Package ‘sp’

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Title Classes and Methods for Spatial Data
Depends R (>= 3.5.0), methods
Imports utils, stats, graphics, grDevices, lattice, grid
Suggests RColorBrewer, gstat, deldir, knitr, rmarkdown, sf, terra, raster
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. From this version, 'rgdal', 'maptools', and 'rgeos' are no longer used at all, see <https://r-spatial.org/r/2023/05/15/evolution4.html> for details.
License GPL (>= 2)
BugReports https://github.com/edzer/sp/issues
R topics documented:

- gridlines.R
- spdists.R
- flipSGDF.R
- chfids.R
- loadmeuse.R
- compassRose.R
- surfaceArea.R
- spOptions.R
- subset.R
- disaggregate.R
- sp_spat1.R
- merge.R
- aggregate.R
- elide.R
- sp2Mondrian.R

VignetteBuilder: knitr

NeedsCompilation: yes

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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

Description

spatial aggregation of thematic information in spatial objects

Usage

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

Arguments

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

Details

For as far as these functions use package rgeos, (lines, polygons, `dissolve = TRUE`), they are deprecated as rgeos will retire; try using sf::aggregate instead.

`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` 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 computes the intersection of `x` and `by`; see examples below. As this uses code from package rgeos, it is deprecated as package rgeos will retire.

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

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

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

```r
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 `CRS-class`
- `obj` SpatialPixels object
hex SpatialPoints object with points that are generated by hexagonal sampling; see `spsample`
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

```r
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)
```
bbox-methods

Usage

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

Arguments

Srl 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

```r
# 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)
```

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

---

### bpy.colors

**blue-pink-yellow color scheme, which also prints well on black/white printers**

---

**Description**

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

**Usage**

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

**Arguments**

- **n** number of colors (>= 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$ycoordinates(p) <- c("x", "y")gridded(p) <- TRUEimage(p, col = bpy.colors(100), asp = 1)
# require(lattice)
# trellis.par.set("regions", list(col=bpy.colors())) # make this default pallette
Arguments

- **obj**: object of, or extending, class SpatialPointsDataFrame or SpatialGridDataFrame, see coordinates or SpatialPointsDataFrame; the object knows about its spatial coordinates
- **zcol**: z-variable column name, or column number after removing spatial coordinates from x@data: 1 refers to the first non-coordinate column
- **fill**: logical; if TRUE, filled circles are plotted (pch = 16), else open circles (pch = 1); the pch argument overrides this
- **maxsize**: cex value for largest circle
- **do.sqrt**: logical; if TRUE the plotting symbol area (sqrt(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
- **col**: 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.
- **key.entries**: the values that will be plotted in the key; by default the five quantiles min, q.25, median q.75, max
- **main**: main plotting title
- **identify**: logical; if true, regular plot is called instead of xyplot, and followed by a call to identify().
- **labels**: labels argument passed to plot if identify is TRUE
- **...**: arguments, passed to xyplot, or plot if identification is required.
- **key.space**: location of the key
- **scales**: scales argument as passed to xyplot
- **xlab**: x-axis label
- **ylab**: y-axis label
- **panel**: panel function used
- **sp.layout**: possible layout items; see spplot
- **xlim**: x axis limit
- **ylim**: 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)
compassRose

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

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
coordinates

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

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. ~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
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 `sf` 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 `sf` using PROJ >= 6 and GDAL >= 3, the object may also have a WKTI (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**

```r
CRS(projargs, doCheckCRSArgs=TRUE, SRS_string=NULL, get_source_if_boundcrs=TRUE, use_cache=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.character(NA)`, it may be missing or an empty string of zero length and will then set to the missing value. With `sf` built with PROJ >= 6 and GDAL >= 3, the `+init=` key may only be used with value `epsg:<code>`. From `sp` version 1.4-4, the string associated with the `SRS_string` argument may be entered as-is and will be set as `SRS_string` if the `projargs` argument does not begin with a `+` (suggested by Mikko Vihtakari).

- `doCheckCRSArgs` default TRUE

- `SRS_string` default NULL, only used when `sf` is built with PROJ >= 6 and GDAL >= 3; a valid WKT string or SRS definition such as "EPSG:4326" or "ESRI:102761"

- `get_source_if_boundcrs` (from `rgdal` 1.5-17, default TRUE) The presence of the `+towgs84=` key in a Proj4 string `projargs=` argument value may promote the output WKT2 CRS to BOUNDCRS for PROJ >= 6 and GDAL >= 3, which is a coordinate operation from the input datum to WGS84. This is often unfortunate, so a PROJ function is called through `rgdal` to retrieve the underlying source definition.

- `use_cache` default TRUE, if FALSE ignore cached lookup values

- `x` object having a `proj4string` method, or if `y` is missing, list with objects that have a `proj4string` method

- `y` object of class `Spatial`, or having a `proj4string` 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 `sf` using PROJ >= 6 and GDAL >= 3, the object may also have a WKT2 (2019) string carried as a comment. The initiation function may call the PROJ library through `sf` to verify the argument set against those known in the library, returning error messages where necessary.

**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 deprecated Proj.4 projection arguments and WKT2 2019 representation if available
- `wkt` signature(object = "CRS"): return WKT comment on object
- `rebuild_CRS` rebuild a CRS object, usually used to add a WKT comment with PROJ >= 6 and GDAL >= 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 sf using sf_proj_info). 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, sf_proj_info 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 sf with GDAL >= 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 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 sf is available and built with PROJ >= 6 and GDAL >=3.

Author(s)

Roger Bivand <Roger.Bivand@nhh.no>

References

https://github.com/OSGeo/PROJ

Examples

```r
CRS()
CRS(""
CRS(as.character(NA))
CRS("+proj=longlat +datum=WGS84")
run <- FALSE
run <- require(sf)
```
if (run) {
  print((CRS("+proj=longlat +datum=NAD27")))
}
if (run) {
  print((CRS("+init=epsg:4267")))
}
if (run) {
  print((CRS("+init=epsg:26978")))
}
if (run) {
  print((CRS(paste("+proj=sterea +lat_0=52.15616055555555 +lon_0=5.38763888888889 +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((CRS("+init=epsg:28992")))
}
if (run) {
  print((CRS("EPSG:28992")))
}
if (run) {
  print((CRS(SRS_string="EPSG:28992")))
}
if (run) {
  o <- try(CRS(SRS_string="ESRI:102760"))
  if (!inherits(o, "try-error")) print((o))
}
if (run) {
  o <- try(CRS("EPSG:4326"))
  if (!inherits(o, "try-error")) print((o))
}
if (run) {
  o <- try(CRS("ESRI:102760"))
  if (!inherits(o, "try-error")) print((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 axis
at numeric; if missing, axTicks is called for nice values; see axis
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 axis
...
passed to the actual axis 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

\texttt{obj = "Spatial"} object deriving from class "Spatial"

Examples

```r
# 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)
```

Description

disaggregate \texttt{SpatialLines}, \texttt{SpatialLinesDataFrame}, \texttt{SpatialPolygons}, or \texttt{SpatialPolygonsDataFrame} objects, using functions from rgeos to handle polygon hole nesting

Usage

disaggregate(x, ...)

Arguments

\begin{itemize}
  \item \texttt{x} object of class \texttt{SpatialLines} or \texttt{SpatialPolygons}
  \item \texttt{...} ignored
\end{itemize}

Value

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

Author(s)

Robert Hijmans, Edzer Pebesma
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

```r
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
```
Methods for Function `elide` in Package ‘maptools’

Description
Methods for function `elide` to translate and disguise coordinate placing in the real world.

Usage
`elide(obj, ...)`

Arguments
- `obj`: object to be elided
- `...`: other arguments:
  - `bb`: if NULL, uses bounding box of object, otherwise the given bounding box
  - `shift`: values to shift the coordinates of the input object; this is made ineffective by the scale argument
  - `reflect`: reverse coordinate axes
  - `scale`: if NULL, coordinates not scaled; if TRUE, the longer dimension is scaled to lie within [0,1] and aspect maintained; if a scalar, the output range of [0,1] is multiplied by scale
  - `flip`: translate coordinates on the main diagonal
  - `rotate`: default 0, rotate angle degrees clockwise around center
  - `center`: default NULL, if not NULL, the rotation center, numeric of length two
  - `unitsq`: logical, default FALSE, if TRUE and scale TRUE, impose unit square bounding box (currently only points)

Value
The methods return objects of the input class object with elided coordinates; the coordinate reference system is not set. Note that if the input coordinates or centroids are in the data slot data.frame of the input object, they should be removed before the use of these methods, otherwise they will betray the input positions.

Methods
- `obj = "SpatialPoints"` elides object
- `obj = "SpatialPointsDataFrame"` elides object
- `obj = "SpatialLines"` elides object
- `obj = "SpatialLinesDataFrame"` elides object
- `obj = "SpatialPolygons"` elides object
- `obj = "SpatialPolygonsDataFrame"` elides object
Note

Rotation code kindly contributed by Don MacQueen

Examples

```r
data(meuse)
coordinates(meuse) <- c("x", "y")
proj4string(meuse) <- CRS("+init=epsg:28992")
data(meuse.riv)
river_polygon <- Polygons(list(Polygon(meuse.riv)), ID="meuse")
rivers <- SpatialPolygons(list(river_polygon))
proj4string(rivers) <- CRS("+init=epsg:28992")
rivers1 <- elide(rivers, reflect=c(TRUE, TRUE), scale=TRUE)
meuse1 <- elide(meuse, bb=bbox(rivers), reflect=c(TRUE, TRUE), scale=TRUE)
par <- par(mfrow=c(1,2))
plot(rivers, axes=TRUE)
plot(meuse, add=TRUE)
plot(rivers1, axes=TRUE)
plot(meuse1, add=TRUE)
par(opar)
meuse1 <- elide(meuse, shift=c(10000, -10000))
bbox(meuse)
bbox(meuse1)
rivers1 <- elide(rivers, shift=c(10000, -10000))
bbox(rivers)
bbox(rivers1)
meuse1 <- elide(meuse, rotate=-30, center=apply(bbox(meuse), 1, mean))
bbox(meuse)
bbox(meuse1)
plot(meuse1, axes=TRUE)
```

---

flip

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

Description

rearrange SpatialPointsDataFrame for plotting with spplot or levelplot

Usage

```r
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
grided(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)

Description

gometry 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"
**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)
gidded(obj) <- value
fullgrid(obj)
fullgrid(obj) <- value
gridparameters(obj)
```

**Arguments**

- **obj** object deriving from class "Spatial" (for gridded), or object of class **SpatialGridDataFrame-class** (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.
gridIndex2nb

gridIndex2nb 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
class(S)
summary(S)
plot(S)
gridded(S) <- FALSE
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 SpatialGrid or SpatialPixels
maxdist | maximum distance to be considered (inclusive), expressed in number of grid cell
fullMat | use dist to compute distances from grid (row/col) indices; FALSE avoids forming the full distance matrix, at a large performance cost

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)
girdat(x, easts = pretty(bbox(x)[1,]), norths = pretty(bbox(x)[2,]),
offset = 0.5, side = "WS")
## S3 method for class 'SpatialLines'
lables(object, labelCRS, side = 1:2, ...)
## S3 method for class 'SpatialPointsDataFrame'
text(x, ...)
Arguments

- **x**: object deriving from class `Spatial-class`
- **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 `text`
- **object**: `SpatialLines-class` object, as returned by `gridlines`
- **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 `gridat`: default “WS”, if “EN” labels placed on the top and right borders
- **...**: for labels: ignored; for `text`: arguments passed on to `text`, see below for example use of `adj`

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`

Examples

```r
run <- FALSE
if (requireNamespace("sf", quietly=TRUE)) run <- TRUE

data(meuse)
coordinates(meuse) = ~x+y
plot(meuse)
plot(gridlines(meuse), add = TRUE)
```
gridlines

text(labels(gridlines(meuse)))
title("default gridlines within Meuse bounding box")

if (run) {
  proj4string(meuse) <- CRS("+init=epsg:28992")
crs.longlat <- CRS("+init=epsg:4326")
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)
}

if (run) {
  # 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)
}

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

if (run) {
  # 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")
}

if (run) {
  # 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))
GridsDatums

Description
A data.frame of years and months of Grids & Datums column publications by country and country code.

Usage
data("GridsDatums")

Format
A data frame with 241 observations on the following 4 variables.

  country  name of PE&RS column
  month    issue month
  year     publication year
  ISO      ISO code for country

Details
The journal *Photogrammetric Engineering & Remote Sensing*, run by the American Society for Photogrammetry and Remote Sensing (ASPRS), began publishing a more-or-less monthly column on the spatial reference systems used in different countries, including their datums. The column first appeared in September 1997, and continued until March 2016; subsequent columns are updated reprints of previous ones. Some also cover other topics, such as world and Martian spatial reference systems. They are written by Clifford J. Mugnier, Louisiana State University, Fellow Emeritus ASPRS. To access the columns, visit https://www.asprs.org/asprs-publications/grids-and-datums.

Source
GridTopology-class

Examples

data(GridsDatums)
GridsDatums[grep("Norway", GridsDatums$country),]
GridsDatums[grep("Google", GridsDatums$country),]
GridsDatums[grep("^Mars$", GridsDatums$country),]

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
cellsizel: 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, cellsizel and cells.dim

Author(s)

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

See Also

SpatialGridDataFrame-class, SpatialGrid-class
Examples

```r
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**

```r
## 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 `SpatialGridDataFrame`
<table>
<thead>
<tr>
<th>attr</th>
<th>column of attribute variable; this may be the column name in the data.frame of data (as.data.frame(data)), or a column number</th>
</tr>
</thead>
<tbody>
<tr>
<td>xcol</td>
<td>column number of x-coordinate, in the coordinate matrix</td>
</tr>
<tr>
<td>ycol</td>
<td>column number of y-coordinate, in the coordinate matrix</td>
</tr>
<tr>
<td>col</td>
<td>a vector of colors</td>
</tr>
<tr>
<td>red,green,blue</td>
<td>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 rgb</td>
</tr>
<tr>
<td>axes</td>
<td>logical; should coordinate axes be drawn?</td>
</tr>
<tr>
<td>xlim</td>
<td>x-axis limits</td>
</tr>
<tr>
<td>ylim</td>
<td>y-axis limits</td>
</tr>
<tr>
<td>zlim</td>
<td>data limits for plotting the (raster, attribute) values</td>
</tr>
<tr>
<td>add</td>
<td>logical; if FALSE, the image is added to the plot layout setup by plot(as(x, &quot;Spatial&quot;), axes=axes, xlim=xlim, ylim=ylim, asp=asp) which sets up axes and plotting region; if TRUE, the image is added to the existing plot.</td>
</tr>
<tr>
<td>...</td>
<td>arguments passed to image, see examples</td>
</tr>
<tr>
<td>asp</td>
<td>aspect ratio to be used for plot</td>
</tr>
<tr>
<td>setParUsrBB</td>
<td>default FALSE, see Spatial-class for further details</td>
</tr>
<tr>
<td>useRasterImage</td>
<td>if TRUE, use rasterImage to render the image if available; for legacy rendering set FALSE; should be FALSE on Windows SDI installations</td>
</tr>
<tr>
<td>breaks</td>
<td>class breaks for coloured values</td>
</tr>
<tr>
<td>interpolate</td>
<td>default FALSE, a logical vector (or scalar) indicating whether to apply linear interpolation to the image when drawing, see rasterImage</td>
</tr>
<tr>
<td>angle</td>
<td>default 0, angle of rotation (in degrees, anti-clockwise from positive x-axis, about the bottom-left corner), see rasterImage</td>
</tr>
<tr>
<td>im</td>
<td>list with components named x, y, and z, as used for image</td>
</tr>
<tr>
<td>p4</td>
<td>CRS object, proj4 string</td>
</tr>
<tr>
<td>digits</td>
<td>default 10, number of significant digits to use for checking equal row/column spacing</td>
</tr>
</tbody>
</table>

**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",
userRasterImage=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",
userRasterImage=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 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 >= 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 >= 6 and GDAL >=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 Spatial-class
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"))
Arguments

- **coords**: 2-column numeric matrix with coordinates for a single line
- **slinelist**: list with elements of class `Line-class`
- **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

```r
# 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))
Sl1 = Line(L1)
Sl1a = Line(L1a)
Sl2 = Line(L2)
S1 = Lines(list(Sl1, Sl1a), ID="a")
S2 = Lines(list(Sl2), 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

---

**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

deprecated function to load the Meuse data set

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

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

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 Spatial
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
merge

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

Note
the values for \( x \) are typically obtained from axTicks

See Also
levelplot in package lattice

merge

Merge a Spatial* object having attributes with a data.frame

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 Spatial

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) merge.

all.x
logical; if TRUE, then the returned object will have all rows of x, even those that have 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 match.

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.
meuse

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-1 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-1 soil ("ppm")
- **lead** topsoil lead concentration, mg kg-1 soil ("ppm")
- **zinc** topsoil zinc concentration, mg kg-1 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)-1 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


http://www.gstat.org/

Examples

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

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

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.
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
over-methods

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 SiS-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.

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
\begin{itemize}
\item x = "SpatialPixels", y = "SpatialPoints" returns grid values x at spatial point locations y; NA for NA grid cells or points outside the grid
\item x = "SpatialPoints", y = "SpatialGrid" xx
\item x = "SpatialPoints", y = "SpatialGridDataFrame" xx
\item x = "SpatialPoints", y = "SpatialPixels" xx
\item x = "SpatialPoints", y = "SpatialPixelsDataFrame" xx
\end{itemize}

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.

Author(s)

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

See Also

vignette("over") for examples and figures

---

**panel.spplot**

panel and panel utility functions for spplot

---

Description

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

Usage

spplot.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 `spplot` 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 `SpatialPolygons-class` for `SpatialPolygonsRescale`; of class `SpatialLines-class`, `Lines-class` or `Line-class` for `sp.lines` of a class that has a `coordinates-methods` for `sp.points`; of class `SpatialPolygons-class` for `sp.polygons`. When `obj` is character, the actual object is retrieved by `get(obj)` 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 `col`
- **loc**: numeric vector of two elements
- **txt**: text to be plotted
- **alpha**: alpha (transparency) level
- **lst**: sp.layout argument, see `spplot`
- **p.number**: panel number; in a panel, `panel.number()` 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 `spplot`, `panel.gridplot` for grids, `panel.pointsplot` for points, or `panel.polygonsplot` for lines or polygons can be called with arguments `(x,y, ...)`. Customizing `spplot` plots can be done by extending the panel function, or by supplying an `sp.layout` argument; see the documentation for `spplot`. 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.
point.in.polygon

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))
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-class

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

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 now handled by round-trip coercion to sf and back to sp.

Author(s)

Roger Bivand

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

**Description**

read/write to/from ESRI asciigrid format

**Usage**

```r
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 `SpatialGridDataFrame-class` 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 `SpatialGridDataFrame`
- `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 `write.table`, 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**

```r
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

```r
# Create some data
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)
```

```r
# Create some data for the second example
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)
```
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

data(Rlogo)
d = dim(Rlogo)
cells = 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 * cells[1], y = gt[4] - (d[2] - 0.5) * abs(cells[2]))
g = GridTopology(cellcentre.offset, cells, 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)
spplot(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 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)
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 replace 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 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 Virgilo Gómez-Rubio.

---

**sp-deprecated**

**Deprecated functions in sp**

**Description**

Deprecated functions is sp: getSp*, getPolygon*, getLines* getSL*

**Usage**

set_evolution_status(value)
get_evolution_status()

**Arguments**

value evolution status: only 2L to use sf functions in place of rgdal

**Note**

For overlay the new implementation is found in the over method; this works slightly different and more consistent.
sp2Mondrian

write map data for Mondrian

Description

The function outputs a SpatialPolygonsDataFrame object to be used by Mondrian

Usage

sp2Mondrian(SP, file, new_format=TRUE)

Arguments

SP
  a SpatialPolygonsDataFrame object

file
  file where output is written

new_format
  default TRUE, creates a text data file and a separate map file; the old format put both data sets in a single file - the map file is named by inserting "MAP_" into the file= argument after the rightmost directory separator (if any)

Note

At this release, the function writes out a text file with both data and polygon(s) identified as belonging to each row of data.

Author(s)

Patrick Hausmann and Roger Bivand

References


Examples

if (require("sf", quietly=TRUE)) {
  td <- tempdir()
  xx <- as(sf::st_read(system.file("shape/nc.shp", package="sf")[[1]], quiet=TRUE), "Spatial")
  sp2Mondrian(xx, file=file.path(td, "sids1.txt"))
}
**Spatial-class**  

**Class “Spatial”**

**Description**

An abstract class from which useful spatial classes are derived

**Usage**

```r
Spatial(bbox, proj4string = CRS(as.character(NA)))
```

```r
## 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 `subset.data.frame`
- **select**: see `subset.data.frame`
- **drop**: see `subset.data.frame`
- **...**: 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
SpatialGrid-class

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

```r
  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

gird  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
SpatialGridDataFrame-class

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 or 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]]), "Set2") 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 tics 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://r-spatial.org/r/2016/03/08/plotting-spatial-grids.html](https://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 Lines-class
proj4string Object of class "CRS"; holding a valid proj4 string
sl, SL      object of class SpatialLines-class
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` getting `SpatialLinesMidPoints` 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 `rbind`-ing `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

```r
# 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]
S1l = Line(l1)
S1la = Line(l1a)
S12 = Line(l2)
S1 = Lines(list(S1l, S1la), ID="a")
S2 = Lines(list(S12), ID="b")
S = SpatialLines(list(S1,S2))
```
summary(Sl)
plot(Sl, 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.
SpatialMultiPoints

Author(s)
Roger Bivand; Edzer Pebesma

See Also
SpatialLines-class

SpatialMultiPoints

create objects of class SpatialMultiPoints 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 SpatialMultiPoints-class is also allowed
proj4string projection string of class CRS-class
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

c1 = cbind(rnorm(3, 10), rnorm(3, 10))
c2 = cbind(rnorm(5, 10), rnorm(5, 0))
c3 = cbind(rnorm(3, 0), rnorm(3, 10))

mp = SpatialMultiPoints(list(c1, c2, c3))
mp = 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(c1, c2, c3), 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

coods: 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
SpatialMultiPoints-class

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

```r
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**

```r
## 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`: `SpatialMultiPointsDataFrame` object
- `from`, `obj`, `object`: class to which to coerce
- `i`, `j`: row indices, column indices
- `drop`: see `Extract`
- `...`: indices passed through

```r
## S4 method for signature 'SpatialMultiPointsDataFrame'
x[i, j, ..., drop = TRUE]
```
SpatialPixels

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

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

```r
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.

```r
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

```r
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

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

Arguments

- **points**: coordinates, either as numeric matrix or as object of class `SpatialPoints-class`
- **grid**: grid topology; object of class `GridTopology-class`; for calls to `SpatialPixelsDataFrame` a value of NULL 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 NULL, otherwise a value passed to as the digits argument to `round` for setting cell size
- **proj4string**: object of class `CRS-class` in the first form only used when `points` does not inherit from `Spatial-class`

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 SpatialPoints-class is also allowed
- proj4string: projection string of class CRS-class
- 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 coordinates<-)
- 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

```r
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

```r
## S4 method for signature 'SpatialPointsDataFrame'
coordinates(x)
## S4 method for signature 'SpatialPointsDataFrame'
show(x)
## S4 method for signature 'SpatialPointsDataFrame'
points(x)
## S3 method for class 'SpatialPointsDataFrame'
rbind(...)
```

Arguments

```r
x, from, obj, object
```

- `x`: SpatialPointsDataFrame object
- `from`: class to which to coerce
- `obj`: see `as`
- `i`: row indices
- `j`: column indices
- `drop`: see `Extract`
- `...`: 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 from lists of Polygons objects and data.frames

Usage

```r
Polygon(coords, hole=as.logical(NA))
Polygons(srl, ID)
SpatialPolygons(Srl, pO, 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 CRS-class
- `srl`: list with Polygon-class objects
- `ID`: character vector of length one with identifier
- `Sr`: list with objects of class Polygons-class
- `pO`: integer vector; plotting order; if missing in reverse order of Polygons area
- `Sr`: object of class SpatialPolygons-class
- `data`: object of class data.frame; the number of rows in data should equal the number of Polygons-class 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 SpatialPolygons-class
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 \texttt{sp} do not accord with those of the simple features specification of the Open Geospatial Consortium. The \texttt{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 round-trip coercion to \texttt{sf} 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 \texttt{sf} 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 \texttt{Polygon}; Polygons returns an object of class \texttt{Polygons}; SpatialPolygons returns object of class \texttt{SpatialPolygons}; SpatialPolygonsDataFrame returns object of class \texttt{SpatialPolygonsDataFrame} getSpatialPolygonsLabelPoints returns an object of class \texttt{SpatialPoints} with label points.

References

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 \texttt{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
phbg 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 round-trip coercion to sf 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 sf or terra 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


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")
SpatialPolygonsDataFrame-class

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
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

Examples

```r
## Not run:
if(require(sf)) {
  xx <- as(st_read(system.file("shape/nc.shp", package="sf")[[1]], "Spatial")
  row.names(xx) <- as.character(xx$"FIPSNO")
  row.names(as(xx, "data.frame"))
  xx1 <- spChFIDs(xx, as.character(xx$"CNY_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

```r
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 coordinates 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 coordinates 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 is.projected(x)
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

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, 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**

```r
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, xlab = NULL, ylab = NULL, aspect = mapasp(obj, xlim, ylim),
            panel = panel.gridplot, sp.layout = NULL, formula, xlab = NULL, ylab = NULL, aspect = mapasp(obj, xlim, ylim),
```
ylim = bbox(obj)[2, ], col.regions = get_col_regions()
spplot.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)
spplot.locator(n = 512, type = "n", ...)
set_col_regions(value)
get_col_regions()

Arguments

obj object of class extending Spatial-class
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 list(draw = TRUE) to draw
  axes scales; see xyplot for full options
... other arguments passed to levelplot (grids, polygons) or xyplot (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, panel.polygonsplot (for polygons or lines), panel.gridplot
  (grids) or panel.pointsplot (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 sp.layout 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 row.names(as.data.frame(obj)).
If TRUE, identify on panel (1,1); for identifying on panel i,j, pass the value
  c(i,j)
formula optional; may be useful to plot a transformed value. Defaults to z~x+y for single
  and z~x+y|name for multiple attributes; use e.g. exp(x)~x+y|name 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 levelplot (see below for an example)
**spplot**

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>widths</td>
<td>width of grob</td>
</tr>
<tr>
<td>heights</td>
<td>heights of grob</td>
</tr>
<tr>
<td>fill</td>
<td>fill color of grob</td>
</tr>
<tr>
<td>just</td>
<td>grob placement justification</td>
</tr>
<tr>
<td>set</td>
<td>logical; if TRUE, trellis.par.set is called, else a list is returned that can be passed to trellis.par.set()</td>
</tr>
<tr>
<td>regions</td>
<td>color ramp for the theme</td>
</tr>
<tr>
<td>height</td>
<td>height of scale bar; width is 1.0</td>
</tr>
<tr>
<td>n</td>
<td>see locator</td>
</tr>
<tr>
<td>type</td>
<td>see locator</td>
</tr>
<tr>
<td>checkEmptyRC</td>
<td>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.</td>
</tr>
<tr>
<td>col.regions</td>
<td>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</td>
</tr>
<tr>
<td>value</td>
<td>vector with color values, default for col.regions</td>
</tr>
</tbody>
</table>

**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**

```r
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(
        "sp.plot","sp.plot"))
    )
)
spsample

**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**

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

**Arguments**

- **x**  
  Spatial object; `spsample(x, ...)` is a generic method for the existing `sample.Xxx` functions

- **...**  
  optional arguments, passed to the appropriate `sample.Xxx` functions; see NOTES for `nclusters` and `iter`
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 *spsample* methods is a random location in the unit cell \([0,1] \times [0,1]\), leading to a different grid after each call; if this is set to \(c(0.5, 0.5)\), 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; *spsample* 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. \((\text{sample.Spatial})\). 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**

\[
\begin{align*}
x &= \"Spatial\" \quad \text{sample in the bbox of } x \\
x &= \"Line\" \quad \text{sample on a line} \\
x &= \"Polygon\" \quad \text{sample in a Polygon} \\
x &= \"Polygons\" \quad \text{sample in a Polygons object, consisting of possibly multiple Polygon objects (holes must be correctly defined, use checkPolygonsHoles if need be)} \\
x &= \"SpatialPolygons\" \quad \text{sample in an SpatialPolygons object; sampling takes place over all Polygons objects present, use subsetting to vary sampling intensity (density); holes must be correctly defined, use checkPolygonsHoles if need be}
\end{align*}
\]
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)
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References
Chapter 3 in B.D. Ripley, 1981. Spatial Statistics, Wiley
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**

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

**Arguments**

- `x`: object to be transformed
- `CRSobj`: object of class `CRS`, or of class character in which case it is converted to `CRS`
- `...`: further arguments (ignored)

**Value**

object with coordinates transformed to the new coordinate reference system.

**Note**

Package `sf` provides the methods doing actual transformation.
Description

rearrange SpatialPointsDataFrame for plotting with spplot or levelplot

Usage

spmap.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) SpatialPointsDataFrame or SpatialGridDataFrame
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 zcol
n number of columns to be stacked
x same as data
select same as zcol
... ignored

Value

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

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

spplot, levelplot in package lattice, and stack
Examples

```r
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 spplot:
levelplot(z~x+y|name, spmap.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, spmap.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

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

Arguments

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


Examples

```r
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                   find point pairs with equal spatial coordinates
```

Description

find point pairs with equal spatial coordinates

Usage

```r
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 `SpatialPoints`
- `obj1` object of, or extending, class `SpatialPoints`
- `obj2` object of, or extending, class `SpatialPoints`
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 duplices. 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[10:33,1,10],]
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