	object of class <a href="#">SpatialLines-class</a>
data	object of class data.frame; the number of rows in data should equal the number of Lines elements in sl
match.ID	logical: (default TRUE): match SpatialLines member Lines ID slot values with data.frame row names, and re-order the data frame rows if necessary; if character: indicates the column in data with Lines IDs to match
SLDF	SpatialLinesDataFrame object
Ls	Object of class Lines
cc	Object of class Line, or two-column matrix with points
longlat	if FALSE, Euclidean distance, if TRUE Great Circle distance in kilometers
sum	logical; if TRUE return scalar length of sum of segments in Line, if FALSE return vector with segment lengths

**Value**

SpatialLines returns object of class SpatialLines; SpatialLinesDataFrame returns object of class SpatialLinesDataFrame getSpatialLinesMidPoints returns an object of class SpatialPoints, each point containing the (weighted) mean of the lines elements; weighted in the sense that mean is called twice.

**See Also**

[SpatialLines-class](#)

---

SpatialLines-class     *a class for spatial lines*

---

**Description**

a class that holds spatial lines

**Objects from the Class**

hold a list of Lines objects; each Lines object holds a list of Line (line) objects.

**Slots**

**lines:** Object of class "list"; list members are all of class [Lines-class](#)

**bbox:** Object of class "matrix"; see [Spatial-class](#)

**proj4string:** Object of class "CRS"; see [CRS-class](#)

**Extends**

Class "Spatial", directly.

**Methods**

[ signature(obj = "SpatialLines"): select subset of (sets of) lines; NAs are not permitted in the row index

**coordinates** value is a list of lists with matrices

**plot** signature(x = "SpatialLines", y = "missing"): plot lines in SpatialLines object

**lines** signature(x = "SpatialLines"): add lines in SpatialLines object to a plot

**rbind** signature(object = "SpatialLines"): rbind-like method, see notes

**summary** signature(object = "SpatialLines"): summarize object

**plot method arguments**

The plot method for “SpatialLines” objects takes the following arguments:

**x** object of class SpatialLines  
**xlim** default NULL; the x limits (x1, x2) of the plot  
**ylim** default NULL; the y limits of the plot  
**col** default 1; default plotting color  
**lwd** default 1; line width  
**lty** default 1; line type  
**add** default FALSE; add to existing plot  
**axes** default FALSE; a logical value indicating whether both axes should be drawn  
**lend** default 0; line end style  
**ljoin** default 0; line join style  
**lmitre** default 10; line mitre limit  
**...** passed through  
**setParUsrBB** set the par “usr” bounding box, see note in [Spatial-class](#)

**Note**

rbind calls the function [SpatialLines](#), where it is checked that all IDs are unique. If rbinding SpatialLines without unique IDs, it is possible to set the argument `makeUniqueIDs = TRUE`, although it is preferred to change these explicitly with [spChFIDs](#).

**Author(s)**

Roger Bivand, Edzer Pebesma

**See Also**

[Line-class](#), [Lines-class](#)

**Examples**

```
# from the sp vignette:
l1 = cbind(c(1,2,3),c(3,2,2))
rownames(l1) = letters[1:3]
l1a = cbind(l1[,1]+.05,l1[,2]+.05)
rownames(l1a) = letters[1:3]
l2 = cbind(c(1,2,3),c(1,1.5,1))
rownames(l2) = letters[1:3]
S11 = Line(l1)
S11a = Line(l1a)
S12 = Line(l2)
S1 = Lines(list(S11, S11a), ID="a")
S2 = Lines(list(S12), ID="b")
S1 = SpatialLines(list(S1,S2))
```

```
summary(S1)
plot(S1, col = c("red", "blue"))
```

---

SpatialLinesDataFrame-class

*a class for spatial lines with attributes*

---

### Description

this class holds data consisting of (sets of lines), where each set of lines relates to an attribute row in a data.frame

### Objects from the Class

can be created by the function [SpatialLinesDataFrame](#)

### Slots

**data:** Object of class [data.frame](#) containing the attribute table

**lines:** Object of class "list"; see [SpatialLines-class](#)

**bbox:** Object of class "matrix"; see [Spatial-class](#)

**proj4string:** Object of class "CRS"; see [CRS-class](#)

### Extends

Class "SpatialLines", directly. Class "Spatial", by class "SpatialLines".

### Methods

Methods defined with class "SpatialLinesDataFrame" in the signature:

[ signature(x = "SpatialLinesDataFrame"): subset rows or columns; in case of row subsetting, the line sets are also subsetted; NAs are not permitted in the row index

**coordinates** signature(obj = "SpatialLinesDataFrame"): retrieves a list with lists of coordinate matrices

**show** signature(object = "SpatialLinesDataFrame"): print method

**plot** signature(x = "SpatialLinesDataFrame"): plot points

**lines** signature(object = "SpatialLinesDataFrame"): add lines to plot

**rbind** signature(object = "SpatialLinesDataFrame"): rbind-like method

### Note

rbind for SpatialLinesDataFrame is only possible for objects with unique IDs. If you want to rbind objects with duplicated IDs, see [spChFIDs](#).

**Author(s)**

Roger Bivand; Edzer Pebesma

**See Also**

[SpatialLines-class](#)

---

SpatialMultiPoints      *create objects of class SpatialMultiPoints or SpatialMultiPoints-DataFrame*

---

**Description**

create objects of class [SpatialMultiPoints-class](#) or [SpatialMultiPointsDataFrame-class](#) from coordinates, and from coordinates and data.frames

**Usage**

```
SpatialMultiPoints(coords, proj4string=CRS(as.character(NA)), bbox = NULL)
SpatialMultiPointsDataFrame(coords, data,
                             proj4string = CRS(as.character(NA)), match.ID, bbox = NULL)
```

**Arguments**

coords	list with in each element a numeric matrix or data.frame with coordinates (each row representing a point); in case of SpatialMultiPointsDataFrame an object of class <a href="#">SpatialMultiPoints-class</a> is also allowed
proj4string	projection string of class <a href="#">CRS-class</a>
bbox	bounding box matrix, usually NULL and constructed from the data, but may be passed through for coercion purposes if clearly needed
data	object of class data.frame; the number of rows in data should equal the number of points in the coords object
match.ID	logical or character; if missing, and coords and data both have row names, and their order does not correspond, matching is done by these row names and a warning is issued; this warning can be suppressed by setting match.ID to TRUE. If TRUE AND coords has non-automatic rownames (i.e., coerced to a matrix by as.matrix, dimnames(coords)[[1]] is not NULL), AND data has row.names (i.e. is a data.frame), then the SpatialMultiPointsDataFrame object is formed by matching the row names of both components, leaving the order of the coordinates in tact. Checks are done to see whether both row names are sufficiently unique, and all data are matched. If FALSE, coordinates and data are simply "glued" together, ignoring row names. If character: indicates the column in data with coordinates IDs to use for matching records. See examples below.

**Value**

SpatialMultiPoints returns an object of class SpatialMultiPoints; SpatialMultiPointsDataFrame returns an object of class SpatialMultiPointsDataFrame;

**See Also**

[coordinates](#), [SpatialMultiPoints-class](#), [SpatialMultiPointsDataFrame-class](#)

**Examples**

```
c11 = cbind(rnorm(3, 10), rnorm(3, 10))
c12 = cbind(rnorm(5, 10), rnorm(5, 0))
c13 = cbind(rnorm(7, 0), rnorm(7, 10))

mp = SpatialMultiPoints(list(c11, c12, c13))
mpx = rbind(mp, mp) # rbind method
plot(mp, col = 2, cex = 1, pch = 1:3)
mp
mp[1:2]

print(mp, asWKT=TRUE, digits=3)

mpdf = SpatialMultiPointsDataFrame(list(c11, c12, c13), data.frame(a = 1:3))
mpdf
mpdfx = rbind(mpdf, mpdf) # rbind method

plot(mpdf, col = mpdf$a, cex = 1:3)
as(mpdf, "data.frame")
mpdf[1:2,]
```

---

SpatialMultiPoints-class

*Class "SpatialMultiPoints"*

---

**Description**

Class for (irregularly spaced) MultiPoints

**Objects from the Class**

Objects can be created by calls of the form SpatialPoints(x).

**Slots**

**coords:** Object of class "list", containing the coordinates of point sets (each list element is a matrix)

**bbox:** Object of class "matrix", with bounding box

**proj4string:** Object of class "CRS", projection string



**Extends**

Class "Spatial", directly.

**Methods**

**[** signature(x = "SpatialMultiPoints"): subsets point sets  
**coerce** signature(from = "SpatialPoints", to = "data.frame"): coerce to data.frame  
**coordinates** signature(obj = "SpatialMultiPoints"): retrieves all the coordinates, as one single matrix  
**plot** signature(x = "SpatialPoints", y = "missing"): plot points  
**summary** signature(object = "SpatialPoints"): summarize object  
**points** signature(x = "SpatialPoints"): add point symbols to plot  
**show** signature(object = "SpatialPoints"): prints coordinates  
**rbind** signature(object = "SpatialPoints"): rbind-like method

**plot method arguments**

The plot method for "SpatialPoints" objects takes the following arguments:

**x** object of class SpatialPoints  
**pch** default 3; either an integer specifying a symbol or a single character to be used as the default in plotting points  
**axes** default FALSE; a logical value indicating whether both axes should be drawn  
**add** default FALSE; add to existing plot  
**xlim** default NULL; the x limits (x1, x2) of the plot  
**ylim** default NULL; the y limits of the plot  
**...** passed through  
**setParUsrBB** default FALSE; set the par "usr" bounding box, see note in [Spatial-class](#)  
**cex** default 1; numerical value giving the amount by which plotting text and symbols should be magnified relative to the default  
**col** default 1; default plotting color  
**lwd** default 1; line width  
**bg** default 1; colour to be used for the background of the device region

**Author(s)**

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

**See Also**

[SpatialMultiPointsDataFrame-class](#) [SpatialPoints-class](#)

**Examples**

```

c11 = cbind(rnorm(3, 10), rnorm(3, 10))
c12 = cbind(rnorm(5, 10), rnorm(5, 0))
c13 = cbind(rnorm(7, 0), rnorm(7, 10))

mp = SpatialMultiPoints(list(c11, c12, c13))
plot(mp, col = 2, cex = 1, pch = 1:3)
mp
mp[1:2]

print(mp, asWKT=TRUE, digits=3)

```

---

SpatialMultiPointsDataFrame-class

*Class "SpatialMultiPointsDataFrame"*

---

**Description**

Class for spatial attributes that correspond to point sets

**Usage**

```

## S4 method for signature 'SpatialMultiPointsDataFrame'
x[i, j, ..., drop = TRUE]
## S4 method for signature 'SpatialMultiPointsDataFrame,data.frame'
coerce(from, to, strict=TRUE)
## S4 method for signature 'SpatialMultiPointsDataFrame'
coordinates(obj)
## S4 method for signature 'SpatialMultiPointsDataFrame'
show(object)
## S4 method for signature 'SpatialMultiPointsDataFrame'
points(x)

```

**Arguments**

x, from, obj, object	SpatialMultiPointsDataFrame object
to	class to which to coerce
strict	see <a href="#">as</a>
i	row indices
j	column indices
drop	see <a href="#">Extract</a>
...	indices passed through

**Slots**

**data:** Object of class `data.frame` containing the attribute data (may or may not contain the coordinates in its columns)

**coords:** Object of class `"list"`; the list with coordinates matrices; points are rows in the matrix, the list length equals the number of rows in the data slot

**bbox:** Object of class `"matrix"`; bounding box

**proj4string:** Object of class `"CRS"`; projection string

**Extends**

Class `"SpatialMultiPoints"`, directly. Class `"Spatial"`, by class `"SpatialMultiPoints"`.

**Author(s)**

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

**See Also**

[coordinates](#), [SpatialMultiPoints-class](#)

**Examples**

```
# create three sets of points:
c11 = cbind(rnorm(3, 10), rnorm(3, 10))
c12 = cbind(rnorm(5, 10), rnorm(5, 0))
c13 = cbind(rnorm(7, 0), rnorm(7, 10))

mpdf = SpatialMultiPointsDataFrame(list(c11, c12, c13), data.frame(a = 1:3))
mpdf

plot(mpdf, col = mpdf$a, cex = 1:3)
as(mpdf, "data.frame")
mpdf[1:2,]
```

---

SpatialPixels

*define spatial grid*

---

**Description**

defines spatial grid by offset, cell size and dimensions

**Usage**

```

GridTopology(cellcentre.offset, cellsize, cells.dim)
SpatialPixels(points, tolerance = sqrt(.Machine$double.eps),
proj4string = CRS(as.character(NA)), round = NULL, grid = NULL)
SpatialGrid(grid, proj4string = CRS(as.character(NA)))
coordinatevalues(obj)
points2grid(points, tolerance = sqrt(.Machine$double.eps), round=NULL)
getGridIndex(cc, grid, all.inside = TRUE)
getGridTopology(obj)
areaSpatialGrid(obj)

```

**Arguments**

<code>cellcentre.offset</code>	numeric; vector with the smallest centroid coordinates for each dimension; coordinates refer to the cell centre
<code>cellsize</code>	numeric; vector with the cell size in each dimension
<code>cells.dim</code>	integer; vector with number of cells in each dimension
<code>points</code>	coordinates, object of class <a href="#">SpatialPoints-class</a>
<code>grid</code>	grid topology; object of class <a href="#">GridTopology-class</a> ; for calls to <code>SpatialPixels</code> , a value of <code>NULL</code> implies that this will be derived from the point coordinates
<code>tolerance</code>	precision, used to which extent points are exactly on a grid
<code>round</code>	default <code>NULL</code> , otherwise a value passed to as the <code>digits</code> argument to <code>round</code> for setting cell size
<code>proj4string</code>	object of class <a href="#">CRS-class</a>
<code>obj</code>	object of class or deriving from <a href="#">SpatialGrid-class</a>
<code>cc</code>	numeric matrix with coordinates
<code>all.inside</code>	logical; if <code>TRUE</code> and <code>cc</code> points fall outside the grid area, an error message is generated; if <code>FALSE</code> , <code>NA</code> values are generated for such points

**Value**

`GridTopology` returns a value of class [GridTopology-class](#); `SpatialGrid` returns an object of class [SpatialGrid-class](#)

`coordinatevalues` returns a list with the unique x-coordinates, the unique y-coordinate, etc. instead of the [coordinates](#) of all grid cells

`SpatialGrid` returns an object of class [SpatialGrid-class](#).

`points2grid` returns the [GridTopology-class](#) from a set of points.

`getGridIndex` finds the index of a set of point coordinates in a given grid topology, and depending on `all.inside` setting, generates `NA` or an error message if points are outside the grid domain.

`getGridTopology` returns the slot of class [GridTopology-class](#) from `obj`.

`areaSpatialGrid` returns the spatial area of (the non-missing valued cells of) the grid. For objects of class [SpatialGridDataFrame-class](#) the area refers to cells where any (one or more) of the attribute columns are non-missing valued.

**Note**

SpatialGrid stores grid topology and may or may not store the coordinates of the actual points, which may form a subset of the full grid. To find out or change this, see [fullgrid](#).

points2grid tries to figure out the grid topology from points. It succeeds only if points on a grid line have constant y column, and points on a grid column have constant x coordinate, etc. In other cases, use signif on the raw coordinate matrices to make sure this is the case.

**Author(s)**

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

**See Also**

[SpatialGrid-class](#), [SpatialGridDataFrame-class](#),

**Examples**

```
x = GridTopology(c(0,0), c(1,1), c(5,4))
class(x)
x
summary(x)
coordinates(x)
coordinates(GridTopology(c(0,0), c(1,1), c(5,4)))
coordinatevalues(x)
data(meuse.grid)
coordinates(meuse.grid) <- c("x", "y")
points2grid(meuse.grid)
data(meuse.grid)
set.seed(1)
meuse.grid$x <- meuse.grid$x + rnorm(length(meuse.grid$x), 0, 0.002)
meuse.grid$y <- meuse.grid$y + rnorm(length(meuse.grid$y), 0, 0.002)
coordinates(meuse.grid) <- c("x", "y")
#EJP
# points2grid(meuse.grid, tolerance=0.76, round=1)
data(meuse.grid)
a <- which(meuse.grid$x == 180140)
b <- which(meuse.grid$x == 180180)
c <- which(meuse.grid$x == 179260)
d <- which(meuse.grid$y == 332460)
e <- which(meuse.grid$y == 332420)
f <- which(meuse.grid$y == 330740)
meuse.grid <- meuse.grid[-c(a, b, c, d, e, f),]
coordinates(meuse.grid) <- c("x", "y")
points2grid(meuse.grid)
data(meuse.grid)
set.seed(1)
meuse.grid$x <- meuse.grid$x + rnorm(length(meuse.grid$x), 0, 0.002)
meuse.grid$y <- meuse.grid$y + rnorm(length(meuse.grid$y), 0, 0.002)
meuse.grid <- meuse.grid[-c(a, b, c, d, e, f),]
coordinates(meuse.grid) <- c("x", "y")
# EJP
```

```
# points2grid(meuse.grid, tolerance=0.69, round=1)
```

---

SpatialPixels-class    *Class "SpatialPixels"*

---

### Description

class for defining a pixels, forming a possibly incomplete rectangular grid of arbitrary dimension

### Objects from the Class

Objects are created by using e.g.

```
SpatialPixels(points)
```

with points of class [SpatialPoints-class](#)

### Slots

`grid` object of class [GridTopology-class](#), defining the grid topology (offset, cellsize, dim)

`grid.index` integer; index of points in full grid

`coords` coordinates of points, or bbox of grid

`bbox`: Object of class "matrix"; bounding box

`proj4string`: Object of class "CRS"; projection

### Extends

Class "SpatialPoints" directly; Class "Spatial", by class "SpatialPoints".

### Methods

**coordinates** signature(x = "SpatialPixels"): calculates coordinates for each point on the grid; coordinates are not stored in objects of class SpatialGrid

**summary** signature(object = "SpatialPixels"): summarize object

**plot** signature(x = "SpatialPixels"): plots cell centers

**"["** signature(x = "SpatialPixels"): select pixel cells; the argument drop=FALSE (default) does not recalculate grid topology for the selection, if drop=TRUE the grid topology is recomputed, and might change.

**rbind** signature(x = "SpatialPixels"): rbind-like method

### Author(s)

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

### See Also

[SpatialPixelsDataFrame-class](#), [SpatialGrid-class](#)

**Examples**

```

data(meuse.grid)
pts = meuse.grid[c("x", "y")]
y = SpatialPixels(SpatialPoints(pts))
class(y)
y
summary(y)
plot(y) # plots grid
plot(y, grid = FALSE) # plots points

```

---

SpatialPixelsDataFrame

*define spatial grid with attribute data*


---

**Description**

defines spatial grid by offset, cell size and dimensions

**Usage**

```

SpatialPixelsDataFrame(points, data, tolerance = sqrt(.Machine$double.eps),
proj4string = CRS(as.character(NA)), round = NULL, grid = NULL)
SpatialGridDataFrame(grid, data, proj4string = CRS(as.character(NA)))

```

**Arguments**

points	coordinates, either as numeric matrix or as object of class <a href="#">SpatialPoints-class</a>
grid	grid topology; object of class <a href="#">GridTopology-class</a> ; for calls to <code>SpatialPixelsDataFrame</code> a value of <code>NULL</code> implies that this will be derived from the point coordinates
data	data.frame; contains the attribute (actual grid) data
tolerance	precision up to which extent points should be exactly on a grid
round	default <code>NULL</code> , otherwise a value passed to as the <code>digits</code> argument to <code>round</code> for setting cell size
proj4string	object of class <a href="#">CRS-class</a> in the first form only used when <code>points</code> does not inherit from <a href="#">Spatial-class</a>

**Value**

`SpatialPixelsDataFrame` returns an object of class [SpatialPixelsDataFrame-class](#); `SpatialGridDataFrame` returns an object of class [SpatialGridDataFrame-class](#).

**Note**

`SpatialPixels` stores grid topology and coordinates of the actual points, which may be in the form of a subset (set of pixels) of a full grid. To find out or change this, see [fullgrid](#) and [SpatialGrid-class](#).

**Author(s)**

Edzer Pebesma

**See Also**[gridded](#), [gridded<-](#), [SpatialGrid](#), [SpatialGrid-class](#)**Examples**

```
data(meuse.grid)
m = SpatialPixelsDataFrame(points = meuse.grid[c("x", "y")], data = meuse.grid)
class(m)
summary(m)
```

---

 SpatialPixelsDataFrame-class

*Class "SpatialPixelsDataFrame"*


---

**Description**

Class for spatial attributes that have spatial locations on a regular grid.

**Objects from the Class**

Objects can be created by calls of the form `as(x, "SpatialPixelsDataFrame")`, where `x` is of class [SpatialPointsDataFrame-class](#), or by importing through `rgdal`. Ordered full grids are stored instead of unordered non-NA cells;

**Slots**

`bbox`: Object of class "matrix"; bounding box

`proj4string`: Object of class "CRS"; projection

`coords`: see [SpatialPoints](#); points slot

`coords.nrs` see [SpatialPointsDataFrame](#)

`grid`: see [GridTopology-class](#); grid parameters

`grid.index`: integer; index of points in the list to points in the full (ordered) grid. `x` cycles fastest; all coordinates increase from low to high except `y`, which decreases from high to low

`data`: Object of class `data.frame`, containing the attribute data

**Extends**

Class "SpatialPixels", directly. Class "Spatial", by class "SpatialPixels".



**Methods**

- coordinates** signature(x = "SpatialPixelsDataFrame"): retrieves coordinates
- [ signature(x = "SpatialPixelsDataFrame"): selects row(s) and/or attribute(s), and returns an object of class SpatialPixelsDataFrame; rows refer here to the pixel numbers, not grid lines. For selecting a square block in a grid, coerce to a [SpatialGridDataFrame-class](#) first, and use [ on that object
- as.matrix** signature(x = "SpatialPixelsDataFrame"): coerce to matrix
- rbind** signature(x = "SpatialPixelsDataFrame"): rbind-like method
- plot** signature(x = "SpatialPixelsDataFrame", y = "missing"): see [SpatialGridDataFrame-class](#) for details

**Author(s)**

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

**See Also**

[SpatialPixels-class](#), which does not contain the attribute data

**Examples**

```
data(meuse.grid) # only the non-missing valued cells
coordinates(meuse.grid) = c("x", "y") # promote to SpatialPointsDataFrame
gridded(meuse.grid) <- TRUE # promote to SpatialPixelsDataFrame
meuse.grid[["idist"]] = 1 - meuse.grid[["dist"]] # assigns new attribute
image(meuse.grid[["idist"]]) # note the single [

# toy example:
df = data.frame(z = c(1:6, NA, 8, 9),
               xc = c(1, 1, 1, 2, 2, 2, 3, 3, 3),
               yc = c(rep(c(0, 1.5, 3), 3)))
coordinates(df) = ~xc+yc
gridded(df) = TRUE
image(df[["z"]])
# draw labels to verify:
cc = coordinates(df)
z=df[["z"]]
zc=as.character(z)
zc[is.na(zc)]= "NA"
text(cc[,1], cc[,2], zc)
```

---

SpatialPoints                      *create objects of class SpatialPoints or SpatialPointsDataFrame*

---

### Description

create objects of class [SpatialPoints-class](#) or [SpatialPointsDataFrame-class](#) from coordinates, and from coordinates and data.frames

### Usage

```
SpatialPoints(coords, proj4string=CRS(as.character(NA)), bbox = NULL)
SpatialPointsDataFrame(coords, data, coords.nrs = numeric(0),
  proj4string = CRS(as.character(NA)), match.ID, bbox = NULL)
```

### Arguments

coords	numeric matrix or data.frame with coordinates (each row is a point); in case of SpatialPointsDataFrame an object of class <a href="#">SpatialPoints-class</a> is also allowed
proj4string	projection string of class <a href="#">CRS-class</a>
bbox	bounding box matrix, usually NULL and constructed from the data, but may be passed through for coercion purposes if clearly needed
data	object of class data.frame; the number of rows in data should equal the number of points in the coords object
coords.nrs	numeric; if present, records the column positions where in data the coordinates were taken from (used by <a href="#">coordinates&lt;-</a> )
match.ID	logical or character; if missing, and coords and data both have row names, and their order does not correspond, matching is done by these row names and a warning is issued; this warning can be suppressed by setting match.ID to TRUE. If TRUE AND coords has non-automatic rownames (i.e., coerced to a matrix by as.matrix, dimnames(coords)[[1]] is not NULL), AND data has row.names (i.e. is a data.frame), then the SpatialPointsDataFrame object is formed by matching the row names of both components, leaving the order of the coordinates in tact. Checks are done to see whether both row names are sufficiently unique, and all data are matched. If FALSE, coordinates and data are simply "glued" together, ignoring row names. If character: indicates the column in data with coordinates IDs to use for matching records. See examples below.

### Value

SpatialPoints returns an object of class SpatialPoints; SpatialPointsDataFrame returns an object of class SpatialPointsDataFrame;

### See Also

[coordinates](#), [SpatialPoints-class](#), [SpatialPointsDataFrame-class](#)

**Examples**

```

set.seed(1331)
pts = cbind(1:5, 1:5)
dimnames(pts)[[1]] = letters[1:5]
df = data.frame(a = 1:5)
row.names(df) = letters[5:1]

library(sp)
options(warn=1) # show warnings where they occur
SpatialPointsDataFrame(pts, df) # warn
SpatialPointsDataFrame(pts, df, match.ID = TRUE) # don't warn
SpatialPointsDataFrame(pts, df, match.ID = FALSE) # don't warn
df$m = letters[5:1]
SpatialPointsDataFrame(pts, df, match.ID = "m") # don't warn

dimnames(pts)[[1]] = letters[5:1]
SpatialPointsDataFrame(pts, df) # don't warn: ID matching doesn't reorder

```

---

SpatialPoints-class    *Class "SpatialPoints"*

---

**Description**

Class for (irregularly spaced) points

**Objects from the Class**

Objects can be created by calls of the form `SpatialPoints(x)`.

**Slots**

**coords:** Object of class "matrix", containing the coordinates (each row is a point)

**bbox:** Object of class "matrix", with bounding box

**proj4string:** Object of class "CRS", projection string

**Extends**

Class "Spatial", directly.

**Methods**

[ signature(`x = "SpatialPoints"`): subsets the points; only rows (points) can be subsetted

**coerce** signature(`from = "SpatialPoints"`, `to = "data.frame"`): retrieves the data part

**coerce** signature(`from = "SpatialPoints"`, `to = "SpatialPixels"`): equivalent to assigning gridded TRUE for a copy of the object

**coerce** signature(`from = "SpatialPointsDataFrame"`, `to = "SpatialPixelsDataFrame"`): equivalent to assigning gridded TRUE for a copy of the object

**coerce** signature(from = "data.frame", to = "SpatialPoints"): sets coordinates, which may be in a data frame

**coerce** signature(from = "matrix", to = "SpatialPoints"): set coordinates, which may be in a matrix

**coordinates** signature(obj = "SpatialPoints"): retrieves the coordinates, as matrix

**plot** signature(x = "SpatialPoints", y = "missing"): plot points

**summary** signature(object = "SpatialPoints"): summarize object

**points** signature(x = "SpatialPoints"): add point symbols to plot

**show** signature(object = "SpatialPoints"): prints coordinates

**rbind** signature(object = "SpatialPoints"): rbind-like method

### plot method arguments

The plot method for "SpatialPoints" objects takes the following arguments:

**x** object of class SpatialPoints

**pch** default 3; either an integer specifying a symbol or a single character to be used as the default in plotting points

**axes** default FALSE; a logical value indicating whether both axes should be drawn

**add** default FALSE; add to existing plot

**xlim** default NULL; the x limits (x1, x2) of the plot

**ylim** default NULL; the y limits of the plot

... passed through

**setParUsrBB** default FALSE; set the par "usr" bounding box, see note in [Spatial-class](#)

**cex** default 1; numerical value giving the amount by which plotting text and symbols should be magnified relative to the default

**col** default 1; default plotting color

**lwd** default 1; line width

**bg** default 1; colour to be used for the background of the device region

### Author(s)

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

### See Also

[SpatialPointsDataFrame-class](#)

### Examples

```
x = c(1,2,3,4,5)
y = c(3,2,5,1,4)
S <- SpatialPoints(cbind(x,y))
S <- SpatialPoints(list(x,y))
S <- SpatialPoints(data.frame(x,y))
S
plot(S)
```

---

```
SpatialPointsDataFrame-class
      Class "SpatialPointsDataFrame"
```

---

### Description

Class for spatial attributes that have spatial point locations

### Usage

```
## S4 method for signature 'SpatialPointsDataFrame'
x[i, j, ..., drop = TRUE]
## S4 method for signature 'SpatialPointsDataFrame,SpatialPoints'
coerce(from, to, strict=TRUE)
## S4 method for signature 'SpatialPointsDataFrame,data.frame'
coerce(from, to, strict=TRUE)
## S4 method for signature 'SpatialPointsDataFrame'
coordinates(obj)
## S4 method for signature 'SpatialPointsDataFrame'
show(object)
## S4 method for signature 'SpatialPointsDataFrame'
points(x)
## S3 method for class 'SpatialPointsDataFrame'
rbind(...)
```

### Arguments

<code>x, from, obj, object</code>	SpatialPointsDataFrame object
<code>to</code>	class to which to coerce
<code>strict</code>	see <a href="#">as</a>
<code>i</code>	row indices
<code>j</code>	column indices
<code>drop</code>	see <a href="#">Extract</a>
<code>...</code>	indices passed through

### Objects from the Class

Objects can be created by calls of the form `coordinates(x) = c("x", "y")` . or of the form `coordinates(x) = xy`; see [coordinates](#).

**Slots**

**data:** Object of class `data.frame` containing the attribute data (may or may not contain the coordinates in its columns)

**coords:** Object of class `"matrix"`; the coordinates matrix (points are rows in the matrix)

**coords.nrs** Object of class `logical`; if `TRUE`, when the object was created the coordinates were retrieved from the `data.frame`, and hence stripped from it; after coercion to `data.frame`, e.g. by `as.data.frame(x)`, coordinates will again be added (as first few columns) to the `data.frame`

**bbox:** Object of class `"matrix"`; bounding box

**proj4string:** Object of class `"CRS"`; projection string

**Extends**

Class `"SpatialPoints"`, directly. Class `"Spatial"`, by class `"SpatialPoints"`.

**Author(s)**

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

**See Also**

[coordinates](#), [SpatialPoints-class](#)

**Examples**

```
data(meuse)
xy = meuse[c("x", "y")] # retrieve coordinates as data.frame
class(meuse)
data(meuse) # reload data.frame
coordinates(meuse) = c("x", "y") # specify column names
class(meuse)
data(meuse) # reload data.frame
coordinates(meuse) = c(1, 2) # specify column names
class(meuse)
data(meuse) # reload data.frame
coordinates(meuse) = ~x+y # formula
class(meuse)
data(meuse) # reload data.frame
coordinates(meuse) = xy # as data frame
class(meuse)
data(meuse) # reload data.frame
coordinates(meuse) = as.matrix(xy) # as matrix
meuse$log.zn = log(meuse$zinc)
class(meuse)
dim(meuse)
```

---

SpatialPolygons      *create objects of class SpatialPolygons or SpatialPolygonsDataFrame*

---

## Description

create objects of class SpatialPolygons or SpatialPolygonsDataFrame from lists of Polygons objects and data.frames

## Usage

```
Polygon(coords, hole=as.logical(NA))
Polygons(srl, ID)
SpatialPolygons(Sr1, p0, proj4string=CRS(as.character(NA)))
SpatialPolygonsDataFrame(Sr, data, match.ID = TRUE)
getSpatialPolygonsLabelPoints(SP)
```

## Arguments

coords	2-column numeric matrix with coordinates; first point (row) should equal last coordinates (row); if the hole argument is not given, the status of the polygon as a hole or an island will be taken from the ring direction, with clockwise meaning island, and counter-clockwise meaning hole
hole	logical value for setting polygon as hole or not; if the hole argument is not given, the status of the polygon as a hole or an island will be taken from the ring direction, with clockwise meaning island, and counter-clockwise meaning hole
proj4string	projection string of class <a href="#">CRS-class</a>
srl	list with <a href="#">Polygon-class</a> objects
ID	character vector of length one with identifier
Sr1	list with objects of class <a href="#">Polygons-class</a>
p0	integer vector; plotting order; if missing in reverse order of Polygons area
Sr	object of class <a href="#">SpatialPolygons-class</a>
data	object of class <code>data.frame</code> ; the number of rows in data should equal the number of <a href="#">Polygons-class</a> objects in Sr
match.ID	logical: (default TRUE): match SpatialPolygons member Polygons ID slot values with data frame row names, and re-order the data frame rows if necessary. If character: indicates the column in data with Polygons IDs to match
SP	object of class <a href="#">SpatialPolygons-class</a>

**Details**

In Polygon, if the hole argument is not given, the status of the polygon as a hole or an island will be taken from the ring direction, with clockwise meaning island, and counter-clockwise meaning hole. In Polygons, if all of the member Polygon objects are holes, the largest by area will be converted to island status. Until 2010-04-17, version 0.9-61, the area of this converted object was erroneously left at its hole value of zero. Thanks to Patrick Giraudoux for spotting the bug.

The class definitions used for polygons in **sp** do not accord with those of the simple features specification of the Open Geospatial Consortium. The **rgeos** package, an interface to Geometry Engine – Open Source (GEOS), uses this specification, in which each hole (interior ring) must be associated with its containing exterior ring. In order to avoid introducing incompatible changes into the class definition of Polygons objects, a comment has been added as a single character string to each such object. Here we can trust the data source to assign the hole status correctly, and use the simple function `createSPComment` to add such comments to each Polygons member of the polygons slot of this SpatialPolygons object. Exterior rings are coded zero, while interior rings are coded with the 1-based index of the exterior ring to which they belong. SpatialPolygons objects created by reading using `readOGR` from **rgdal** have the comments set on input, as OGR also uses SFS.

Refer to Bivand et al. (2013), pages 47-48 and 132-133 for a further discussion.

**Value**

Polygon returns an object of class Polygon; Polygons returns an object of class Polygons; SpatialPolygons returns object of class SpatialPolygons; SpatialPolygonsDataFrame returns object of class SpatialPolygonsDataFrame `getSpatialPolygonsLabelPoints` returns an object of class SpatialPoints with label points.

**References**

Roger Bivand, Edzer Pebesma and Virgilio Gomez-Rubio, 2013. Applied spatial data analysis with R, Second edition. Springer, NY. <https://asdar-book.org/>

**See Also**

[SpatialPolygons-class](#), [SpatialPolygonsDataFrame-class](#)

---

SpatialPolygons-class *Class "SpatialPolygons"*

---

**Description**

class to hold polygon topology (without attributes)

**Objects from the Class**

Objects can be created by calls to the function [SpatialPolygons](#)



**Slots**

**polygons:** Object of class "list"; list elements are all of class [Polygons-class](#)  
**plotOrder:** Object of class "integer"; integer array giving the order in which objects should be plotted  
**bbox:** Object of class "matrix"; see [Spatial-class](#)  
**proj4string:** Object of class "CRS"; see [CRS-class](#)

**Extends**

Class "Spatial", directly.

**Methods**

Methods defined with class "SpatialPolygons" in the signature:

[ signature(obj = "SpatialPolygons"): select subset of (sets of) polygons; NAs are not permitted in the row index  
**plot** signature(x = "SpatialPolygons", y = "missing"): plot polygons in SpatialPolygons object  
**summary** signature(object = "SpatialPolygons"): summarize object  
**rbind** signature(object = "SpatialPolygons"): rbind-like method

**plot method arguments**

The plot method for spatial polygons takes the following arguments:

**x** a SpatialPolygons object  
**col** a vector of colour values  
**border** default par("fg"); the colour to draw the border  
**add** default FALSE; if TRUE, add to existing plot  
**xlim, ylim** default NULL; ranges for the plotted 'x' and 'y' values  
**xpd** default NULL; controls clipping, see [par](#)  
**density** default NULL; the density of shading lines, in lines per inch, see [polygon](#)  
**angle** default 45; the slope of shading lines, given as an angle in degrees (counter-clockwise), see [polygon](#)  
**pbg** default NULL, set to par("bg") by default "transparent"; the colour to paint holes  
**axes** default FALSE; draw axes  
**lty** default par("lty"); border line type  
**...** other arguments passed through  
**setParUsrBB** default FALSE; see [Spatial-class](#) for further details  
**usePolypath** default NULL to set from option value; use [polypath](#) for hole-handling in plot  
**rule** default NULL to set from option value; character value specifying the path fill mode, see [polypath](#)

The options for `usePolypath` and `rule` may be retrieved with `get_Polypath` (default TRUE on package load) and `get_PolypathRule` (default “winding” on package load), and set with `set_Polypath` and `set_PolypathRule`

The class definitions used for polygons in **sp** do not accord with those of the simple features specification of the Open Geospatial Consortium. The **rgeos** package, an interface to Geometry Engine – Open Source (GEOS), uses this specification, in which each hole (interior ring) must be associated with its containing exterior ring. In order to avoid introducing incompatible changes into the class definition of Polygons objects, a comment has been added as a single character string to each such object. Here we can trust the data source to assign the hole status correctly, and use the simple function `createSPComment` to add such comments to each Polygons member of the polygons slot of this SpatialPolygons object. Exterior rings are coded zero, while interior rings are coded with the 1-based index of the exterior ring to which they belong. SpatialPolygons objects created by reading using `readOGR` from **rgdal** have the comments set on input, as OGR also uses SFS.

Refer to Bivand et al. (2013), pages 47-48 and 132-133 for a further discussion.

### Note

`rbind` calls the function `SpatialPolygons`, where it is checked that all IDs are unique. If `rbind`-ing `SpatialPolygons` without unique IDs, it is possible to set the argument `makeUniqueIDs = TRUE`, although it is preferred to change these explicitly with `spChFIDs`.

### Author(s)

Roger Bivand

### References

Roger Bivand, Edzer Pebesma and Virgilio Gomez-Rubio, 2013. Applied spatial data analysis with R, Second edition. Springer, NY. <https://asdar-book.org/>

### See Also

[SpatialPolygons](#)

### Examples

```
# simple example, from vignette("sp"):
Sr1 = Polygon(cbind(c(2,4,4,1,2),c(2,3,5,4,2)))
Sr2 = Polygon(cbind(c(5,4,2,5),c(2,3,2,2)))
Sr3 = Polygon(cbind(c(4,4,5,10,4),c(5,3,2,5,5)))
Sr4 = Polygon(cbind(c(5,6,6,5,5),c(4,4,3,3,4)), hole = TRUE)

Srs1 = Polygons(list(Sr1), "s1")
Srs2 = Polygons(list(Sr2), "s2")
Srs3 = Polygons(list(Sr3, Sr4), "s3/4")
SpP = SpatialPolygons(list(Srs1,Srs2,Srs3), 1:3)
plot(SpP, col = 1:3, pbg="white")

grd <- GridTopology(c(1,1), c(1,1), c(10,10))
polys <- as(grd, "SpatialPolygons")
```

```
plot(polys)
text(coordinates(polys), labels=row.names(polys))
```

---

SpatialPolygonsDataFrame-class

*Class "SpatialPolygonsDataFrame"*

---

## Description

class to hold polygons with attributes

## Objects from the Class

Objects can be created by calls to the function [SpatialPolygonsDataFrame](#)

## Slots

**data:** Object of class "data.frame"; attribute table

**polygons:** Object of class "list"; see [SpatialPolygons-class](#)

**plotOrder:** Object of class "integer"; see [SpatialPolygons-class](#)

**bbox:** Object of class "matrix"; see [Spatial-class](#)

**proj4string:** Object of class "CRS"; see [CRS-class](#)

## Extends

Class "SpatialPolygons", directly. Class "Spatial", by class "SpatialPolygons".

## Methods

Methods defined with class "SpatialPolygonsDataFrame" in the signature:

[ signature(x = "SpatialPolygonsDataFrame"): select subset of (sets of) polygons; NAs are not permitted in the row index

**rbind** signature(object = "SpatialPolygonsDataFrame"): rbind-like method, see notes below

## Note

SpatialPolygonsDataFrame with default ID matching checks the data frame row names against the Polygons ID slots. They must then agree with each other, and be unique (no Polygons objects can share IDs); the data frame rows will be re-ordered if needed to match the Polygons IDs..

If you want to rbind objects with duplicated IDs, see [spChFIDs](#).

## Author(s)

Roger Bivand

**See Also**

[SpatialPolygons-class](#)

**Examples**

```
# simple example, from scratch:
Sr1 = Polygon(cbind(c(2,4,4,1,2),c(2,3,5,4,2)))
Sr2 = Polygon(cbind(c(5,4,2,5),c(2,3,2,2)))
Sr3 = Polygon(cbind(c(4,4,5,10,4),c(5,3,2,5,5)))
Sr4 = Polygon(cbind(c(5,6,6,5,5),c(4,4,3,3,4)), hole = TRUE)

Srs1 = Polygons(list(Sr1), "s1")
Srs2 = Polygons(list(Sr2), "s2")
Srs3 = Polygons(list(Sr3, Sr4), "s3/4")
SpP = SpatialPolygons(list(Srs1,Srs2,Srs3), 1:3)
plot(SpP, col = 1:3, pbg="white")

grd <- GridTopology(c(1,1), c(1,1), c(10,10))
polys <- as(grd, "SpatialPolygons")
centroids <- coordinates(polys)
x <- centroids[,1]
y <- centroids[,2]
z <- 1.4 + 0.1*x + 0.2*y + 0.002*x*x
ex_1.7 <- SpatialPolygonsDataFrame(polys,
  data=data.frame(x=x, y=y, z=z, row.names=row.names(polys)))
brks <- quantile(z, seq(0,1,1/7))
cols <- grey((length(brks):2)/length(brks))
dens <- (2:length(brks))*3
plot(ex_1.7, col=cols[findInterval(z, brks, all.inside=TRUE)])
plot(ex_1.7, density=dens[findInterval(z, brks, all.inside=TRUE)])
```

---

spChFIDs-methods

*change feature IDs in spatial objects*

---

**Description**

When the feature IDs need to be changed in `SpatialLines*` or `SpatialPolygons*` objects, these methods may be used. The new IDs should be a character vector of unique IDs of the correct length.

**Methods**

**obj** = "`SpatialLines`", **x** = "`character`" replace IDs in a `SpatialLines` object

**obj** = "`SpatialLinesDataFrame`", **x** = "`character`" replace IDs in a `SpatialLinesDataFrame` object

**obj** = "`SpatialPolygons`", **x** = "`character`" replace IDs in a `SpatialPolygons` object

**obj** = "`SpatialPolygonsDataFrame`", **x** = "`character`" replace IDs in a `SpatialPolygonsDataFrame` object

**Note**

It is usually sensible to keep a copy of the original feature IDs in the object, but this should be done by the user.

**Author(s)**

Roger Bivand

**See Also**

[spCbind-methods](#), [spRbind-methods](#)

**Examples**

```
## Not run:
require(maptools)
xx <- readShapePoly(system.file("shapes/sids.shp", package="maptools")[1],
  IDvar="FIPSN0", proj4string=CRS("+proj=longlat +ellps=clrk66"))
row.names(as(xx, "data.frame"))
xx1 <- spChFIDs(xx, as.character(xx$CNTY_ID))
row.names(as(xx1, "data.frame"))

## End(Not run)
```

---

spDistsN1

*Euclidean or Great Circle distance between points*


---

**Description**

The function returns a vector of distances between a matrix of 2D points, first column longitude, second column latitude, and a single 2D point, using Euclidean or Great Circle distance (WGS84 ellipsoid) methods.

**Usage**

```
spDistsN1(pts, pt, longlat = FALSE)
spDists(x, y = x, longlat = FALSE, segments = FALSE, diagonal = FALSE)
```

**Arguments**

pts	A matrix of 2D points, first column x/longitude, second column y/latitude, or a SpatialPoints or SpatialPointsDataFrame object
pt	A single 2D point, first value x/longitude, second value y/latitude, or a SpatialPoints or SpatialPointsDataFrame object with one point only
x	A matrix of n-D points with row denoting points, first column x/longitude, second column y/latitude, or a Spatial object that has a <a href="#">coordinates</a> method

y	A matrix of n-D points with row denoting points, first column x/longitude, second column y/latitude, or a Spatial object that has a <code>coordinates</code> method
longlat	logical; if FALSE, Euclidean distance, if TRUE Great Circle (WGS84 ellipsoid) distance; if x is a Spatial object, longlat should not be specified but will be derived from <code>is.projected(x)</code>
segments	logical; if TRUE, y must be missing; the vector of distances between consecutive points in x is returned.
diagonal	logical; if TRUE, y must be given and have the same number of points as x; the vector with distances between points with identical index is returned.

**Value**

spDistsN1 returns a numeric vector of distances in the metric of the points if longlat=FALSE, or in kilometers if longlat=TRUE.

spDists returns a full matrix of distances in the metric of the points if longlat=FALSE, or in kilometers if longlat=TRUE; it uses spDistsN1 in case points are two-dimensional. In case of spDists(x, x), it will compute all n x n distances, not the sufficient n x (n-1).

**Note**

The function can also be used to find a local kilometer equivalent to a plot scaled in decimal degrees in order to draw a scale bar.

**Author(s)**

Roger Bivand, Edzer Pebesma

**References**

[http://www.abecedarical.com/javascript/script\\_greatcircle.html](http://www.abecedarical.com/javascript/script_greatcircle.html)

**See Also**

[is.projected](#)

**Examples**

```
ll <- matrix(c(5, 6, 60, 60), ncol=2)
km <- spDistsN1(ll, ll[1,], longlat=TRUE)
zapsmall(km)
utm32 <- matrix(c(276.9799, 332.7052, 6658.1572, 6655.2055), ncol=2)
spDistsN1(utm32, utm32[1,])
dg <- spDistsN1(ll, ll[1,])
dg
dg[2]/km[2]
data(meuse)
coordinates(meuse) <- c("x", "y")
res <- spDistsN1(meuse, meuse[1,])
summary(res)
```

```

p1 = SpatialPoints(cbind(1:3, 1:3))
spDists(p1)
spDists(p1, p1)
spDists(p1, p1, diagonal = TRUE)
try(spDists(p1, p1, segments = TRUE))
spDists(p1, segments = TRUE)
p2 = SpatialPoints(cbind(5:2, 2:5))
spDists(p1, p2)
try(spDists(p1, p2, diagonal = TRUE)) # fails
try(spDists(p1, p2, segments = TRUE)) # fails

# longlat points:
proj4string(p1) = "+proj=longlat +ellps=WGS84"
proj4string(p2) = "+proj=longlat +ellps=WGS84"
is.projected(p1)
is.projected(p2)
spDists(p1)
spDists(p1, p1)
spDists(p1, p1, diagonal = TRUE)
spDists(p1, p2)
try(spDists(p1, p2, diagonal = TRUE)) # fails
spDists(p1, p2[1:length(p1),], diagonal = TRUE)
spDists(p1, segments = TRUE)
spDists(p1[0],p2[0],diagonal=TRUE)
spDists(p1[0])

p1 = SpatialPoints(cbind(1:3, 1:3, 1:3))
spDists(p1)
spDists(p1, p1)
try(spDists(p1, p1, diagonal = TRUE))
try(spDists(p1, p1, segments = TRUE))
try(spDists(p1, segments = TRUE))
p2 = SpatialPoints(cbind(5:2, 2:5, 3:6))
spDists(p1, p2)
try(spDists(p1, p2, diagonal = TRUE)) # fails
try(spDists(p1, p2, segments = TRUE)) # fails

```

---

spplot

*Plot methods for spatial data with attributes*


---

## Description

Lattice (trellis) plot methods for spatial data with attributes

## Usage

```

spplot(obj, ...)
spplot.grid(obj, zcol = names(obj), ..., names.attr, scales = list(draw = FALSE),
  xlab = NULL, ylab = NULL, aspect = mapasp(obj,xlim,ylim),

```

```

panel = panel.gridplot, sp.layout = NULL, formula, xlim = bbox(obj)[1, ],
ylim = bbox(obj)[2, ], checkEmptyRC = TRUE, col.regions = get_col_regions())
splot.polygons(obj, zcol = names(obj), ..., names.attr, scales = list(draw = FALSE),
xlab = NULL, ylab = NULL, aspect = mapasp(obj,xlim,ylim),
panel = panel.polygonsplot, sp.layout = NULL, formula, xlim = bbox(obj)[1, ],
ylim = bbox(obj)[2, ], col.regions = get_col_regions())
splot.points(obj, zcol = names(obj), ..., names.attr, scales = list(draw = FALSE),
xlab = NULL, ylab = NULL, aspect = mapasp(obj,xlim,ylim),
panel = panel.pointsplot, sp.layout = NULL, identify = FALSE, formula,
xlim = bbexpand(bbox(obj)[1, ], 0.04), ylim = bbexpand(bbox(obj)[2, ], 0.04),
edge.col = "transparent", colorkey = FALSE, col.regions = get_col_regions())
mapLegendGrob(obj, widths = unit(1, "cm"), heights = unit(1, "cm"),
fill = "black", just = "right")
sp.theme(set = FALSE, regions = list(col = bpy.colors(100)), ...)
layout.north.arrow(type = 1)
layout.scale.bar(height = 0.05)
splot.locator(n = 512, type = "n", ...)
set_col_regions(value)
get_col_regions()

```

## Arguments

obj	object of class extending <a href="#">Spatial-class</a>
zcol	character; attribute name(s) or column number(s) in attribute table
names.attr	names to use in panel, if different from zcol names
scales	scales argument to be passed to Lattice plots; use <code>list(draw = TRUE)</code> to draw axes scales; see <a href="#">xyplot</a> for full options
...	other arguments passed to <a href="#">levelplot</a> (grids, polygons) or <a href="#">xyplot</a> (points)
xlab	label for x-axis
ylab	label for y-axis
aspect	aspect ratio for spatial axes; defaults to "iso" (one unit on the x-axis equals one unit on the y-axis) but may be set to more suitable values if the data are e.g. if coordinates are latitude/longitude
panel	depending on the class of obj, <a href="#">panel.polygonsplot</a> (for polygons or lines), <a href="#">panel.gridplot</a> (grids) or <a href="#">panel.pointsplot</a> (points) is used; for further control custom panel functions can be supplied that call one of these panel functions, but do read below how the argument <code>sp.layout</code> may help
sp.layout	NULL or list; see notes below
identify	if not FALSE, identify plotted objects (currently only working for points plots). Labels for identification are the row.names of the attribute table <code>row.names(as.data.frame(obj))</code> . If TRUE, identify on panel (1, 1); for identifying on panel i, j, pass the value <code>c(i, j)</code>
formula	optional; may be useful to plot a transformed value. Defaults to <code>z~x+y</code> for single and <code>z~x+y name</code> for multiple attributes; use e.g. <code>exp(x)~x+y name</code> to plot the exponent of the z-variable



xlim	numeric; x-axis limits
ylim	numeric; y-axis limits
edge.col	color of symbol edge
colorkey	if FALSE, use symbol key; if TRUE, use continuous, levelplot-like colorkey; if list, follow syntax of argument colorkey in <a href="#">levelplot</a> (see below for an example)
widths	width of grob
heights	heights of grob
fill	fill color of grob
just	grob placement justification
set	logical; if TRUE, trellis.par.set is called, else a list is returned that can be passed to trellis.par.set()
regions	color ramp for the theme
height	height of scale bar; width is 1.0
n	see locator
type	see locator
checkEmptyRC	logical; if TRUE, a check is done to see if empty rows or columns are present, and need to be taken care of. Setting to FALSE may improve speed.
col.regions	vector with fill colours; in case the variable to be plotted is a factor, this vector should have length equal to the number of factor levels
value	vector with color values, default for col.regions

## Value

spplot returns a lattice plot of class "trellis", if you fail to "see" it, explicitly call `print(spplot(...))`. If `identify` is TRUE, the plot is plotted and the return value is a vector with row names of the selected points.

`spplot.locator` returns a matrix with identified point locations; use `trellis.focus` first to focus on a given panel.

`get_col_regions` returns the default value for `col.regions`

## Methods

**obj = "SpatialPixelsDataFrame"** see [spplot](#)

**obj = "SpatialGridDataFrame"** see [spplot](#)

**obj = "SpatialPolygonsDataFrame"** see [spplot](#)

**obj = "SpatialLinesDataFrame"** see [spplot](#)

**obj = "SpatialPointsDataFrame"** see [spplot](#)

**Note**

Missing values in the attributes are (currently) not allowed.

`spplot.grid`, `spplot.polygons` and `spplot.points` are S4 methods for `spplot`; see [spplot-methods](#).

Useful arguments that can be passed as . . . are:

`layout` integer; for the layout of panels (cols,rows)

`pretty` logical; choose colour breaks at pretty numbers?

`at` specify at which values colours change

`as.table` logical; start drawing panels upper-left instead of lower-left

`page` to add marks to each plotted page

for useful values see the appropriate documentation of [xyplot](#) (in case of points), and [levelplot](#) (otherwise).

If `obj` is of `SpatialPointsDataFrame`, the following options are useful to pass:

`key.space` character: "bottom", "right", "left" or "right" to denote key location, or list: see argument `key` in the help for [xyplot](#) what the options are

`legendEntries` character; array with key legend (text) entries; suitable defaults obtained from data

`cuts` number of cuts, or, for objects of class `SpatialPointsDataFrame` only, the actual cuts to use

`do.log` logical; if TRUE use log-linear scale to divide range in equal cuts, else use a linear scale if `cuts` is only number of cuts

`pch` integer; plotting character to use; defaults to 16 if `fill` is TRUE, else 1

`cex` numeric; character expansion, proportional to default value of 1

`fill` logical; use filled circles?

`layout.north.arrow` and `layout.scale.bar` can be used to set a north arrow or scale bar.

The `sp.layout` argument is either a single layout item, or a list with one or more layout items. A layout item is one of

- a list with one or more `Spatial*` objects, along with style arguments like `col`, `lty`, `pch`, `fill` etc.
- a list with its first argument the layout function or the name of the layout function to be called: `sp.points` for `SpatialPoints`, `sp.polygons` for `SpatialPolygons` object, `sp.lines` for a `SpatialLines` object, and `sp.text` for text to place. The second argument contains the object (or text) to be plotted; remaining arguments are passed to the corresponding `panel.*` functions.

The order of items in `sp.layout` matters; objects are drawn in the order they appear. With respect to `obj`, default plot order and precedence of `sp.layout` items is as follows: for points and lines, `sp.layout` items are drawn over (after) `obj`; for grids and polygons, `sp.layout` items are drawn behind (before) `obj`. Transparency may further help making multiple things visible. Adding a `first` argument to a layout item overrides its default plotting order with respect to `obj`:

Special control elements of `sp.layout` items:

`first` logical; should the layout item be drawn before the `obj` (TRUE), or after (FALSE)? This overrides the default order (points and lines in front, polygons and grids behind).

which integer; controls to which panel a layout item should be added. If which is present in the main, top-level list it applies to all layout items; in sub-lists with layout items it denotes the (set of) panel(s) in which the layout item should be drawn. Without a which item, layout items are drawn in each panel.

sp.theme returns a lattice theme; use, after loading package lattice, the command trellis.par.set(sp.theme()) after a device is opened or changed to make this work. Currently, this only sets the colors to [bpy.colors](#).

If the attributes to be plotted are of type factor, spplot tries to create a legend that reflects this. In this case, the color ramp passed needs to be of the same length as the number of factor levels. The factor levels are derived from the first map; subsequent factors with different factor levels result in an error.

### Author(s)

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

### References

<https://edzer.github.io/sp/>

### See Also

[xyplot](#), [levelplot](#), [panel.identify](#) to identify objects

### Examples

```
library(lattice)
trellis.par.set(sp.theme()) # sets bpy.colors() ramp
demo(meuse, ask = FALSE, echo = FALSE)
l2 = list("SpatialPolygonsRescale", layout.north.arrow(), offset = c(181300,329800),
scale = 400)
l3 = list("SpatialPolygonsRescale", layout.scale.bar(), offset = c(180500,329800),
scale = 500, fill=c("transparent","black"))
l4 = list("sp.text", c(180500,329900), "0")
l5 = list("sp.text", c(181000,329900), "500 m")

spplot(meuse, c("ffreq"), sp.layout=list(l2,l3,l4,l5), col.regions= "black",
pch=c(1,2,3), key.space=list(x=0.1,y=.95,corner=c(0,1)))
spplot(meuse, c("zinc", "lead"), sp.layout=list(l2,l3,l4,l5, which = 2),
key.space=list(x=0.1,y=.95,corner=c(0,1)))
# plotting factors:
meuse$f = factor(sample(letters[6:10], 155, replace=TRUE),levels=letters[1:10])
meuse$g = factor(sample(letters[1:5], 155, replace=TRUE),levels=letters[1:10])
spplot(meuse, c("f","g"), col.regions=bpy.colors(10))

if (require(RColorBrewer)) {
spplot(meuse, c("ffreq"), sp.layout=list(l2,l3,l4,l5),
col.regions=brewer.pal(3, "Set1"))
}
```

```

meuse.grid$g = factor(sample(letters[1:5], 3103, replace=TRUE),
  levels=letters[1:10])
meuse.grid$f = factor(sample(letters[6:10], 3103, replace=TRUE),
  levels=letters[1:10])
spplot(meuse.grid, c("f","g"), col.regions=bpy.colors(10))

# example modifying colorkey for points:
spplot(meuse["dist"], colorkey = list(
  right = list( # see ?levelplot in package trellis, argument colorkey:
  fun = draw.colorkey,
  args = list(
  key = list(
  at = seq(0, 1, .1), # colour breaks
  col = bpy.colors(11), # colours
  labels = list(
  at = c(0, .2, .4, .6, .8, 1),
  labels = c("0x", "20x", "40x", "60x", "80x", "100x")
  )
  )
  )
  )
  ))
l6 = list(meuse.grid["dist"], col = grey(seq(.5,.9,length.out=10)))
spplot(meuse, c("zinc", "lead"), sp.layout = l6)
spplot(meuse, c("zinc", "lead"),
  sp.layout = list(meuse.grid, meuse.riv, col = 'grey'))

# Custom legend placement, taken from
# http://stackoverflow.com/questions/29344692/custom-placement-of-spplot-legend-in-the-map
s <- spplot(meuse.grid[, 'dist'], colorkey = list(space = "left", height = 0.4))

args <- s$legend$left$args$key

## Prepare list of arguments needed by `legend=` argument (as described in ?xyplot)
library(lattice) # draw.colorkey
legendArgs <- list(fun = draw.colorkey,
  args = list(key = args),
  corner = c(0.05, .75))

## Call spplot() again, this time passing in to legend the arguments
## needed to print a color key
spplot(meuse.grid[, 'dist'], colorkey = FALSE,
  legend = list(inside = legendArgs))

```

---

spsample

*sample point locations in (or on) a spatial object*


---

### Description

sample point locations within a square area, a grid, a polygon, or on a spatial line, using regular or random sampling methods; the methods used assume that the geometry used is not spherical, so

objects should be in planar coordinates

## Usage

```
spsample(x, n, type, ...)
makegrid(x, n = 10000, nsig = 2, cellsize, offset = rep(0.5, nrow(bb)),
pretty = TRUE)
```

## Arguments

x	Spatial object; <code>spsample(x, ...)</code> is a generic method for the existing <code>sample.Xxx</code> functions
...	optional arguments, passed to the appropriate <code>sample.Xxx</code> functions; see NOTES for <code>nclusters</code> and <code>iter</code>
n	(approximate) sample size
type	character; "random" for completely spatial random; "regular" for regular (systematically aligned) sampling; "stratified" for stratified random (one single random location in each "cell"); "nonaligned" for nonaligned systematic sampling (nx random y coordinates, ny random x coordinates); "hexagonal" for sampling on a hexagonal lattice; "clustered" for clustered sampling; "Fibonacci" for Fibonacci sampling on the sphere (see references).
bb	bounding box of the sampled domain; setting this to a smaller value leads to sub-region sampling
offset	for square cell-based sampling types (regular, stratified, nonaligned, hexagonal): the offset (position) of the regular grid; the default for <code>spsample</code> methods is a random location in the unit cell [0,1] x [0,1], leading to a different grid after each call; if this is set to <code>c(0.5, 0.5)</code> , the returned grid is not random (but, in Ripley's wording, "centric systematic"). For line objects, a single offset value is taken, where the value varies within the [0, 1] interval, and 0 is the beginning of each Line object, and 1 its end
cellsize	if missing, a cell size is derived from the sample size n; otherwise, this cell size is used for all sampling methods except "random"
nsig	for "pretty" cell size; <code>spsample</code> does not result in pretty grids
pretty	logical; if TRUE, choose pretty (rounded) coordinates

## Value

an object of class [SpatialPoints-class](#). The number of points is only guaranteed to equal n when sampling is done in a square box, i.e. (`sample.Spatial`). Otherwise, the obtained number of points will have expected value n.

When x is of a class deriving from [Spatial-class](#) for which no [spsample-methods](#) exists, sampling is done in the bounding box of the object, using `spsample.Spatial`. An overlay using [over](#) may be necessary to select the features inside the geometry afterwards.

Sampling type "nonaligned" is not implemented for line objects.

Some methods may return NULL if no points could be successfully placed.

makegrid makes a regular grid that covers `x`; when `cellsize` is not given it derives one from the number of grid points requested (approximating the number of cells). It tries to choose pretty cell size and grid coordinates.

### Methods

`x = "Spatial"` sample in the bbox of `x`

`x = "Line"` sample on a line

`x = "Polygon"` sample in a Polygon

`x = "Polygons"` sample in a Polygons object, consisting of possibly multiple Polygon objects (holes must be correctly defined, use `checkPolygonsHoles` if need be)

`x = "SpatialPolygons"` sample in an SpatialPolygons object; sampling takes place over all Polygons objects present, use subsetting to vary sampling intensity (density); holes must be correctly defined, use `checkPolygonsHoles` if need be

`x = "SpatialGrid"` sample in an SpatialGrid object

`x = "SpatialPixels"` sample in an SpatialPixels object

### Note

If an [Polygon-class](#) object has zero area (i.e. is a line), samples on this line element are returned. If the area is very close to zero, the algorithm taken here (generating points in a square area, selecting those inside the polygon) may be very resource intensive. When numbers of points per polygon are small and `type="random"`, the number searched for is inflated to ensure hits, and the points returned sampled among these.

The following two arguments can be further specified:

`nclusters` Number of clusters (strata) to sample from.

`iter`(default = 4) number of times to try to place sample points in a polygon before giving up and returning NULL - this may occur when trying to hit a small and awkwardly shaped polygon in a large bounding box with a small number of points

### Author(s)

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

### References

Chapter 3 in B.D. Ripley, 1981. Spatial Statistics, Wiley

Fibonacci sampling: Alvaro Gonzalez, 2010. Measurement of Areas on a Sphere Using Fibonacci and Latitude-Longitude Lattices. Mathematical Geosciences 42(1), p. 49-64

### See Also

[over](#), [point.in.polygon](#), [sample](#)

**Examples**

```
data(meuse.riv)
meuse.sr = SpatialPolygons(list(Polygons(list(Polygon(meuse.riv)), "x")))

plot(meuse.sr)
points(spsample(meuse.sr, n = 1000, "regular"), pch = 3)

plot(meuse.sr)
points(spsample(meuse.sr, n = 1000, "random"), pch = 3)

plot(meuse.sr)
points(spsample(meuse.sr, n = 1000, "stratified"), pch = 3)

plot(meuse.sr)
points(spsample(meuse.sr, n = 1000, "nonaligned"), pch = 3)

plot(meuse.sr)
points(spsample(meuse.sr@polygons[[1]], n = 100, "stratified"), pch = 3, cex=.5)

data(meuse.grid)
gridded(meuse.grid) = ~x+y
image(meuse.grid)
points(spsample(meuse.grid,n=1000,type="random"), pch=3, cex=.5)
image(meuse.grid)
points(spsample(meuse.grid,n=1000,type="stratified"), pch=3, cex=.5)
image(meuse.grid)
points(spsample(meuse.grid,n=1000,type="regular"), pch=3, cex=.5)
image(meuse.grid)
points(spsample(meuse.grid,n=1000,type="nonaligned"), pch=3, cex=.5)

fullgrid(meuse.grid) = TRUE
image(meuse.grid)
points(spsample(meuse.grid,n=1000,type="stratified"), pch=3,cex=.5)
```

---

spTransform

*spTransform for map projection and datum transformation*

---

**Description**

spTransform for map projection and datum transformation

**Usage**

```
spTransform(x, CRSobj, ...)
```

**Arguments**

x	object to be transformed
CRSobj	object of class <a href="#">CRS</a> , or of class character in which case it is converted to <a href="#">CRS</a>
...	further arguments (ignored)

**Value**

object with coordinates transformed to the new coordinate reference system.

**Note**

Package `rgdal` provides the methods doing actual transformation, see [spTransform](#); when `rgdal` cannot be loaded, an error message follows.

---

stack	<i>rearrange data in <code>SpatialPointsDataFrame</code> or <code>SpatialGridDataFrame</code> for plotting with <code>splot</code> (<code>levelplot</code>/<code>xyplot</code> wrapper)</i>
-------	---

---

**Description**

rearrange `SpatialPointsDataFrame` for plotting with `splot` or `levelplot`

**Usage**

```

smap.to.lev(data, zcol = 1:n, n = 2, names.attr)
## S3 method for class 'SpatialPointsDataFrame'
stack(x, select, ...)
## S3 method for class 'SpatialGridDataFrame'
stack(x, select, ...)

```

**Arguments**

data	object of class (or extending) <code>SpatialPointsDataFrame</code> or <code>SpatialGridDataFrame</code>
zcol	z-coordinate column name(s), or a column number (range) (after removing the spatial coordinate columns: 1 refers to the first non-coordinate column, etc. )
names.attr	names of the set of z-columns (these names will appear in the plot); if omitted, column names of <code>zcol</code>
n	number of columns to be stacked
x	same as <code>data</code>
select	same as <code>zcol</code>
...	ignored



**Value**

`smap.to.lev` returns a data frame with the following elements:

<code>x</code>	x-coordinate for each row
<code>y</code>	y-coordinate for each row
<code>z</code>	column vector with each of the elements in columns <code>zcol</code> of data stacked
<code>name</code>	factor; name of each of the stacked <code>z</code> columns

`stack` is an S3 method: it return a data.frame with a column values that has the stacked coordinates and attributes, and a column `ind` that indicates the variable stacked; it also replicates the coordinates.

**See Also**

[splot](#), [levelplot](#) in package `lattice`, and [stack](#)

**Examples**

```
library(lattice)
data(meuse.grid) # data frame
coordinates(meuse.grid) = c("x", "y") # promotes to SpatialPointsDataFrame
meuse.grid[["idist"]] = 1 - meuse.grid[["dist"]] # add variable
# the following is made much easier by splot:
levelplot(z~x+y|name, smap.to.lev(meuse.grid, z=c("dist","idist"), names.attr =
c("distance", "inverse of distance")), aspect = "iso")
levelplot(values~x+y|ind, as.data.frame(stack(meuse.grid)),aspect = "iso")
gridded(meuse.grid) = TRUE
levelplot(z~x+y|name, smap.to.lev(meuse.grid, z=c("dist","idist"), names.attr =
c("distance", "inverse of distance")), aspect = "iso")
levelplot(values~x+y|ind, as.data.frame(stack(meuse.grid)), asp = "iso")
```

---

surfaceArea

*Compute surface area of a digital elevation model.*

---

**Description**

It is often said that if Wales was flattened out it would have an area bigger than England. This function computes the surface area of a grid of heights taking into account the sloping nature of the surface.

**Usage**

```
surfaceArea(m, ...)
surfaceArea.matrix(m, cellx = 1, celly = 1, byCell = FALSE)
```

**Arguments**

<code>m</code>	a matrix of height values, or an object of class <code>SpatialPixelsDataFrame</code> or <code>SpatialGridDataFrame</code> .
<code>cellx</code>	the size of the grid cells in the x-direction, in the same units as the height values.
<code>celly</code>	the size of the grid cells in the y-direction, in the same units as the height values.
<code>byCell</code>	return single value or matrix of values
<code>...</code>	ignored

**Value**

Either a single value of the total area if `byCell=FALSE`, or a matrix the same shape as `m` of individual cell surface areas if `byCell=TRUE`. In this case, the sum of the returned matrix should be the same value as that which is returned if `byCell=FALSE`.

Missing values (NA) in the input matrix are allowed. They will produce an NA in the output matrix for `byCell=TRUE`, and contribute zero to the total area. They also have an effect on adjacent cells - see code comments for details.

**Methods**

**obj = "matrix"** takes a matrix as input, requires `cellx` and `celly` to be set

**obj = "SpatialGridDataFrame"** takes an object of class `SpatialGridDataFrame` as input, and retrieves `cellx` and `celly` from this

**obj = "SpatialPixelsDataFrame"** takes an object of class `SpatialPixelsDataFrame` as input, and retrieves `cellx` and `celly` from this

**Author(s)**

Barry Rowlingson <b.rowlingson@lancaster.ac.uk>, integration in sp Edzer Pebesma.

**References**

Calculating Landscape Surface Area from Digital Elevation Models, Jeff S. Jenness Wildlife Society Bulletin, Vol. 32, No. 3 (Autumn, 2004), pp. 829-839

**Examples**

```
surfaceArea(volcano)
image(surfaceArea(volcano,byCell=TRUE))

data(meuse.grid)
gridded(meuse.grid) = ~x+y
image(surfaceArea(meuse.grid["dist"], byCell=TRUE))
surfaceArea(meuse.grid["dist"])
```

---

zerodist	<i>find point pairs with equal spatial coordinates</i>
----------	--

---

### Description

find point pairs with equal spatial coordinates

### Usage

```
zerodist(obj, zero = 0.0, unique.ID = FALSE, memcmp = TRUE)
zerodist2(obj1, obj2, zero = 0.0, memcmp = TRUE)
remove.duplicates(obj, zero = 0.0, remove.second = TRUE, memcmp = TRUE)
```

### Arguments

obj	object of, or extending, class <a href="#">SpatialPoints</a>
obj1	object of, or extending, class <a href="#">SpatialPoints</a>
obj2	object of, or extending, class <a href="#">SpatialPoints</a>
zero	distance values less than or equal to this threshold value are considered to have zero distance (default 0.0); units are those of the coordinates for projected data or unknown projection, or km if coordinates are defined to be longitude/latitude
unique.ID	logical; if TRUE, return an ID (integer) for each point that is different only when two points do not share the same location
memcmp	use memcmp to find exactly equal coordinates; see NOTE
remove.second	logical; if TRUE, the second of each pair of duplicate points is removed, if FALSE remove the first

### Value

zerodist and zerodist2 return a two-column matrix with in each row pairs of row numbers with identical coordinates; a matrix with zero rows is returned if no such pairs are found. For zerodist, row number pairs refer to row pairs in obj. For zerodist2, row number pairs refer to rows in obj and obj2, respectively. remove.duplicates removes duplicate observations if present, and else returns obj.

### Note

When using kriging, duplicate observations sharing identical spatial locations result in singular covariance matrices. This function may help identify and remove spatial duplicates. The full matrix with all pair-wise distances is not stored; the double loop is done at the C level.

When unique.ID=TRUE is used, an integer index is returned. sp 1.0-14 returned the highest index, sp 1.0-15 and later return the lowest index.

When zero is 0.0 and memcmp is not FALSE, zerodist uses memcmp to evaluate exact equality of coordinates; there may be cases where this results in a different evaluation compared to doing the double arithmetic of computing distances.

**Examples**

```
data(meuse)
summary(meuse)
# pick 10 rows
n <- 10
ran10 <- sample(nrow(meuse), size = n, replace = TRUE)
meusedup <- rbind(meuse, meuse[ran10, ])
coordinates(meusedup) <- c("x", "y")
zd <- zerodist(meusedup)
sum(abs(zd[1:n,1] - sort(ran10))) # 0!
# remove the duplicate rows:
meusedup2 <- meusedup[-zd[,2], ]
summary(meusedup2)
meusedup3 <- subset(meusedup, !(1:nrow(meusedup) %in% zd[,2]))
summary(meusedup3)
coordinates(meuse) <- c("x", "y")
zerodist2(meuse, meuse[c(10:33,1,10),])
```

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