Package 'rgeos'

January 27, 2015

Title Interface to Geometry Engine - Open Source (GEOS)

Version 0.3-8

Date 2014-09-20

Depends R (>= 2.14.0)

Imports methods, sp (>= 1.0-12)

LinkingTo sp

Suggests maptools (>= 0.8-5), testthat, XML

LazyLoad yes

Description Interface to Geometry Engine - Open Source (GEOS) using the C API for topology operations on geometries. The GEOS library is external to the package, and, when installing the package from source, must be correctly installed first. Windows and Mac Intel OS X binaries are provided on CRAN.

License GPL (>= 2)

URL https://r-forge.r-project.org/projects/rgeos/

http://trac.osgeo.org/geos/

SystemRequirements GEOS (>= 3.2.0); for building from source: GEOS from http://trac.osgeo.org/geos/; GEOS OSX frameworks built by William Kyngesburye at http://www.kyngchaos.com/ may be used for source installs on OSX.

Author Roger Bivand [cre, aut],
Colin Rundel [aut],
Edzer Pebesma [ctb],
Karl Ove Hufthammer [ctb]

Maintainer Roger Bivand <Roger.Bivand@nhh.no>

NeedsCompilation yes

Repository CRAN

Date/Publication 2014-09-21 17:11:13

R topics documented:

gArea *Area of Geometry*

Description

Calculates the area of the given geometry.

Usage

```
gArea(spgeom, byid=FALSE)
```

Arguments

spgeom	sp object as defined in package sp
byid	Logical determining if the function should be applied across subgeometries (TRUE) or the entire object (FALSE)

Value

Returns the area of the geometry in the units of the current projection. By definition non-[MULTI]POLYGON geometries have an area of 0. The area of a POLYGON is the area of its shell less the area of any holes. Note that this value may be different from the `area` slot of the `Polygons` class as this value does not subtract the area of any holes in the geometry.

Author(s)

Roger Bivand & Colin Rundel

See Also

gLength

Examples

```
gArea(readWKT("POINT(1 1)"))
gArea(readWKT("LINESTRING(0 0,1 1,2 2)"))
gArea(readWKT("LINEARRING(0 0,3 0,3 3,0 3,0 0)"))


p1 = readWKT("POLYGON((0 0,3 0,3 3,0 3,0 0))")
p2 = readWKT("POLYGON((0 0,3 0,3 3,0 3,0 0),(1 1,2 1,2 2,1 2,1 1))")

gArea(p1)
p1@polygons[[1]]@area

gArea(p2)
p2@polygons[[1]]@area
```

gBoundary *Boundary of Geometry*

Description

Function for determinging the Boundary of the given geometry as defined by SFS Section 2.1.13.1

Usage

```
gBoundary(spgeom, byid=FALSE, id = NULL)
```

Arguments

spgeom	sp object as defined in package sp
byid	Logical determining if the function should be applied across subgeometries (TRUE) or the entire object (FALSE)
id	Character vector defining id labels for the resulting geometries, if unspecified returned geometries will be labeled based on their parent geometries' labels.

Value

Depending of the class of the spgeom the returned results will differ.

Based on the documentation of JTS (on which GEOS is based) the following outputs are expected:

Point	empty GeometryCollection
MultiPoint	empty GeometryCollection
LineString	if closed: empty MultiPoint if not closed: MultiPoint containing the two endpoints.
MultiLineString	MultiPoint obtained by applying the Mod-2 rule to the boundaries of the element LineStrings
LinearRing	empty MultiPoint
Polygon	MultiLineString containing the LinearRings of the shell and holes, in that order (SFS 2.1.10)
MultiPolygon	MultiLineString containing the LinearRings for the boundaries of the element polygons, in the same or
GeometryCollection	The boundary of an arbitrary collection of geometries whose interiors are disjoint consist of geometries

The mod-2 rule states that for a multiline a point is on the boundary if and only if it on the boundary of an odd number of subgeometries of the multiline (See example below).

Author(s)

Roger Bivand & Colin Rundel

See Also

gCentroid gConvexHull gEnvelope gPointOnSurface

Examples

```
x = readWKT("POLYGON((0 0,10 0,10 10,0 10,0 0))")
b = gBoundary(x)

plot(x,col='black')
plot(b,col='red',lwd=3,add=TRUE)

# mod-2 rule example
x1 = readWKT("MULTILINESTRING((2 2,2 0),(2 2,0 2))")
x2 = readWKT("MULTILINESTRING((2 2,2 0),(2 2,0 2),(2 2,4 2))")
x3 = readWKT("MULTILINESTRING((2 2,2 0),(2 2,0 2),(2 2,4 2),(2 2,2 4))")
x4 = readWKT("MULTILINESTRING((2 2,2 0),(2 2,0 2),(2 2,4 2),(2 2,2 4),(2 2,4 4))")

b1 = gBoundary(x1)
b2 = gBoundary(x2)
b3 = gBoundary(x3)
b4 = gBoundary(x4)

par(mfrow=c(2,2))
plot(x1); plot(b1,pch=16,col='red',add=TRUE)
plot(x2); plot(b2,pch=16,col='red',add=TRUE)
plot(x3); plot(b3,pch=16,col='red',add=TRUE)
plot(x4); plot(b4,pch=16,col='red',add=TRUE)
```

---

gBuffer *Buffer Geometry*

Description

Expands the given geometry to include the area within the specified width with specific styling options.

Usage

```
gBuffer(spgeom, byid=FALSE, id=NULL, width=1.0, quadsegs=5, capStyle="ROUND",
 joinStyle="ROUND", mitreLimit=1.0)
```

Arguments

spgeom	sp object as defined in package sp
byid	Logical determining if the function should be applied across subgeometries (TRUE) or the entire object (FALSE)
id	Character vector defining id labels for the resulting geometries, if unspecified returned geometries will be labeled based on their parent geometries' labels.

width	Distance from original geometry to include in the new geometry. Negative values are allowed. Either a numeric vector of length 1 when byid is FALSE; if byid is TRUE: of length 1 replicated to the number of input geometries, or of length equal to the number of input geometries
quadsegs	Number of line segments to use to approximate a quarter circle.
capStyle	Style of cap to use at the ends of the geometry. Allowed values: ROUND,FLAT,SQUARE
joinStyle	Style to use for joints in the geometry. Allowed values: ROUND,MITRE,BEVEL
mitreLimit	Numerical value that specifies how far a joint can extend if a mitre join style is used.

Value

SpatialPolygons (or a SpatialPolygonsDataFrame if byid=TRUE and spgeom has a data.frame); if negative width(s) lead the object to disappear, NULL is returned for byid FALSE, and component Polygons objects are dropped if empty for byid TRUE; the SpatialPolygonsDataFrame is subsetted by row.names or id if given to retain non-empty geometry rows

Author(s)

Roger Bivand & Colin Rundel

Examples

```
p1 = readWKT("POLYGON((0 1,0.95 0.31,0.59 -0.81,-0.59 -0.81,-0.95 0.31,0 1))")
p2 = readWKT("POLYGON((2 2,-2 2,-2 -2,2 -2,2 2),(1 1,-1 1,-1 -1,1 -1,1 1))")

par(mfrow=c(2,3))
plot(gBuffer(p1,width=-0.2),col='black',xlim=c(-1.5,1.5),ylim=c(-1.5,1.5))
plot(p1,border='blue',lwd=2,add=TRUE);title("width: -0.2")
plot(gBuffer(p1,width=0),col='black',xlim=c(-1.5,1.5),ylim=c(-1.5,1.5))
plot(p1,border='blue',lwd=2,add=TRUE);title("width: 0")
plot(gBuffer(p1,width=0.2),col='black',xlim=c(-1.5,1.5),ylim=c(-1.5,1.5))
plot(p1,border='blue',lwd=2,add=TRUE);title("width: 0.2")

plot(gBuffer(p2,width=-0.2),col='black',pbg='white',xlim=c(-2.5,2.5),ylim=c(-2.5,2.5))
plot(p2,border='blue',lwd=2,add=TRUE);title("width: -0.2")
plot(gBuffer(p2,width=0),col='black',pbg='white',xlim=c(-2.5,2.5),ylim=c(-2.5,2.5))
plot(p2,border='blue',lwd=2,add=TRUE);title("width: 0")
plot(gBuffer(p2,width=0.2),col='black',pbg='white',xlim=c(-2.5,2.5),ylim=c(-2.5,2.5))
plot(p2,border='blue',lwd=2,add=TRUE);title("width: 0.2")

p3 <- readWKT(paste("GEOMETRYCOLLECTION(",
 "POLYGON((0 1,0.95 0.31,0.59 -0.81,-0.59 -0.81,-0.95 0.31,0 1)),",
 "POLYGON((2 2,-2 2,-2 -2,2 -2,2 2),(1 1,-1 1,-1 -1,1 -1,1 1)))"))

par(mfrow=c(1,1))
plot(gBuffer(p3, byid=TRUE, width=c(-0.2, -0.1)),col='black',pbg='white',
xlim=c(-2.5,2.5),ylim=c(-2.5,2.5))
plot(p3,border=c('blue', 'red'),lwd=2,add=TRUE);title("width: -0.2, -0.1")
```

```
library(sp)
p3df <- SpatialPolygonsDataFrame(p3, data=data.frame(i=1:length(p3),
 row.names=row.names(p3)))
dim(p3df)
row.names(p3df)
dropEmpty = gBuffer(p3df, byid=TRUE, id=letters[1:nrow(p3df)], width=c(-1, 0))
dim(dropEmpty)
row.names(dropEmpty)
row.names(slot(dropEmpty, "data"))
plot(dropEmpty, col='black', pbg='white', xlim=c(-2.5,2.5),ylim=c(-2.5,2.5))
plot(p3df,border=c('blue'),lwd=2,add=TRUE);title("width: -1, 0")
par(mfrow=c(2,3))


#Style options
l1 = readWKT("LINESTRING(0 0,1 5,4 5,5 2,8 2,9 4,4 6.5)")
par(mfrow=c(2,3))
plot(gBuffer(l1,capStyle="ROUND"));plot(l1,col='blue',add=TRUE);title("capStyle: ROUND")
plot(gBuffer(l1,capStyle="FLAT"));plot(l1,col='blue',add=TRUE);title("capStyle: FLAT")
plot(gBuffer(l1,capStyle="SQUARE"));plot(l1,col='blue',add=TRUE);title("capStyle: SQUARE")

plot(gBuffer(l1,quadsegs=1));plot(l1,col='blue',add=TRUE);title("quadsegs: 1")
plot(gBuffer(l1,quadsegs=2));plot(l1,col='blue',add=TRUE);title("quadsegs: 2")
plot(gBuffer(l1,quadsegs=5));plot(l1,col='blue',add=TRUE);title("quadsegs: 5")



l2 = readWKT("LINESTRING(0 0,1 5,3 2)")
par(mfrow=c(2,3))
plot(gBuffer(l2,joinStyle="ROUND"));plot(l2,col='blue',add=TRUE);title("joinStyle: ROUND")
plot(gBuffer(l2,joinStyle="MITRE"));plot(l2,col='blue',add=TRUE);title("joinStyle: MITRE")
plot(gBuffer(l2,joinStyle="BEVEL"));plot(l2,col='blue',add=TRUE);title("joinStyle: BEVEL")

plot(gBuffer(l2,joinStyle="MITRE",mitreLimit=0.5));plot(l2,col='blue',add=TRUE)
 title("mitreLimit: 0.5")
plot(gBuffer(l2,joinStyle="MITRE",mitreLimit=1));plot(l2,col='blue',add=TRUE)
 title("mitreLimit: 1")
plot(gBuffer(l2,joinStyle="MITRE",mitreLimit=3));plot(l2,col='blue',add=TRUE)
 title("mitreLimit: 3")
```

---

gCentroid *Centroid of Geometry*

Description

Function calculates the centroid of the given geometry.

Usage

```
gCentroid(spgeom, byid=FALSE, id = NULL)
```

Arguments

spgeom	sp object as defined in package sp
byid	Logical determining if the function should be applied across subgeometries (TRUE) or the entire object (FALSE)
id	Character vector defining id labels for the resulting geometries, if unspecified returned geometries will be labeled based on their parent geometries' labels.

Details

Returns a SpatialPoints object of the centroid(s) for spgeom.

Author(s)

Roger Bivand & Colin Rundel

See Also

gBoundary gConvexHull gEnvelope gPointOnSurface

Examples

```
x = readWKT(paste("GEOMETRYCOLLECTION(POLYGON((0 0,10 0,10 10,0 10,0 0)),",
 "POLYGON((15 0,25 15,35 0,15 0)))"))

# Centroids of both the square and circle independently
c1 = gCentroid(x,byid=TRUE)
# Centroid of square and circle together
c2 = gCentroid(x)

plot(x)
plot(c1,col='red',add=TRUE)
plot(c2,col='blue',add=TRUE)
```

---

gContains *Geometry Relationships - Contains and Within*

Description

Functions for testing whether one geometry contains or is contained within another geometry

Usage

```
gContains(spgeom1, spgeom2 = NULL, byid = FALSE, prepared=TRUE,
 returnDense=TRUE, STRsubset=FALSE)
gContainsProperly(spgeom1, spgeom2 = NULL, byid = FALSE, returnDense=TRUE)
gCovers(spgeom1, spgeom2 = NULL, byid = FALSE, returnDense=TRUE)
gCoveredBy(spgeom1, spgeom2 = NULL, byid = FALSE, returnDense=TRUE)
gWithin(spgeom1, spgeom2 = NULL, byid = FALSE, returnDense=TRUE)
```

Arguments

spgeom1, spgeom2	sp objects as defined in package sp. If spgeom2 is NULL then spgeom1 is compared to itself.
byid	Logical vector determining if the function should be applied across ids (TRUE) or the entire object (FALSE) for spgeom1 and spgeom2
prepared	Logical determining if prepared geometry (spatially indexed) version of the GEOS function should be used. In general prepared geometries should be faster than the alternative.
returnDense	default TRUE, if false returns a list of the length of spgeom1 of integer vectors listing the 1:length(spgeom2) indices which would be TRUE in the dense logical matrix representation; useful when the sizes of the byid=TRUE returned matrix is very large and it is sparse
STRsubset	logical argument for future use

Value

gContains returns TRUE if none of the point of spgeom2 is outside of spgeom1 and at least one point of spgeom2 falls within spgeom1.

gContainsProperly returns TRUE under the same conditions as gContains with the additional requirement that spgeom2 does not intersect with the boundary of spgeom1. As such any given geometry will Contain itself but will not ContainProperly itself.

gCovers returns TRUE if no point in spgeom2 is outside of spgeom1. This is slightly different from gContains as it does not require a point within spgeom1 which can be an issue as boundaries are not considered to be "within" a geometry, see gBoundary for specifics of geometry boundaries.

gCoveredBy is the converse of gCovers and is equivalent to swapping spgeom1 and spgeom2.

gWithin is the converse of gContains and is equivalent to swapping spgeom1 and spgeom2.

Author(s)

Roger Bivand & Colin Rundel

References

Helpful information on the subtle differences between these functions: http://lin-ear-th-inking.blogspot.com/2007/06/subtleties-of-ogc-covers-spatial.html

See Also

gCrosses gDisjoint gEquals gEqualsExact gIntersects gOverlaps gRelate gTouches

Examples

```
l1 = readWKT("LINESTRING(0 3,1 1,2 2,3 0)")
l2 = readWKT("LINESTRING(1 3.5,3 3,2 1)")
l3 = readWKT("LINESTRING(1 3.5,3 3,4 1)")
```

```
pt1 = readWKT("MULTIPOINT(1 1,3 0)")
pt2 = readWKT("MULTIPOINT(0 3,3 0)")
pt3 = readWKT("MULTIPOINT(1 1,2 2,3 1)")

p1 = readWKT("POLYGON((0 0,0 2,1 3.5,3 3,4 1,3 0,0 0))")
p2 = readWKT("POLYGON((1 1,1 2,2 2,2 1,1 1))")


par(mfrow=c(2,3))
plot(l1,col='blue');plot(pt1,add=TRUE,pch=16)
title(paste("Contains:",gContains(l1,pt1),
"\nContainsProperly:",gContainsProperly(l1,pt1),
"\nCovers:",gCovers(l1,pt1)))

plot(l1,col='blue');plot(pt2,add=TRUE,pch=16)
title(paste("Contains:",gContains(l1,pt2),
"\nContainsProperly:",gContainsProperly(l1,pt2),
"\nCovers:",gCovers(l1,pt2)))

plot(p1,col='blue',border='blue');plot(pt3,add=TRUE,pch=16)
title(paste("Contains:",gContains(p1,pt3),
"\nContainsProperly:",gContainsProperly(p1,pt3),
"\nCovers:",gCovers(p1,pt3)))

plot(p1,col='blue',border='blue');plot(l2,lwd=2,add=TRUE,pch=16)
title(paste("Contains:",gContains(p1,l2),
"\nContainsProperly:",gContainsProperly(p1,l2),
"\nCovers:",gCovers(p1,l2)))

plot(p1,col='blue',border='blue');plot(l3,lwd=2,add=TRUE,pch=16)
title(paste("Contains:",gContains(p1,l3),
"\nContainsProperly:",gContainsProperly(p1,l3),
"\nCovers:",gCovers(p1,l3)))

plot(p1,col='blue',border='blue');plot(p2,col='black',add=TRUE,pch=16)
title(paste("Contains:",gContains(p1,p2),
"\nContainsProperly:",gContainsProperly(p1,p2),
"\nCovers:",gCovers(p1,p2)))
```

---

gConvexHull *Convex Hull of Geometry*

Description

Function produces the Convex Hull of the given geometry, the smallest convex polygon that contains all subgeometries

Usage

```
gConvexHull(spgeom, byid=FALSE, id = NULL)
```

Arguments

spgeom	sp object as defined in package sp
byid	Logical determining if the function should be applied across subgeometries (TRUE) or the entire object (FALSE)
id	Character vector defining id labels for the resulting geometries, if unspecified returned geometries will be labeled based on their parent geometries' labels.

Details

Returns the convex hull as a SpatialPolygons object.

Author(s)

Roger Bivand & Colin Rundel

See Also

gBoundary gCentroid gEnvelope gPointOnSurface

Examples

```
x = readWKT(paste("POLYGON((0 40,10 50,0 60,40 60,40 100,50 90,60 100,60",
 "60,100 60,90 50,100 40,60 40,60 0,50 10,40 0,40 40,0 40))"))

ch = gConvexHull(x)

plot(x,col='blue',border='blue')
plot(ch,add=TRUE)
```

---

gCrosses *Geometry Relationships - Crosses and Overlaps*

Description

Functions for testing whether geometries share some but not all interior points

Usage

```
gCrosses(spgeom1, spgeom2 = NULL, byid = FALSE, returnDense=TRUE)
gOverlaps(spgeom1, spgeom2 = NULL, byid = FALSE, returnDense=TRUE)
```

Arguments

spgeom1, spgeom2	sp objects as defined in package sp. If spgeom2 is NULL then spgeom1 is compared to itself.
byid	Logical vector determining if the function should be applied across ids (TRUE) or the entire object (FALSE) for spgeom1 and spgeom2
returnDense	default TRUE, if false returns a list of the length of spgeom1 of integer vectors listing the 1:length(spgeom2) indices which would be TRUE in the dense logical matrix representation; useful when the sizes of the byid=TRUE returned matrix is very large and it is sparse

Value

gCrosses returns TRUE when the geometries share some but not all interior points, and the dimension of the intersection is less than that of at least one of the geometries.

gOverlaps returns TRUE when the geometries share some but not all interior points, and the intersection has the same dimension as the geometries themselves.

Author(s)

Roger Bivand & Colin Rundel

See Also

gContains gContainsProperly gCovers gCoveredBy gDisjoint gEquals gEqualsExact gIntersects gRelate gTouches gWithin

Examples

```
l1 = readWKT("LINESTRING(0 3,1 1,2 2,3 0)")
l2 = readWKT("LINESTRING(0 0.5,1 1,2 2,3 2.5)")
l3 = readWKT("LINESTRING(1 3,1.5 1,2.5 2)")

pt1 = readWKT("MULTIPOINT(1 1,3 0)")
pt2 = readWKT("MULTIPOINT(1 1,3 0,1 2)")

p1 = readWKT("POLYGON((0 0,0 2,1 3.5,3 3,4 1,3 0,0 0))")
p2 = readWKT("POLYGON((2 2,3 4,4 1,4 0,2 2))")

par(mfrow=c(2,3))
plot(l1,col='blue');plot(pt1,add=TRUE,pch=16)
title(paste("Crosses:",gCrosses(l1,pt1),
"\nOverlaps:",gOverlaps(l1,pt1)))

plot(l1,col='blue');plot(pt2,add=TRUE,pch=16)
title(paste("Crosses:",gCrosses(l1,pt2),
"\nOverlaps:",gOverlaps(l1,pt2)))

plot(l1,col='blue');plot(l2,add=TRUE)
title(paste("Crosses:",gCrosses(l1,l2),
```

```
"\nOverlaps:",gOverlaps(l1,l2)))

plot(l1,col='blue');plot(l3,add=TRUE)
title(paste("Crosses:",gCrosses(l1,l3),
"\nOverlaps:",gOverlaps(l1,l3)))

plot(p1,border='blue',col='blue');plot(l1,add=TRUE)
title(paste("Crosses:",gCrosses(p1,l1),
"\nOverlaps:",gOverlaps(p1,l1)))

plot(p1,border='blue',col='blue');plot(p2,add=TRUE)
title(paste("Crosses:",gCrosses(p1,p2),
"\nOverlaps:",gOverlaps(p1,p2)))
```

`gDelaunayTriangulation` *Compute Delaunay triangulation between points*

Description

Function to compute the Delaunay triangulation between points; only available for GEOS >= 3.4.0.

Usage

```
gDelaunayTriangulation(spgeom, tolerance=0.0, onlyEdges=FALSE)
```

Arguments

`spgeom`	sp points object as defined in package sp
`tolerance`	Numerical tolerance value to be used in triangulation
`onlyEdges`	Logical, default returns triangles as polygons, if TRUE, returns a SpatialLines object with a single MULTILINESTRING

Details

When onlyEdges is TRUE, the SpatialLines object may be de-merged to identify the input points that are touched by each edge, making it possible to identify spatial neighbours.

Value

Either a SpatialPolygons object or a SpatialLines object containing a single Lines object of the undirected edges in the triangulation.

Author(s)

Roger Bivand

References

http://en.wikipedia.org/wiki/Delaunay_triangulation

Examples

```
if (version_GEOS0() > "3.4.0") {
library(sp)
data(meuse)
coordinates(meuse) <- c("x", "y")
plot(gDelaunayTriangulation(meuse))
points(meuse)
out <- gDelaunayTriangulation(meuse, onlyEdges=TRUE)
lns <- slot(slot(out, "lines")[[1]], "Lines")
out1 <- SpatialLines(lapply(seq(along=lns), function(i) Lines(list(lns[[i]]),
 ID=as.character(i))))
out2 <- lapply(1:length(out1), function(i) which(gTouches(meuse, out1[i],
 byid=TRUE)))
out3 <- do.call("rbind", out2)
o <- order(out3[,1], out3[,2])
out4 <- out3[o,]
out5 <- data.frame(from=out4[,1], to=out4[,2], weight=1)
head(out5)
## Not run:
library(spdep)
class(out5) <- c("spatial.neighbour", class(out5))
attr(out5, "n") <- length(meuse)
attr(out5, "region.id") <- as.character(1:length(meuse))
nb1 <- sn2listw(out5)$neighbours
nb2 <- make.sym.nb(nb1)

## End(Not run)
}
```

---

gDifference *Geometry Difference*

Description

Function for determining the difference between the two given geometries.

Usage

```
gDifference(spgeom1, spgeom2, byid=FALSE, id=NULL, drop_lower_td=FALSE)
```

Arguments

`spgeom1, spgeom2`
: sp objects as defined in package sp

byid	Logical vector determining if the function should be applied across ids (TRUE) or the entire object (FALSE) for spgeom1 and spgeom2
id	Character vector defining id labels for the resulting geometries, if unspecified returned geometries will be labeled based on their parent geometries' labels.
drop_lower_td	default FALSE; if TRUE, objects will be dropped from output GEOMETRYCOLLECTION objects to simplify output if their topological dinension is less than the minimum topological dinension of the input objects.

Details

Returns the regions of spgeom1 that are not within spgeom2. If the geometries do not intersect then the result is just spgeom1. Note that the function is not symmetric for spgeom1 and spgeom2.

Author(s)

Roger Bivand & Colin Rundel

See Also

gIntersection gSymdifference gUnion

Examples

```
x = readWKT("POLYGON ((0 0, 0 10, 10 10, 10 0, 0 0))")
y = readWKT("POLYGON ((3 3, 7 3, 7 7, 3 7, 3 3))")

d = gDifference(x,y)
plot(d,col='red',pbg='white')

# Empty geometry since y is completely contained with x
d2 = gDifference(y,x)
```

---

gDistance *Distance between geometries*

Description

Calculates the distance between the given geometries

Usage

```
gDistance(spgeom1, spgeom2=NULL, byid=FALSE, hausdorff=FALSE, densifyFrac = NULL)
gWithinDistance(spgeom1, spgeom2=NULL, dist, byid=FALSE,
 hausdorff=FALSE, densifyFrac=NULL)
```

Arguments

spgeom1, spgeom2	sp objects as defined in package sp. If spgeom2 is NULL then spgeom1 is compared to itself.
byid	Logical vector determining if the function should be applied across ids (TRUE) or the entire object (FALSE) for spgeom1 and spgeom2
hausdorff	Logical determining if the discrete Hausdorff distance should be calculated
densifyFrac	Numerical value between 0 and 1 that determines the fraction by which to densify each segment of the geometry.
dist	Numerical value that determines cutoff distance

Details

Discrete Hausdorff distance is essentially a measure of the similarity or dissimilarity of the two geometries, see references below for more detailed explanations / descriptions.

If hausdorff is TRUE and densifyFrac is specified then the geometries' segments are densified by splitting each segment into equal length subsegments whose fraction of the total length is equal to densifyFrac.

Value

gDistance by default returns the cartesian minimum distance between the two geometries in the units of the current projection. If hausdorff is TRUE then the Hausdorff distance is returned for the two geometries.

gWithinDistance returns TRUE if returned distance is less than or equal to the specified dist.

Author(s)

Roger Bivand & Colin Rundel

References

Hausdorff Differences: http://en.wikipedia.org/wiki/Hausdorff_distance http://lin-ear-th-inking.blogspot.com/2009/01/computing-geometric-similarity.html

See Also

gWithinDistance

Examples

```
pt1 = readWKT("POINT(0.5 0.5)")
pt2 = readWKT("POINT(2 2)")

p1 = readWKT("POLYGON((0 0,1 0,1 1,0 1,0 0))")
p2 = readWKT("POLYGON((2 0,3 1,4 0,2 0))")
```

```
gDistance(pt1,pt2)
gDistance(p1,pt1)
gDistance(p1,pt2)
gDistance(p1,p2)


p3 = readWKT("POLYGON((0 0,2 0,2 2,0 2,0 0))")
p4 = readWKT("POLYGON((0 0,2 0,2 1.9,1.9 2,0 2,0 0))")
p5 = readWKT("POLYGON((0 0,2 0,2 1.5,1.5 2,0 2,0 0))")
p6 = readWKT("POLYGON((0 0,2 0,2 1,1 2,0 2,0 0))")
p7 = readWKT("POLYGON((0 0,2 0,0 2,0 0))")

gDistance(p3,hausdorff=TRUE)
gDistance(p3,p4,hausdorff=TRUE)
gDistance(p3,p5,hausdorff=TRUE)
gDistance(p3,p6,hausdorff=TRUE)
gDistance(p3,p7,hausdorff=TRUE)
```

`gEnvelope` *Envelope of Geometry*

Description

Function calculates the rectangular bounding box for the given geometry

Usage

```
gEnvelope(spgeom, byid=FALSE, id = NULL)
```

Arguments

`spgeom`	sp object as defined in package sp
`byid`	Logical determining if the function should be applied across subgeometries (TRUE) or the entire object (FALSE)
`id`	Character vector defining id labels for the resulting geometries, if unspecified returned geometries will be labeled based on their parent geometries' labels.

Details

Returns the rectangular bounding box as a SpatailPolygons object. If spgeom is a degenerate case (horizontal/vertical line, single point) then the function may return an object with lower dimension (SpatialLines or SpatialPoints) or an invalid polygon.

Author(s)

Roger Bivand & Colin Rundel

See Also

gBoundary gCentroid gConvexHull gPointOnSurface

Examples

```
x = readWKT(paste("POLYGON((0 40,10 50,0 60,40 60,40 100,50 90,60 100,60",
 "60,100 60,90 50,100 40,60 40,60 0,50 10,40 0,40 40,0 40))"))
env = gEnvelope(x)

plot(x,col='blue',border='blue')
plot(env,add=TRUE)

#Degenerate Cases
gEnvelope(readWKT("POINT(1 1)")) #returns SpatialPoints
gEnvelope(readWKT("LINESTRING(1 1,1 2)")) #invalid polygon
gEnvelope(readWKT("LINESTRING(1 1,2 1)")) #invalid polygon
```

---

gEquals *Geometry Relationships - Equality*

Description

Function for testing equivalence of the given geometries

Usage

```
gEquals(spgeom1, spgeom2 = NULL, byid = FALSE, returnDense=TRUE)
gEqualsExact(spgeom1, spgeom2 = NULL, tol=0.0, byid = FALSE, returnDense=TRUE)
```

Arguments

spgeom1, spgeom2	sp objects as defined in package sp. If spgeom2 is NULL then spgeom1 is compared to itself.
byid	Logical vector determining if the function should be applied across ids (TRUE) or the entire object (FALSE) for spgeom1 and spgeom2
tol	Numerical value of tolerance to use when assessing equivalence
returnDense	default TRUE, if false returns a list of the length of spgeom1 of integer vectors listing the `1:length(spgeom2)` indices which would be TRUE in the dense logical matrix representation; useful when the sizes of the byid=TRUE returned matrix is very large and it is sparse

Value

gEquals returns TRUE if geometries are "spatially equivalent" which requires that spgeom1 is within spgeom2 and spgeom2 is within spgeom1, this ignores ordering of points within the geometries. Note that it is possible for geometries with different coordinates to be "spatially equivalent".

gEqualsExact returns TRUE if geometries are "exactly equivalent" which requires that spgeom1 and spgeom1 are "spatially equivalent" and that their constituent points are in the same order.

Author(s)

Roger Bivand & Colin Rundel

See Also

gContains gContainsProperly gCovers gCoveredBy gCrosses gDisjoint gEqualsExact gIntersects gOverlaps gRelate gTouches gWithin

Examples

```
# p1 and p2 are spatially identical but not exactly identical due to point ordering
p1=readWKT("POLYGON((0 0,1 0,1 1,0 1,0 0))")
p2=readWKT("POLYGON((1 1,0 1,0 0,1 0,1 1))")
p3=readWKT("POLYGON((0.01 0.01,1.01 0.01,1.01 1.01,0.01 1.01,0.01 0.01))")

gEquals(p1,p2)
gEquals(p1,p3)
gEqualsExact(p1,p2)
gEqualsExact(p1,p3,tol=0)
gEqualsExact(p1,p3,tol=0.1)

# pt1 and p2t are spatially identical but not exactly identical due to point ordering
pt1 = readWKT("MULTIPOINT(1 1,2 2,3 3)")
pt2 = readWKT("MULTIPOINT(3 3,2 2,1 1)")
pt3 = readWKT("MULTIPOINT(1.01 1.01,2.01 2.01,3.01 3.01)")

gEquals(pt1,pt2)
gEquals(pt1,pt3)
gEqualsExact(pt1,pt2)
gEqualsExact(pt1,pt3,tol=0)
gEqualsExact(pt1,pt3,tol=0.1)


# l2 contains a point that l1 does not
l1 = readWKT("LINESTRING (10 10, 20 20)")
l2 = readWKT("LINESTRING (10 10, 15 15,20 20)")
gEquals(l1,l2)
gEqualsExact(l1,l2)
```

gIntersection *Geometry Intersections*

Description

Function for determining the intersection between the two given geometries

Usage

```
gIntersection(spgeom1, spgeom2, byid=FALSE, id=NULL, drop_not_poly, drop_lower_td=FALSE)
```

Arguments

spgeom1, spgeom2	sp objects as defined in package sp
byid	Logical vector determining if the function should be applied across ids (TRUE) or the entire object (FALSE) for spgeom1 and spgeom2
id	Character vector defining id labels for the resulting geometries, if unspecified returned geometries will be labeled based on their parent geometries' labels.
drop_not_poly	deprecated argument, use drop_lower_td
drop_lower_td	default FALSE; if TRUE, objects will be dropped from output GEOMETRYCOLLECTION objects to simplify output if their topological dinension is less than the minimum topological dinension of the input objects.

Details

Returns all spatial intersections as sp objects of the appropriate class. If the geometries do not intersect then an empty geometry is returned.

Author(s)

Roger Bivand & Colin Rundel

See Also

gDifference gSymdifference gUnion

Examples

```
library(maptools)
xx <- readShapeSpatial(system.file("shapes/fylk-val-ll.shp", package="maptools")[1],
 proj4string=CRS("+proj=longlat +datum=WGS84"))
bbxx <- bbox(xx)
wdb_lines <- system.file("share/wdb_borders_c.b", package="maptools")
xxx <- Rgshhs(wdb_lines, xlim=bbxx[1,], ylim=bbxx[2,])$SP
res <-gIntersection(xx, xxx)
plot(xx, axes=TRUE)
```

```
plot(xxx, lty=2, add=TRUE)
plot(res, add=TRUE, pch=16,col='red')
pol <- readWKT(paste("POLYGON((-180 -20, -140 55, 10 0, -140 -60, -180 -20),",
 "(-150 -20, -100 -10, -110 20, -150 -20))"))
library(sp)
GT <- GridTopology(c(-175, -85), c(10, 10), c(36, 18))
gr <- as(as(SpatialGrid(GT), "SpatialPixels"), "SpatialPolygons")
try(res <- gIntersection(pol, gr, byid=TRUE))
res <- gIntersection(pol, gr, byid=TRUE, drop_lower_td=TRUE)
# Robert Hijmans difficult intersection case
load(system.file("test_cases/polys.RData", package="rgeos"))
try(res <- gIntersection(a, b, byid=TRUE))
res <- gIntersection(a, b, byid=TRUE, drop_lower_td=TRUE)
unlist(sapply(slot(res, "polygons"), function(p) sapply(slot(p, "Polygons"), slot, "area")))
oT <- get_RGEOS_polyThreshold()
oW <- get_RGEOS_warnSlivers()
oD <- get_RGEOS_dropSlivers()
set_RGEOS_polyThreshold(1e-3)
set_RGEOS_warnSlivers(TRUE)
res1 <- gIntersection(a, b, byid=TRUE, drop_lower_td=TRUE)
unlist(sapply(slot(res1, "polygons"), function(p) sapply(slot(p, "Polygons"), slot, "area")))
set_RGEOS_dropSlivers(TRUE)
res2 <- gIntersection(a, b, byid=TRUE, drop_lower_td=TRUE)
unlist(sapply(slot(res2, "polygons"), function(p) sapply(slot(p, "Polygons"), slot, "area")))
set_RGEOS_dropSlivers(FALSE)
oo <- gUnaryUnion(res1, c(rep("1", 3), "2", "3", "4"))
unlist(sapply(slot(oo, "polygons"), function(p) sapply(slot(p, "Polygons"), slot, "area")))
ooo <- gIntersection(b, oo, byid=TRUE)
gArea(ooo, byid=TRUE)
unlist(sapply(slot(ooo, "polygons"), function(p) sapply(slot(p, "Polygons"), slot, "area")))
set_RGEOS_dropSlivers(TRUE)
ooo <- gIntersection(b, oo, byid=TRUE)
gArea(ooo, byid=TRUE)
unlist(sapply(slot(ooo, "polygons"), function(p) sapply(slot(p, "Polygons"), slot, "area")))
set_RGEOS_polyThreshold(oT)
set_RGEOS_warnSlivers(oW)
set_RGEOS_dropSlivers(oD)
```

---

gIntersects *Geometry Relationships - Intersects and Disjoint*

Description

Function for testing if the geometries have at least one point in common or no points in common

Usage

```
gIntersects(spgeom1, spgeom2 = NULL, byid = FALSE, prepared=TRUE, returnDense=TRUE)
gDisjoint(spgeom1, spgeom2 = NULL, byid = FALSE, returnDense=TRUE)
```

Arguments

spgeom1, spgeom2	sp objects as defined in package sp. If spgeom2 is NULL then spgeom1 is compared to itself.
byid	Logical vector determining if the function should be applied across ids (TRUE) or the entire object (FALSE) for spgeom1 and spgeom2
prepared	Logical determining if prepared geometry (spatially indexed) version of the GEOS function should be used. In general prepared geometries should be faster than the alternative.
returnDense	default TRUE, if false returns a list of the length of spgeom1 of integer vectors listing the `1:length(spgeom2)` indices which would be TRUE in the dense logical matrix representation; useful when the sizes of the byid=TRUE returned matrix is very large and it is sparse

Value

`gIntersects` returns TRUE if `spgeom1` and `spgeom2` have at least one point in common.

`gDisjoint` returns TRUE if `spgeom1` and `spgeom2` have no points in common.

Author(s)

Roger Bivand & Colin Rundel

See Also

`gContains` `gContainsProperly` `gCovers` `gCoveredBy` `gCrosses` `gEquals` `gEqualsExact` `gOverlaps` `gRelate` `gTouches` `gWithin`

Examples

```
p1 = readWKT("POLYGON((0 0,1 0,1 1,0 1,0 0))")
p2 = readWKT("POLYGON((0.5 1,0 2,1 2,0.5 1))")
p3 = readWKT("POLYGON((0.5 0.5,0 1.5,1 1.5,0.5 0.5))")

l1 = readWKT("LINESTRING(0 3,1 1,2 2,3 0)")
l2 = readWKT("LINESTRING(1 3.5,3 3,2 1)")
l3 = readWKT("LINESTRING(-0.1 0,-0.1 1.1,1 1.1)")

pt1 = readWKT("MULTIPOINT(1 1,3 0,2 1)")
pt2 = readWKT("MULTIPOINT(0 3,3 0,2 1)")
pt3 = readWKT("MULTIPOINT(-0.2 0,1 -0.2,1.2 1,0 1.2)")


par(mfrow=c(3,2))
plot(p1,col='blue',border='blue',ylim=c(0,2.5));plot(p2,col='black',add=TRUE,pch=16)
title(paste("Intersects:",gIntersects(p1,p2),
"\nDisjoint:",gDisjoint(p1,p2)))

plot(p1,col='blue',border='blue',ylim=c(0,2.5));plot(p3,col='black',add=TRUE,pch=16)
```

```
title(paste("Intersects:",gIntersects(p1,p3),
"\nDisjoint:",gDisjoint(p1,p3)))

plot(l1,col='blue');plot(pt1,add=TRUE,pch=16)
title(paste("Intersects:",gIntersects(l1,pt1),
"\nDisjoint:",gDisjoint(l1,pt1)))

plot(l1,col='blue');plot(pt2,add=TRUE,pch=16)
title(paste("Intersects:",gIntersects(l1,pt2),
"\nDisjoint:",gDisjoint(l1,pt2)))

plot(p1,col='blue',border='blue',xlim=c(-0.5,2),ylim=c(0,2.5))
plot(l3,lwd=2,col='black',add=TRUE)
title(paste("Intersects:",gIntersects(p1,l3),
"\nDisjoint:",gDisjoint(p1,l3)))

plot(p1,col='blue',border='blue',xlim=c(-0.5,2),ylim=c(-0.5,2))
plot(pt3,pch=16,col='black',add=TRUE)
title(paste("Intersects:",gIntersects(p1,pt3),
"\nDisjoint:",gDisjoint(p1,pt3)))
```

`gIsEmpty` *Is Geometry Empty?*

Description

Tests if the given geometry is empty

Usage

```
gIsEmpty(spgeom, byid = FALSE)
```

Arguments

`spgeom`	sp object as defined in package sp
`byid`	Logical determining if the function should be applied across subgeometries (TRUE) or the entire object (FALSE)

Details

Because no sp Spatial object may be empty, the function exists but cannot work, as `readWKT` is not permitted to create an empty object.

Value

Returns TRUE if the given geometry is empty, FALSE otherwise.

Author(s)

Roger Bivand & Colin Rundel

See Also

gIsRing gIsSimple gIsValid

Examples

```
try(gIsEmpty(readWKT("POINT EMPTY")))
gIsEmpty(readWKT("POINT(1 1)"))
try(gIsEmpty(readWKT("LINESTRING EMPTY")))
gIsEmpty(readWKT("LINESTRING(0 0,1 1)"))
try(gIsEmpty(readWKT("POLYGON EMPTY")))
gIsEmpty(readWKT("POLYGON((0 0,1 0,1 1,0 1,0 0))"))
```

---

gIsRing *Is Geometry a Ring?*

Description

Tests if the given geometry is a ring

Usage

```
gIsRing(spgeom, byid = FALSE)
```

Arguments

spgeom	sp object as defined in package sp
byid	Logical determining if the function should be applied across subgeometries (TRUE) or the entire object (FALSE)

Value

Returns TRUE if the geometry is a LINEARRING.

Returns TRUE if the geometry is a LINESTRING that is both Simple (gIsSimple) and Closed (end points intersect), FALSE otherwise.

Returns FALSE if the geometry is a [MULTI]POINT, MULTILINESTRING, or [MULTI]POLYGON.

Author(s)

Roger Bivand & Colin Rundel

See Also

gIsEmpty gIsSimple gIsValid

Examples

```
l1 = readWKT("LINESTRING(0 0, 1 1, 1 0, 0 1, 0 0)")
l2 = readWKT("LINESTRING(0 0,1 0,1 1,0 1,0 0)")
r1 = readWKT("LINEARRING(0 0, 1 1, 1 0, 0 1, 0 0)")
r2 = readWKT("LINEARRING(0 0,1 0,1 1,0 1,0 0)")
p1 = readWKT("POLYGON((0 0, 1 1, 1 0, 0 1, 0 0))")
p2 = readWKT("POLYGON((0 0,1 0,1 1,0 1,0 0))")

par(mfrow=c(3,2))
plot(l1);title(paste("LINESTRING\nRing:",gIsRing(l1)))
plot(l2);title(paste("LINESTRING\nRing:",gIsRing(l2)))
plot(r1);title(paste("LINEARRING\nRing:",gIsRing(r1)))
plot(r2);title(paste("LINEARRING\nRing:",gIsRing(r2)))
plot(p1);title(paste("POLYGON\nRing:",gIsRing(p1)))
plot(p2);title(paste("POLYGON\nRing:",gIsRing(p2)))
```

---

gIsSimple *Is Geometry Simple?*

Description

Function tests if the given geometry is simple

Usage

```
gIsSimple(spgeom, byid = FALSE)
```

Arguments

spgeom	sp object as defined in package sp
byid	Logical determining if the function should be applied across subgeometries (TRUE) or the entire object (FALSE)

Details

Simplicity is used in reference to 0 and 1-dimensional geometries ([MULTI]POINT and [MULTI]LINESTRING) whereas Validity (gIsValid) is used in reference to 2-dimensional geometries ([MULTI]POLYGON).

A POINT is always simple.

A MULTIPOINT is simple if no two points are identical.

A LINESTRING is simple if it does not pass through the same point twice (self intersection) except at the end points, in which case it is a ring (gIsRing).

A MULTILINESTRING is simple if all of its subgeometries are simple and none of the subgeometries intersect except at end points.

A [MULTI]POLYGON is simple by definition.

Many of the functions in rgeos expect simple/valid geometries and may exhibit unpredictable behavior if given an invalid geometry. Checking of validity/simplicity can be computationally expensive for complex geometries and so is not done by default, any new geometries should be checked.

Value

Returns TRUE if the given geometry does not contain anomalous points, such as self intersection or self tangency.

Author(s)

Roger Bivand & Colin Rundel

References

Validity Details: http://postgis.refractions.net/docs/ch04.html#OGC_Validity

See Also

gIsEmpty gIsRing gIsValid

Examples

```
# MULTIPOINT examples
gIsSimple(readWKT("MULTIPOINT(1 1,2 2,3 3)"))
gIsSimple(readWKT("MULTIPOINT(1 1,2 2,1 1)"))

# LINESTRING examples
l1 = readWKT("LINESTRING(0 5,3 4,2 3,5 2)")
l2 = readWKT("LINESTRING(0 5,4 2,5 4,0 1)")
l3 = readWKT("LINESTRING(3 5,0 4,0 2,2 0,5 1,4 4,4 5,3 5)")
l4 = readWKT("LINESTRING(3 5,0 4,4 3,5 2,3 0,1 2,4 5,3 5)")

par(mfrow=c(2,2))
plot(l1);title(paste("Simple:",gIsSimple(l1)))
plot(l2);title(paste("Simple:",gIsSimple(l2)))
plot(l3);title(paste("Simple:",gIsSimple(l3)))
plot(l4);title(paste("Simple:",gIsSimple(l4)))

# MULTILINESTRING examples
ml1 = readWKT("MULTILINESTRING((0 5,1 2,5 0),(3 5,5 4,4 1))")
ml2 = readWKT("MULTILINESTRING((0 5,1 2,5 0),(0 5,5 4,4 1))")
ml3 = readWKT("MULTILINESTRING((0 5,1 2,5 0),(3 5,5 4,2 0))")

par(mfrow=c(1,3))
plot(ml1);title(paste("Simple:",gIsSimple(ml1)))
plot(ml2);title(paste("Simple:",gIsSimple(ml2)))
plot(ml3);title(paste("Simple:",gIsSimple(ml3)))
```

gIsValid *Is Geometry Valid?*

Description

Function tests if the given geometry is valid

Usage

```
gIsValid(spgeom, byid = FALSE, reason=FALSE)
```

Arguments

spgeom	sp object as defined in package sp
byid	Logical determining if the function should be applied across subgeometries (TRUE) or the entire object (FALSE)
reason	Logical determining if the function should return a character string describing why the geometry is invalid

Details

Validity is used in reference to 2-dimensional geometries (LINEARRING and [MULTI]POLYGON) whereas Simplicity (gIsSimple) is used in reference to 0 and 1-dimensional geometries ([MULTI]POINT and [MULTI]LINESTRING).

A LINEARRING is valid if it does not intersect itself.

A POLYGON is valid if no two rings in the boundary (made up of an exterior ring and interior rings) cross. The boundary of a POLYGON may intersect at a POINT but only as a tangent (i.e. not on a line). A POLYGON may not have cut lines or spikes and the interior rings must be contained entirely within the exterior ring.

A MULTIPOLYGON is valid if and only if all of its elements are valid and the interiors of no two elements intersect. The boundaries of any two elements may touch, but only at a finite number of POINTs.

Many of the functions in rgeos expect simple/valid geometries and may exhibit unpredictable behavior if given an invalid geometry. Checking of validity/simplicity can be computationally expensive for complex geometries and so is not done by default, any new geometries should be checked.

Value

By default will return TRUE if the given geometry is well formed, FALSE otherwise. If reason is set to TRUE then a character string is returned describing the geometry, "Valid Geometry" if it is valid or details of the specific issue. Any given geometry may have multiple issues that make it invalid, gIsValid will only return the first, once it has been corrected additionally checking is necessary to confirm that additional issues do not remain.

Author(s)

Roger Bivand & Colin Rundel

References

Validity Details: http://postgis.refractions.net/docs/ch04.html#OGC_Validity

See Also

gIsEmpty gIsRing gIsSimple

Examples

```
#LINEARRING Example
l = readWKT("LINEARRING(0 0, 100 100, 100 0, 0 100, 0 0)")
plot(l);title(paste("Valid:",gIsValid(l),"\n",gIsValid(l,reason=TRUE)))

#POLYGON and MULTIPOLYGON Examples
p1 = readWKT("POLYGON ((0 60, 0 0, 60 0, 60 60, 0 60), (20 40, 20 20, 40 20, 40 40, 20 40))")
p2 = readWKT("POLYGON ((0 60, 0 0, 60 0, 60 60, 0 60), (20 40, 20 20, 60 20, 20 40))")
p3 = readWKT(paste("POLYGON ((0 120, 0 0, 140 0, 140 120, 0 120),",
 "(100 100, 100 20, 120 20, 120 100, 100 100),",
 "(20 100, 20 40, 100 40, 20 100))"))

p4 = readWKT("POLYGON ((0 40, 0 0, 40 40, 40 0, 0 40))")
p5 = readWKT("POLYGON ((-10 50, 50 50, 50 -10, -10 -10, -10 50), (0 40, 0 0, 40 40, 40 0, 0 40))")
p6 = readWKT("POLYGON ((0 60, 0 0, 60 0, 60 20, 100 20, 60 20, 60 60, 0 60))")
p7 = readWKT(paste("POLYGON ((40 300, 40 20, 280 20, 280 300, 40 300),",
 "(120 240, 80 180, 160 220, 120 240),",
 "(220 240, 160 220, 220 160, 220 240),",
 "(160 100, 80 180, 100 80, 160 100),",
 "(160 100, 220 160, 240 100, 160 100))"))
p8 = readWKT(paste("POLYGON ((40 320, 340 320, 340 20, 40 20, 40 320),",
 "(100 120, 40 20, 180 100, 100 120),",
 "(200 200, 180 100, 240 160, 200 200),",
 "(260 260, 240 160, 300 200, 260 260),",
 "(300 300, 300 200, 340 320, 300 300))"))
p9 = readWKT(paste("MULTIPOLYGON (((20 380, 420 380, 420 20, 20 20, 20 380),",
 "(220 340, 180 240, 60 200, 200 180, 340 60, 240 220, 220 340)),",
 "((60 200, 340 60, 220 340, 60 200)))"))

par(mfrow=c(3,3))
plot(p1,col='black',pbg='white');title(paste("Valid:",gIsValid(p1),"\n",gIsValid(p1,reason=TRUE)))
plot(p2,col='black',pbg='white');title(paste("Valid:",gIsValid(p2),"\n",gIsValid(p2,reason=TRUE)))
plot(p3,col='black',pbg='white');title(paste("Valid:",gIsValid(p3),"\n",gIsValid(p3,reason=TRUE)))
plot(p4,col='black',pbg='white');title(paste("Valid:",gIsValid(p4),"\n",gIsValid(p4,reason=TRUE)))
plot(p5,col='black',pbg='white');title(paste("Valid:",gIsValid(p5),"\n",gIsValid(p5,reason=TRUE)))
plot(p6,col='black',pbg='white');title(paste("Valid:",gIsValid(p6),"\n",gIsValid(p6,reason=TRUE)))
plot(p7,col='black',pbg='white');title(paste("Valid:",gIsValid(p7),"\n",gIsValid(p7,reason=TRUE)))
plot(p8,col='black',pbg='white');title(paste("Valid:",gIsValid(p8),"\n",gIsValid(p8,reason=TRUE)))
plot(p9,col='black',pbg='white')
```

```
title(paste("Valid:",gIsValid(p9),"\n",gIsValid(p9,reason=TRUE)))
```

---

gLength *Length of Geometry*

Description

Calculates the length of the given geometry.

Usage

```
gLength(spgeom, byid=FALSE)
```

Arguments

spgeom	sp object as defined in package sp
byid	Logical determining if the function should be applied across subgeometries (TRUE) or the entire object (FALSE)

Value

Returns the length of the geometry in the units of the current projection. By definition [MULTI]POINTs have a length of 0. The length of POLYGONs is the sum of the length of their shell and their hole(s).

Author(s)

Roger Bivand & Colin Rundel

See Also

gArea

Examples

```
gLength(readWKT("POINT(1 1)"))

gLength(readWKT("LINESTRING(0 0,1 1,2 2)"))
gLength(readWKT("LINESTRING(0 0,1 1,2 0,3 1)"))

gLength(readWKT("POLYGON((0 0,3 0,3 3,0 3,0 0))"))
gLength(readWKT("POLYGON((0 0,3 0,3 3,0 3,0 0),(1 1,2 1,2 2,1 2,1 1))"))
```

gNode *Linestring Noder*

Description

Function attempts to node a linestring object, inserting coordinates at intersection points; only available for GEOS >= 3.4.0.

Usage

```
gNode(spgeom);
```

Arguments

spgeom	an sp object inheriting from SpatialLines

Details

Because gPolygonize expects linestrings to be fully noded, as such they must not cross and must touch only at endpoints. gNodee takes an object inheriting from SpatialLines and attempts to add omitted nodes. Issue reported by Nicola Farina 21 March 2014.

Value

Returns a noded linestring object.

Author(s)

Roger Bivand

See Also

gPolygonize

Examples

```
library(sp)
pol1 <- readWKT(paste("POLYGON((39.936 43.446, 39.94 43.446, 39.94 43.45,",
 "39.936 43.45, 39.936 43.446))"))
pol2 <- readWKT(paste("POLYGON((39.9417 43.45, 39.9395 43.4505,",
 "39.9385 43.4462, 39.9343 43.4452, 39.9331 43.4469, 39.9417 43.45))"))
plot(pol2, axes=TRUE)
plot(pol1, add=TRUE, border="blue")
gIsValid(pol1)
gIsValid(pol2)
try(res <- gUnion(pol1, pol2))
if (version_GEOS0() > "3.4.0") {
pol2a <- gPolygonize(gNode(as(pol2, "SpatialLines")))
try(res <- gUnion(pol1, pol2a))
```

```
plot(res, add=TRUE, border="red", lty=2, lwd=2)
set.seed(1)
# rw from Jim Holtman's R-help posting 2010-12-2
n <- 1000
rw <- matrix(0, ncol = 2, nrow = n)
indx <- cbind(seq(n), sample(c(1, 2), n, TRUE))
rw[indx] <- sample(c(-1, 1), n, TRUE)
rw[,1] <- cumsum(rw[, 1])
rw[, 2] <- cumsum(rw[, 2])
slrw <- SpatialLines(list(Lines(list(Line(rw)), "1")))
res0 <- gNode(slrw)
print(length(slrw))
print(length(res0))
res <- gPolygonize(res0)
print(summary(res))
print(length(res))
plot(res0, axes=TRUE)
plot(res, add=TRUE, col=sample(rainbow(length(res))))
# library(spatstat)
# set.seed(0)
# X <- psp(runif(100), runif(100), runif(100), runif(100), window=owin())
# library(maptools)
# sppsp <- as(X, "SpatialLines")
# writeLines(writeWKT(sppsp, byid=FALSE), con="sppsp.wkt")
sppsp <- readWKT(readLines(system.file("wkts/sppsp.wkt", package="rgeos")))
plot(sppsp, axes=TRUE)
res0 <- gNode(sppsp)
res <- gPolygonize(res0)
plot(res, add=TRUE, col=sample(rainbow(length(res))))
}
```

`gpc.poly-class` *Class "gpc.poly"*

Description

A class for representing polygons composed of multiple contours, some of which may be holes.

Objects from the Class

Objects can be created by calls of the form `new("gpc.poly", ...)` or by reading in from a file using `read.polyfile`.

Slots

pts Object of class "list". Actually, `pts` is a list of lists with length equal to the number of contours in the `"gpc.poly"` object. Each element of `pts` is a list of length 3 with names `x`, `y`, and `hole`. `x` and `y` are vectors containing the `x` and `y` coordinates, respectively, while `hole` is a logical indicating whether or not the contour is a hole.

Methods

[`signature(x = "gpc.poly")`: ...

append.poly `signature(x = "gpc.poly", y = "gpc.poly")`: ...

area.poly `signature(object = "gpc.poly")`: ...

coerce `signature(from = "matrix", to = "gpc.poly")`: ...

coerce `signature(from = "data.frame", to = "gpc.poly")`: ...

coerce `signature(from = "numeric", to = "gpc.poly")`: ...

coerce `signature(from = "list", to = "gpc.poly")`: ...

coerce `signature(from = "SpatialPolygons", to = "gpc.poly")`: ...

coerce `signature(from = "gpc.poly", to = "matrix")`: ...

coerce `signature(from = "gpc.poly", to = "numeric")`: ...

coerce `signature(from = "gpc.poly", to = "SpatialPolygons")`: ...

get.bbox `signature(x = "gpc.poly")`: ...

get.pts `signature(object = "gpc.poly")`: ...

intersect `signature(x = "gpc.poly", y = "gpc.poly")`: ...

plot `signature(x = "gpc.poly")`: The argument `poly.args` can be used to pass a list of additional arguments to be passed to the underlying `polygon` call.

scale.poly `signature(x = "gpc.poly")`: ...

setdiff `signature(x = "gpc.poly", y = "gpc.poly")`: ...

show `signature(object = "gpc.poly")`: Scale `x` and `y` coordinates by amount `xscale` and `yscale`. By default `xscale` equals `yscale`.

symdiff `signature(x = "gpc.poly", y = "gpc.poly")`: ...

union `signature(x = "gpc.poly", y = "gpc.poly")`: ...

tristrip `signature(x = "gpc.poly")`: ...

triangulate `signature(x = "gpc.poly")`: ...

Note

The class `"gpc.poly.nohole"` is identical to `"gpc.poly"` except the `hole` flag for each contour of a `"gpc.poly.nohole"` object is always `FALSE`.

Author(s)

Roger D. Peng

Examples

```
## Make some random polygons
set.seed(100)
a <- cbind(rnorm(100), rnorm(100))
a <- a[chull(a), ]

## Convert `a' from matrix to "gpc.poly"
```

```
a <- as(a, "gpc.poly")

b <- cbind(rnorm(100), rnorm(100))
b <- as(b[chull(b), ], "gpc.poly")

## More complex polygons with an intersection
p1 <- read.polyfile(system.file("poly-ex-gpc/ex-poly1.txt", package = "rgeos"))
p2 <- read.polyfile(system.file("poly-ex-gpc/ex-poly2.txt", package = "rgeos"))

## Plot both polygons and highlight their intersection in red
plot(append.poly(p1, p2))
plot(intersect(p1, p2), poly.args = list(col = 2), add = TRUE)

## Highlight the difference p1 \ p2 in green
plot(setdiff(p1, p2), poly.args = list(col = 3), add = TRUE)

## Highlight the difference p2 \ p1 in blue
plot(setdiff(p2, p1), poly.args = list(col = 4), add = TRUE)

## Plot the union of the two polygons
plot(union(p1, p2))

## Take the non-intersect portions and create a new polygon
## combining the two contours
p.comb <- append.poly(setdiff(p1, p2), setdiff(p2, p1))
plot(p.comb, poly.args = list(col = 2, border = 0))

## Coerce from a matrix
x <-
structure(c(0.0934073560027759, 0.192713393476752, 0.410062456627342,
0.470020818875781, 0.41380985426787, 0.271408743927828, 0.100902151283831,
0.0465648854961832, 0.63981588032221, 0.772382048331416,
0.753739930955121, 0.637744533947066, 0.455466052934407,
0.335327963176065, 0.399539700805524,
0.600460299194476), .Dim = c(8, 2))
y <-
structure(c(0.404441360166551, 0.338861901457321, 0.301387925052047,
0.404441360166551, 0.531852879944483, 0.60117973629424, 0.625537820957668,
0.179976985040276, 0.341542002301496, 0.445109321058688,
0.610817031070196, 0.596317606444189, 0.459608745684695,
0.215189873417722), .Dim = c(7, 2))

x1 <- as(x, "gpc.poly")
y1 <- as(y, "gpc.poly")

plot(append.poly(x1, y1))
plot(intersect(x1, y1), poly.args = list(col = 2), add = TRUE)

## Show the triangulation
#plot(append.poly(x1, y1))
#triangles <- triangulate(append.poly(x1,y1))
#for (i in 0:(nrow(triangles)/3 - 1))
#    polygon(triangles[3*i + 1:3,], col="lightblue")
```

`gpc.poly.nohole-class` *Class "gpc.poly.nohole"*

Description

A class for representing polygons with multiple contours but without holes.

Objects from the Class

Objects can be created by calls of the form 'new("gpc.poly.nohole", ...) or by calling `read.polyfile`'.

Slots

pts Object of class "list". See the help for "gpc.poly" for details.

Extends

Class "gpc.poly", directly.

Methods

coerce `signature(from = "numeric", to = "gpc.poly.nohole")`: ...

Note

This class is identical to ""gpc.poly"" and is needed because the file formats for polygons without holes is slightly different from the file format for polygons with holes. For a "gpc.poly.nohole" object, the hole flag for each contour is always `FALSE`.

Also, `write.polyfile` will write the correct file format, depending on whether the object is of class "gpc.poly" or "gpc.poly.nohole".

Author(s)

Roger D. Peng

See Also

`gpc.poly-class`

Examples

```
## None
```

gPointOnSurface *Point on Surface of Geometry*

Description

Function returns a point on the surface of the given geometry

Usage

```
gPointOnSurface(spgeom, byid=FALSE, id = NULL)
```

Arguments

spgeom	sp object as defined in package sp
byid	Logical determining if the function should be applied across subgeometries (TRUE) or the entire object (FALSE)
id	Character vector defining id labels for the resulting geometries, if unspecified returned geometries will be labeled based on their parent geometries' labels.

Details

Returns a SpatialPoints object with a point that intersects with the geometry

Author(s)

Roger Bivand & Colin Rundel

See Also

gBoundary gCentroid gConvexHull gEnvelope

Examples

```
# Based on test geometries from JTS
g1 = readWKT(paste("MULTIPOINT (60 300, 200 200, 240 240, 200 300, 40 140,",
 "80 240, 140 240, 100 160, 140 200, 60 200)"))
g2 = readWKT("LINESTRING (0 0, 7 14)")
g3 = readWKT("LINESTRING (0 0, 3 15, 6 2, 11 14, 16 5, 16 18, 2 22)")
g4 = readWKT(paste("MULTILINESTRING ((60 240, 140 300, 180 200, 40 140, 100 100, 120 220),",
 "(240 80, 260 160, 200 240, 180 340, 280 340, 240 180, 180 140, 40 200, 140 260))"))
g5 = readWKT("POLYGON ((0 0, 0 10, 10 10, 10 0, 0 0))")
g6 = readWKT(paste("MULTIPOLYGON (((50 260, 240 340, 260 100, 20 60, 90 140, 50 260),",
 "(200 280, 140 240, 180 160, 240 140, 200 280)),",
 "((380 280, 300 260, 340 100, 440 80, 380 280),",
 "(380 220, 340 200, 400 100, 380 220)))"))

par(mfrow=c(2,3))
plot(g1); plot(gPointOnSurface(g1),col='red',add=TRUE)
```

```
plot(g2); plot(gPointOnSurface(g2),col='red',add=TRUE)
plot(g3); plot(gPointOnSurface(g3),col='red',add=TRUE)
plot(g4); plot(gPointOnSurface(g4),col='red',add=TRUE)
plot(g5); plot(gPointOnSurface(g5),col='red',add=TRUE)
plot(g6); plot(gPointOnSurface(g6),col='red',add=TRUE)
```

---

gPolygonize *Linestring Polygonizer*

Description

Function attempts to polygonize the given list of linestrings. If the linestrings are not noded (co-ordinates inserted at intersection points), the function may fail. gNode may be tried to insert such missing points

Usage

```
gPolygonize( splist, getCutEdges=FALSE);
```

Arguments

splist	a list of sp SpatialLines objects
getCutEdges	Logical vector indicating if cut edges should be returned

Details

Polygonization is the process of forming polygons from linestrings which enclose an area. Linestrings are expected to be fully noded, as such they must not cross and must touch only at endpoints. gPolygonize takes a list of fully noded linestrings and forms all the polygons which are enclosed by the lines. Polygonization errors such as dangling lines or cut lines can be identified and reported.

Value

By default returns polygons generated by polygonizing the given linestrings. If getCutEdges is TRUE then any cut edges are returned.

Author(s)

Roger Bivand & Colin Rundel

See Also

gNode

Examples

```
library(sp)
linelist = list(readWKT("LINESTRING (0 0 , 10 10)"),
readWKT("LINESTRING (185 221, 100 100)"),
readWKT("LINESTRING (185 221, 88 275, 180 316)"),
readWKT("LINESTRING (185 221, 292 281, 180 316)"),
readWKT("LINESTRING (189 98, 83 187, 185 221)"),
readWKT("LINESTRING (189 98, 325 168, 185 221)"))

par(mfrow=c(1,2))
plot(linelist[[1]],xlim=c(0,350),ylim=c(0,350))
title("Linestrings with nodes")
plot(as(linelist[[1]],"SpatialPoints"),pch=16,add=TRUE)

for(i in 2:length(linelist)) {
plot(linelist[[i]],add=TRUE)
plot(as(linelist[[i]],"SpatialPoints"),pch=16,add=TRUE)
}

plot(gPolygonize(linelist),xlim=c(0,350),ylim=c(0,350))
title("Polygonized Results")

gPolygonize(linelist,getCutEdges=TRUE) # no cut edges



linelist2 = list(readWKT("LINESTRING(1 3, 3 3, 3 1, 1 1, 1 3)"),
 readWKT("LINESTRING(1 3, 3 3, 3 1, 1 1, 1 3)"))

gPolygonize(linelist2,getCutEdges=FALSE) # NULL
gPolygonize(linelist2,getCutEdges=TRUE) # Contains LineStrings
# bug fix 130206
LS = list(
readWKT("LINESTRING (425963 576719, 425980 576703)"),
readWKT("LINESTRING (425963 576719, 425882 577073)"),
readWKT("LINESTRING (425980 576703, 426082 577072)"),
readWKT("LINESTRING (425882 577073, 426082 577072)"),
readWKT("LINESTRING (426138 577068, 426082 577072)"),
readWKT("LINESTRING (426138 577068, 426420 577039)"),
readWKT("LINESTRING (426420 577039, 426554 576990)"),
readWKT("LINESTRING (426751 576924, 426776 576823)"),
readWKT("LINESTRING (426751 576924, 426783 576919)"),
readWKT("LINESTRING (426751 576924, 426714 576953)"),
readWKT("LINESTRING (426776 576823, 426783 576919)"),
readWKT("LINESTRING (426658 576966, 426554 576990)"),
readWKT("LINESTRING (426658 576966, 426667 577031)"),
readWKT("LINESTRING (426658 576966, 426714 576953)"),
readWKT("LINESTRING (426667 577031, 426714 576953)")
)
plot(gPolygonize(LS))
```

gRelate *Geometry Relationships - Intersection Matrix Pattern (DE-9IM)*

Description

Determines the relationships between two geometries by comparing the intersection of Interior, Boundary and Exterior of both geometries to each other. The results are summarized by the Dimensionally Extended 9-Intersection Matrix or DE-9IM.

Usage

```
gRelate(spgeom1, spgeom2 = NULL, pattern = NULL, byid = FALSE)
```

Arguments

spgeom1, spgeom2	sp objects as defined in package sp. If spgeom2 is NULL then spgeom1 is compared to itself.
byid	Logical vector determining if the function should be applied across ids (TRUE) or the entire object (FALSE) for spgeom1 and spgeom2
pattern	Character string containing intersection matrix pattern to match against DE-9IM for given geometries. Wild card * or * characters allowed.

Details

Each geometry is decomposed into an interior, a boundary, and an exterior region, all the resulting geometries are then tested by intersection against one another resulting in 9 total comparisons. These comparisons are summarized by the dimensions of the intersection region, as such intersection at point(s) is labeled 0, at linestring(s) is labeled 1, at polygons(s) is labeled 2, and if they do not intersect labeled F.

If a pattern is specified then limited matching with wildcards is possible, * matches any character whereas T matches any non-F character.

See references for additional details.

Value

By default returns a 9 character string that represents the DE-9IM.

If pattern returns TRUE if the pattern matches the DE-9IM.

Author(s)

Roger Bivand & Colin Rundel

References

Documentation of Intersection Matrix Patterns: http://docs.codehaus.org/display/GEOTDOC/Point+Set+Theory+and+the+DE-9IM+Matrix#PointSetTheoryandtheDE-9IMMatrix-9IntersectionMatrix

See Also

gContains gContainsProperly gCovers gCoveredBy gCrosses gDisjoint gEquals gEqualsExact gIntersects gOverlaps gTouches gWithin

Examples

```
x = readWKT("POLYGON((1 0,0 1,1 2,2 1,1 0))")
x.inter = x
x.bound = gBoundary(x)

y = readWKT("POLYGON((2 0,1 1,2 2,3 1,2 0))")
y.inter = y
y.bound = gBoundary(y)


xy.inter = gIntersection(x,y)
xy.inter.bound = gBoundary(xy.inter)

xy.union = gUnion(x,y)
bbox = gBuffer(gEnvelope(xy.union),width=0.5,joinStyle='mitre',mitreLimit=3)

x.exter = gDifference(bbox,x)
y.exter = gDifference(bbox,y)

# geometry decomposition
par(mfrow=c(2,3))
plot(bbox,border='grey');plot(x,col="black",add=TRUE);title("Interior",ylab = "Polygon X")
plot(bbox,border='grey');plot(x.bound,col="black",add=TRUE);title("Boundary")
plot(bbox,border='grey');plot(x.exter,col="black",pbg='white',add=TRUE);title("Exterior")
plot(bbox,border='grey');plot(y,col="black",add=TRUE);title(ylab = "Polygon Y")
plot(bbox,border='grey');plot(y.bound,col="black",add=TRUE)
plot(bbox,border='grey');plot(y.exter,col="black",pbg='white',add=TRUE)



defaultplot = function() {
plot(bbox,border='grey')
plot(x,add=TRUE,col='red1',border="red3")
plot(y,add=TRUE,col='blue1',border="blue3")
plot(xy.inter,add=TRUE,col='orange1',border="orange3")
}

# Dimensionally Extended 9-Intersection Matrix
pat = gRelate(x,y)
patchars = strsplit(pat,"")[[1]]

par(mfrow=c(3,3))
defaultplot(); plot(gIntersection(x.inter,y.inter),add=TRUE,col='black')
title(paste("dim:",patchars[1]))
defaultplot(); plot(gIntersection(x.bound,y.inter),add=TRUE,col='black',lwd=2)
title(paste("dim:",patchars[2]))
defaultplot(); plot(gIntersection(x.exter,y.inter),add=TRUE,col='black')
```

```
title(paste("dim:",patchars[3]))

defaultplot(); plot(gIntersection(x.inter,y.bound),add=TRUE,col='black',lwd=2)
title(paste("dim:",patchars[4]))
defaultplot(); plot(gIntersection(x.bound,y.bound),add=TRUE,col='black',pch=16)
title(paste("dim:",patchars[5]))
defaultplot(); plot(gIntersection(x.exter,y.bound),add=TRUE,col='black',lwd=2)
title(paste("dim:",patchars[6]))

defaultplot(); plot(gIntersection(x.inter,y.exter),add=TRUE,col='black')
title(paste("dim:",patchars[7]))
defaultplot(); plot(gIntersection(x.bound,y.exter),add=TRUE,col='black',lwd=2)
title(paste("dim:",patchars[8]))
defaultplot(); plot(gIntersection(x.exter,y.exter),add=TRUE,col='black')
title(paste("dim:",patchars[9]))
```

`gSimplify` *Simplify Geometry*

Description

Function simplifies the given geometry using the Douglas-Peuker algorithm

Usage

```
gSimplify(spgeom, tol, topologyPreserve=FALSE)
```

Arguments

`spgeom`	sp object as defined in package sp
`tol`	Numerical tolerance value to be used by the Douglas-Peuker algorithm
`topologyPreserve`	Logical determining if the algorithm should attempt to preserve the topology of the original geometry

Details

When applied to lines it is possible for the resulting geometry to lose simplicity (`gIsSimple`). If topologyPreserve is not specified it is also possible that the resulting geometries may no longer be valid (`gIsValid`). Remember to check the resulting geometry as many other functions rely on simplicity and or validity when performing their calculations.

Value

Returns a simplified version of the given geometry when applied to [MULTI]LINEs or [MULTI]POLYGONs.

Author(s)

Roger Bivand & Colin Rundel

References

Douglas-Peuker Algorithm: http://en.wikipedia.org/wiki/Ramer-Douglas-Peucker_algorithm

Examples

```
p = readWKT(paste("POLYGON((0 40,10 50,0 60,40 60,40 100,50 90,60 100,60",
 "60,100 60,90 50,100 40,60 40,60 0,50 10,40 0,40 40,0 40))"))
l = readWKT("LINESTRING(0 7,1 6,2 1,3 4,4 1,5 7,6 6,7 4,8 6,9 4)")

par(mfrow=c(2,4))
plot(p);title("Original")
plot(gSimplify(p,tol=10));title("tol: 10")
plot(gSimplify(p,tol=20));title("tol: 20")
plot(gSimplify(p,tol=25));title("tol: 25")

plot(l);title("Original")
plot(gSimplify(l,tol=3));title("tol: 3")
plot(gSimplify(l,tol=5));title("tol: 5")
plot(gSimplify(l,tol=7));title("tol: 7")
par(mfrow=c(1,1))
```

---

gSymdifference *Geometry Symmetric Difference*

Description

Function for determining the symmetric difference between the two given geometries

Usage

```
gSymdifference(spgeom1, spgeom2, byid=FALSE, id=NULL, drop_lower_td=FALSE)
```

Arguments

spgeom1, spgeom2	sp objects as defined in package sp
byid	Logical vector determining if the function should be applied across ids (TRUE) or the entire object (FALSE) for spgeom1 and spgeom2
id	Character vector defining id labels for the resulting geometries, if unspecified returned geometries will be labeled based on their parent geometries' labels.
drop_lower_td	default FALSE; if TRUE, objects will be dropped from output GEOMETRYCOLLECTION objects to simplify output if their topological dinension is less than the minimum topological dinension of the input objects.

Details

Returns the regions of spgeom1 and spgeom2 that do not intersect. If the geometries do not intersect then spgeom1 and spgeom2 will be returned as separate subgeometries.

Author(s)

Roger Bivand & Colin Rundel

See Also

gDifference gIntersection gUnion

Examples

```
x = readWKT("POLYGON ((0 0, 0 10, 10 10, 10 0, 0 0))")
y = readWKT("POLYGON ((5 5, 15 5, 15 15, 5 15, 5 5))")

d = gSymdifference(x,y)
plot(d,col='red',pbg='white')
```

---

gTouches *Geometry Relationships - Touches*

Description

Functions for testing if the geometries have at least one boundary point in common, but no interior points

Usage

```
gTouches(spgeom1, spgeom2 = NULL, byid = FALSE, returnDense=TRUE)
```

Arguments

spgeom1, spgeom2	sp objects as defined in package sp. If spgeom2 is NULL then spgeom1 is compared to itself.
byid	Logical vector determining if the function should be applied across ids (TRUE) or the entire object (FALSE) for spgeom1 and spgeom2
returnDense	default TRUE, if false returns a list of the length of spgeom1 of integer vectors listing the 1:length(spgeom2) indices which would be TRUE in the dense logical matrix representation; useful when the sizes of the byid=TRUE returned matrix is very large and it is sparse

Value

Returns TRUE if the intersection of the boundaries of the two geometries is not empty.

Author(s)

Roger Bivand & Colin Rundel

See Also

gContains gContainsProperly gCovers gCoveredBy gCrosses gDisjoint gEquals gEqualsExact gIntersects gOverlaps gRelate gWithin

Examples

```
p1 = readWKT("POLYGON((0 0,1 0,1 1,0 1,0 0))")
p2 = readWKT("POLYGON((0 1,0.5 2,1 1,0 1))")
p3 = readWKT("POLYGON((0.5 1,0 2,1 2,0.5 1))")
p4 = readWKT("POLYGON((0.5 0.5,0 1.5,1 1.5,0.5 0.5))")

l0 = readWKT("LINESTRING(0 1,0.5 2,1 1)")

l1 = readWKT("LINESTRING(0 0,2 2)")
l2 = readWKT("LINESTRING(1 1,2 0)")
l3 = readWKT("LINESTRING(0 2,2 0)")


par(mfrow=c(2,3))
plot(p1,col='blue',border='blue',ylim=c(0,2.5));plot(p2,col='black',add=TRUE,pch=16)
title(paste("Touches:",gTouches(p1,p2)))

plot(p1,col='blue',border='blue',ylim=c(0,2.5));plot(p3,col='black',add=TRUE,pch=16)
title(paste("Touches:",gTouches(p1,p3)))

plot(p1,col='blue',border='blue',ylim=c(0,2.5));plot(p4,col='black',add=TRUE,pch=16)
title(paste("Touches:",gTouches(p1,p4)))

plot(p1,col='blue',border='blue',ylim=c(0,2.5));plot(l0,lwd=2,col='black',add=TRUE,pch=16)
title(paste("Touches:",gTouches(p1,l0)))

plot(l1,lwd=2,col='blue');plot(l2,lwd=2,col='black',add=TRUE,pch=16)
title(paste("Touches:",gTouches(l1,l2)))

plot(l1,lwd=2,col='blue');plot(l3,lwd=2,col='black',add=TRUE,pch=16)
title(paste("Touches:",gTouches(l1,l3)))
```

---

gUnion *Geometry Union*

Description

Functions for joining intersecting geometries.

Usage

```
gUnion(spgeom1, spgeom2, byid=FALSE, id=NULL, drop_lower_td=FALSE)
gUnionCascaded(spgeom, id = NULL)
gUnaryUnion(spgeom, id = NULL)
gLineMerge(spgeom, byid=FALSE, id = NULL)
```

Arguments

spgeom1, spgeom2	sp objects as defined in package sp
byid	Logical vector determining if the function should be applied across ids (TRUE) or the entire object (FALSE) for spgeom1 and spgeom2
id	Character vector defining id labels for the resulting geometries, if unspecified returned geometries will be labeled based on their parent geometries' labels; it may contain NA values for input objects not included in the union; it should define the memberships of the output Polygons objects
drop_lower_td	default FALSE; if TRUE, objects will be dropped from output GEOMETRYCOLLECTION objects to simplify output if their topological dinension is less than the minimum topological dinension of the input objects.
spgeom	sp Polygon(s) or Line(s) depending on the function used

Details

Returns an sp object with intersecting geometries merged. If geometries do not intersect then both are returned as distinct subgeometries.

gUnionCascaded expects a single sp object of class SpatialPolygons with subgeometries which it unions together. gUnionCascaded can only dissolve MultiPolygon objects, so GeometryCollection objects to be dissolved, here a SpatialPolygons object, must be flattened a Polygons object; if GEOS version 3.3.0 is available, use gUnaryUnion.

gUnaryUnion expects a single sp object of class SpatialPolygons with subgeometries which it unions together; introduced in GEOS version 3.3.0, and handles GeometryCollection objects. If the id argument is used, it should be a character vector defining the memberships of the output Polygons objects, equal in length to the length of the polygons slot of spgeom.

gLineMerge is similar to gUnionCascaded but is written to work with lines, specifically it joins line segments with intersecting end points.

Author(s)

Roger Bivand & Colin Rundel

See Also

gDifference gIntersection gSymdifference

Examples

```
library(maptools)
nc1 <- readShapePoly(system.file("shapes/sids.shp", package="maptools")[1],
 proj4string=CRS("+proj=longlat +datum=NAD27"))
lps <- coordinates(nc1)
ID <- cut(lps[,1], quantile(lps[,1]), include.lowest=TRUE)
if (version_GEOS0() < "3.3.0") {
   reg4 <- gUnionCascaded(nc1, ID)
} else {
   reg4 <- gUnaryUnion(nc1, ID)
}
row.names(reg4)
par(mfrow=c(2,1))
plot(nc1)
plot(reg4)

par(mfrow=c(1,1))
gt <- GridTopology(c(0.05,0.05), c(0.1,0.1), c(2,2))
set.seed(1)
xv <- rnorm(length(coordinates(gt)[,1]))
xvs <- ifelse(xv > 0.2,1,0)
grd <- SpatialGridDataFrame(gt, data.frame(xvs))
spix <- as(grd, "SpatialPixelsDataFrame")
spol <- as(spix, "SpatialPolygonsDataFrame")
image(grd, axes=TRUE)
if (version_GEOS0() < "3.3.0") {
  spol1 <- gUnionCascaded(spol, as.character(spol$xvs))
} else {
  spol1 <- gUnaryUnion(spol, as.character(spol$xvs))
}
plot(spol1, add=TRUE)
```

`new-generics` *Generics/Methods for polygon objects*

Description

Some generic functions and methods for polygon objects

Usage

```
append.poly(x, y)
area.poly(object, ...)
get.pts(object)
get.bbox(x)
scale.poly(x, ...)
tristrip(x)
triangulate(x)
```

Arguments

x,object	A polygon object
y	A polygon object
...	Other arguments passed to methods

Details

The result of `tristrip(x)` is a list of two-column matrices. Each matrix is a tristrip, i.e. the rows are vertices of triangles, with each overlapping triple of rows corresponding to a separate triangle.

The result of `triangulate(x)` is a single two-column matrix. The rows are vertices of triangles, taken in non-overlapping triples.

Methods

append.poly `signature(x = "gpc.poly", y = "gpc.poly")`: Combine all contours of two `"gpc.poly"` objects and return the combined polygon as a `"gpc.poly"` object.

area.poly `signature(object = "gpc.poly")`: Compute and return the sum of the areas of all contours in a `"gpc.poly"` object.

scale.poly `signature(x = "gpc.poly")`: Scale (divide) the x and y coordinates of a `"gpc.poly"` object by the amount `xscale` and `yscale`, respectively. Return a scaled `"gpc.poly"` object.

get.pts `signature(object = "gpc.poly")`: Return the list of x and y coordinates of the vertices of a `"gpc.poly"` object.

get.bbox `signature(x = "gpc.poly")`: Return the bounding box for a `"gpc.poly"` object.

tristrip `signature(x = "gpc.poly")`: Return a tristrip list for a `"gpc.poly"` object.

triangulate `signature(x = "gpc.poly")`: Return a matrix of vertices of a triangulation of a `"gpc.poly"` object.

Author(s)

Roger D. Peng; GPC Library by Alan Murta; tristrip additions by Duncan Murdoch

See Also

`"gpc.poly"` class documentation.

Examples

```
holepoly <- read.polyfile(system.file("poly-ex-gpc/hole-poly.txt",
 package ="rgeos"), nohole = FALSE)
area.poly(holepoly)
stopifnot(area.poly(holepoly) == 8)
```

polyfile *Read/Write polygon data*

Description

Read/Write polygon and contour information from/to a text file.

Usage

```
read.polyfile(filename, nohole = TRUE)
write.polyfile(poly, filename = "GPCpoly.txt")
```

Arguments

filename	the name of the file (a character string) from/to which data should be read/written.
nohole	Is this a polygon without holes?
poly	an object of class "gpc.poly"

Details

The text file representation of a polygon is of the following format:

<number of contours>
<number of points in first contour>
x1 y1
x2 y2
...
<number of points in second contour>
x1 y1
x2 y2
...

For example, a data file for a polygon with 2 contours (a four-sided object and a triangle) might look like:

2
4
1.0 1.0
1.0 2.0
3.4 3.21
10 11.2
3
21.0 11.2
22.3 99.2
4.5 5.4

The vertices of the polygon can be ordered either clockwise or counter-clockwise.

If a polygon has contours which are holes, then the format is slightly different. Basically, a flag is set to indicate that a particular contour is a hole. The format is

<number of contours>
<number of points in first contour>
<hole flag>
x1 y1
x2 y2
...
<number of points in second contour>
<hole flag>
x1 y1
x2 y2
...

The hole flag is either 1 to indicate a hole, or 0 for a regular contour. For example, a four-sided polygon with a triangular hole would be written as:

2
3
1
4.0 4.0
6.0 5.0
5.0 6.0
4
0
2.0 1.0
8.0 2.0
7.0 9.0
1.0 7.0

Value

If `nohole` is `TRUE` (the default) `read.polyfile` returns an object of class `"gpc.poly.nohole"`. This object has the hole flag set to `FALSE` for all contours. If `nohole` is `FALSE`, then an object of class `"gpc.poly"` is returned.

`write.polyfile` does not return anything useful.

Author(s)

Roger D. Peng

See Also

`gpc.poly-class`, `gpc.poly.nohole-class`

Examples

```
## None right now.
```

polygonsLabel *Compute optimal label positions for polygons*

Description

Compute optimal positions for placing labels inside polygons, and optionally plot the labels. Various algorithms for finding the 'optimal' label positions are supported.

Usage

```
polygonsLabel(pols, labels = NULL, method = c("maxdist",
              "buffer", "centroid", "random", "inpolygon")[1],
              gridpoints = 60, polypart = c("all", "largest")[1],
              cex = 1, doPlot = TRUE, ...)
```

Arguments

pols	Object of class, or deriving from, SpatialPolygons.
labels	Character vector of labels. Will be recycled to have the same number of elements as the number of polygons in pols. If labels is NULL or empty, the label box is taken as a square with sides equal to the current line height (see the cex argument).
method	The method(s) to use when finding label positions. Will be recycled. Valid methods are maxdist (currently the default), buffer, centroid, random and inpolygon.
gridpoints	Number of grid points to use for the initial grid search in the maxdist method.
polypart	Should all (default) or only the largest polygon part of each polygon in pols be used for the calculations? Will be recycled. Setting this to largest is very useful when labelling detailed coastlines of a country, consisting of a large polygon (where the label should be placed) and very many tiny islands, as it will greatly speed up the search for an optimal label position. But do note that this also removes any holes (e.g., lakes) before calculating the label position, so the labels are no longer guaranteed not to overlap a hole.
cex	Magnification factor for text labels. Is used both when plotting the labels and when calculating the label positions.
doPlot	Plot the labels on the current graphics device. Calls the text function internally.
...	Further arguments to be passed to text (e.g., col).

Details

There are no perfect definitions of 'optimal' label positions, but any such position should at least satisfy a few requirements: The label should be positioned wholly inside the polygon. It should also be far from any polygon edges. And, though more difficult to quantify, it should be positioned in the visual centre (or bulk) of the polygon. The algorithms implemented here seems to generally do a very good job of finding optimal (or at least 'good') label positions.

The maxdist method is currently the default, and tries to find the label position with a maximal distance from the polygon edges. More precisely, it finds a position where the minimal distance of any point on the (rectangular) label box to the polygon boundary is maximised. It does this by first trying a grid search, using gridpoints regular grid points on the polygon, and then doing local optimisation on the best grid point. The default grid is quite coarse, but usually gives good results in a short amount of time. But for very complicated (and narrow) polygons, it may help increasing gridpoints. Note that while this method gives good results for most natural polygons, e.g., country outlines, the theoretical optimal position is not necessarily unique, and this is sometimes seen when applying the method to regular polygons, like rectangles (see example below), where the resulting position may differ much from what one would judge to be the visual centre of the polygon.

The buffer method works by shrinking the polygon (using negative buffering) until the convex hull of the shrunken polygon can fit wholly inside the original polygon. The label position is then taken as the centroid of the shrunken polygon. This method usually gives excellent results, is surprisingly fast, and seems to capture the 'visual centre' idea of an optimal label position well. However, it does not guarantee that the label can fit wholly inside the polygon. (However, if it does not fit, there are usually no other better position either.)

The centroid method simply returns the centroid of each polygon. Note that although this is the geometrical/mathematical centre of the polygon, it may actually be positioned outside the polygon. For regular polygons (rectangles, hexagons), it gives perfect results. Internally, this method uses the coordinates function. There are three reasons this method is supported: To make it easy to find the centroid of the largest polygon part of a polygon (using the polypart argument), to make it easy to use the centroid algorithm along with other algorithms (using the vector nature of the method argument), and for completeness.

The random method returns a random position guaranteed to be inside the polygon. This will rarely be an optimal label position!

The inpolygon method finds an arbitrary position in the polygon. This position is usually quite similar to the centroid, but is guaranteed the be inside the polygon. Internally, the method uses the gPointOnSurface function.

Value

A two-colum matrix is returned, with each row containing the horizontal and vertical coordinates for the corresponding polygon. If doPlot is TRUE (the default), the labels are also plotted on the current graphics device, with the given value of cex (font size scaling).

Note

Note that both the labels, method and polypart arguments are vectors, so it's possible to use different options for each polygon in the pols object.

Author(s)

Karl Ove Hufthammer, <karl@huftis.org>.

References

The buffer method was inspired by (but is slightly different from) the algorithm described in the paper *Using Shape Analyses for Placement of Polygon Labels* by Hoseok Kang and Shoreh Elhami,

available at http://proceedings.esri.com/library/userconf/proc01/professional/papers/pap388/p388.htm.

See Also

pointLabel

Examples

```
# Simple example with a single polygon
x = c(0, 1.8, 1.8, 1, 1, 3, 3, 2.2, 2.2, 4,
      4, 6, 6, 14, 14, 6, 6,  4, 4, 0, 0)
y = c(0, 0, -2, -2, -10, -10, -2, -2, 0, 0,
      1.8, 1.8, 1, 1, 3, 3, 2.2, 2.2, 4, 4, 0)
xy = data.frame(x,y)
library(sp)
xy.sp = SpatialPolygons(list(Polygons(list(Polygon(xy)), ID = "test")))
plot(xy.sp, col = "khaki")
polygonsLabel(xy.sp, "Hi!")


# Example with multiple polygons, text labels and colours
x1 = c(0, 4, 4, 0, 0)
y1 = c(0, 0, 4, 4, 0)
x2 = c(1, 1, 3, 3, 1)
y2 = c(-2, -10, -10, -2, -2)
x3 = c(6, 14, 14, 6, 6)
y3 = c(1, 1, 3, 3, 1)
xy.sp = SpatialPolygons(list(
  Polygons(list(Polygon(cbind(x1,y1))), ID = "test1"), # box
  Polygons(list(Polygon(cbind(x3,y3))), ID = "test3"), # wide
  Polygons(list(Polygon(cbind(x2,y2))), ID = "test2")  # high
))
plot(xy.sp, col=terrain.colors(3))
labels=c("Hi!", "A very long text string", "N\na\nr\nr\no\nw")

# Note that the label for the tall and narrow box is
# not necessarily centred vertically in the box.
# The reason is that method="maxdist" minimises the
# maximum distance from the label box to the surrounding
# polygon, and this distance is not changed by moving
# the label vertically, as long the vertical distance
# to the polygon boundary is less than the horizontal
# distance. For regular polygons like this, the other
# label positions (e.g., method="buffer") work better.
polygonsLabel(xy.sp, labels, cex=.8,
              col = c('white', 'black', 'maroon'))


## Not run:
## Example showing how bad the centroid
## position can be on real maps.
```

```
# Needed libraries
library(maps)
library(maptools)
library(rgdal)

# Load map data and convert to spatial object
nmap = map("world", c("Norway", "Sweden", "Finland"),
           exact = TRUE, fill = TRUE, col = "transparent", plot = FALSE)
nmap.pol = map2SpatialPolygons(nmap, IDs = nmap$names,
                               proj4string = CRS("+init=epsg:4326"))
nmap.pol = spTransform(nmap.pol, CRS("+init=epsg:3035"))

# Plot map, centroid positions (red dots) and optimal
# label positions using the 'buffer' method.
plot(nmap.pol, col = "khaki")
nmap.centroids = polygonsLabel(nmap.pol, names(nmap.pol),
                               method = "centroid", doPlot = FALSE)
points(nmap.centroids, col = "red", pch=19)
polygonsLabel(nmap.pol, names(nmap.pol), method = "buffer", cex=.8)

## End(Not run)
```

RGEOS Experimental Functions

Experimental Functions

Description

Functions still under development using the GEOS STRtree structure to find intersecting object component envelopes (bounding boxes).

Usage

```
gUnarySTRtreeQuery(obj)
gBinarySTRtreeQuery(obj1, obj2)
poly_findInBoxGEOS(spl, as_points=TRUE)
```

Arguments

obj, obj1, obj2	Objects inheriting from either SpatialPolygons or SpatialLines, obj2 may also inherit from SpatialPoints
spl	Object that inherits from the SpatialPolygons class
as_points	Logical value indicating if the polygon should be treated as points

Details

gUnarySTRtreeQuery and poly_findInBoxGEOS do the same thing, but poly_findInBoxGEOS uses the as_points argument to build the input envelopes from proper geometries. gUnarySTRtreeQuery and gBinarySTRtreeQuery build input envelopes by disregarding topology and reducing the coordinates to a multipoint representation. This permits the tree to be built and queried even when some geometries are invalid. gUnarySTRtreeQuery and poly_findInBoxGEOS return a list of length (n-1) of 1-based indices only for the "greater than i" indices. gBinarySTRtreeQuery returns a list of the length of obj2 with 1-based indices of obj1.

Author(s)

Roger Bivand & Colin Rundel

Examples

```
library(maptools)
xx <- readShapeSpatial(system.file("shapes/fylk-val-ll.shp",
 package="maptools")[1], proj4string=CRS("+proj=longlat +datum=WGS84"))
a0 <- gUnarySTRtreeQuery(xx)
a0
bbxx <- bbox(xx)
wdb_lines <- system.file("share/wdb_borders_c.b", package="maptools")
xxx <- Rgshhs(wdb_lines, xlim=bbxx[1,], ylim=bbxx[2,])$SP
a1 <- gBinarySTRtreeQuery(xx, xxx)
a1
nc1 <- readShapePoly(system.file("shapes/sids.shp", package="maptools")[1],
 proj4string=CRS("+proj=longlat +datum=NAD27"))
a2 <- gUnarySTRtreeQuery(nc1)
a3 <- poly_findInBoxGEOS(nc1)
all.equal(a2, a3)
a2
pl <- slot(nc1, "polygons")[[4]]
a5 <- gUnarySTRtreeQuery(pl)
a5
SG <- Sobj_SpatialGrid(nc1, n=400)$SG
obj1 <- as(as(SG, "SpatialPixels"), "SpatialPolygons")
a4 <- gBinarySTRtreeQuery(nc1, obj1)
plot(nc1, col="orange", border="yellow")
plot(obj1, angle=sapply(a4, is.null)*45, density=20, lwd=0.5, add=TRUE)
set.seed(1)
pts <- spsample(nc1, n=10, type="random")
res <- gBinarySTRtreeQuery(nc1, pts)
```

Description

Utility functions for assigning ownership of holes to parent polygons

Usage

```
createSPComment(sppoly,which=NULL,overwrite=TRUE)
createPolygonsComment(poly)
        set_do_poly_check(value)
        get_do_poly_check()
```

Arguments

sppoly	Object that inherits from the SpatialPolygons class
which	Vector, which subset of geometries in sppoly should comment attributes be generated
overwrite	Logical, if a comment attribute already exists should it be overwritten
poly	Object of class Polygons
value	logical value to set "do_poly_check" option, default TRUE

Details

In order for rgeos to function properly it is necessary that all holes within a given POLYGON or MULTIPOLYGON geometry must belong to a specific polygon. The SpatialPolygons class implementation does not currently include this information. To work around this limitation rgeos uses an additional comment attribute on the Polygons class that indicates which hole belongs to which polygon.

Under the current implementation this comment is a text string of numbers separated by spaces where the order of the numbers corresponds to the order of the Polygon objects in the Polygons slot of the Polygons object. A 0 implies the Polygon object is a polygon, a non-zero number implies that the Polygon object is a hole with the value indicating the index of the Polygon that "owns" the hole.

createPolygonsComment attempts to create a valid comment for a Polygons object by assessing which polygons contain a given hole (using gContains). Ownership is assigned to the smallest polygon (by area) that contains the given hole. This is not guaranteed to generate valid polygons, always check the resulting objects for validity.

createSPComment attempts to create valid comments for all or a subset of polygons within a SpatialPolygons object.

Warning: check polygons

The helper functions get and set the imposition of checking of objects inheriting from SpatialPolygons for proper assignment of hole *interior rings* to *exterior rings* in Polygons objects. The internal GEOS representation defines a POLYGON object as a collection of only one exterior ring and from zero to many interior rings, so an **sp** Polygons object corresponds to a GEOS MULTIPOLYGON object, but without proper hole assignment. By default do_poly_check is TRUE; if it is set to FALSE using set_do_poly_check(FALSE), and the Polygons object is not valid in GEOS terms, GEOS may crash R, which is why checks are imposed by default.

The details below show how hole assignment is handled in the package; here we assume that the hole status slots of all Polygon objects in a given Polygons object are set correctly. In the examples below, we use a data set from **maptools** which has the holes correctly assigned, and we see that the SpatialPolygons object is geometrically valid both initially and after removing the comment attribute on the only Polygons object in `usa` - regenerating internally within **rgeos** from the hole status slots since `do_poly_check` is TRUE.

If we modify `usa` by setting all hole status slots to FALSE, the SpatialPolygons object is geometrically invalid even though a comment attribute can be created - the function `createSPComment` is deceived by the incorrect hole status slots. To rectify this, we use `checkPolygonsHoles` from **maptools** on each `Polygons` object. This function calls `gContains`, `gContainsProperly`, `gEquals` and `createPolygonsComment` from **rgeos** to check whether the hole status slots are set correctly. Experience shows that many imported datasets from for example publically provided shapefiles have incorrect hole status values. Running `checkPolygonsHoles` is time-consuming when the number of member `Polygon` objects is large - attempts will be made to make this more efficient.

Warning: planar geometries

The geometries handled by GEOS are assumed to be planar, so that any **rgeos** functions making measurements will give incorrect results when used on geographical coordinates measured in decimal degrees. Topological functions may work satisfactorily, but will not understand spherical wrap-around.

Author(s)

Roger Bivand & Colin Rundel

Examples

```
library(sp)
p1 <- Polygon(cbind(x=c(0, 0, 10, 10, 0), y=c(0, 10, 10, 0, 0)), hole=FALSE) # I
p2 <- Polygon(cbind(x=c(3, 3, 7, 7, 3), y=c(3, 7, 7, 3, 3)), hole=TRUE) # H
p8 <- Polygon(cbind(x=c(1, 1, 2, 2, 1), y=c(1, 2, 2, 1, 1)), hole=TRUE) # H
p9 <- Polygon(cbind(x=c(1, 1, 2, 2, 1), y=c(5, 6, 6, 5, 5)), hole=TRUE) # H
p3 <- Polygon(cbind(x=c(20, 20, 30, 30, 20), y=c(20, 30, 30, 20, 20)),
 hole=FALSE) # I
p4 <- Polygon(cbind(x=c(21, 21, 29, 29, 21), y=c(21, 29, 29, 21, 21)),
 hole=TRUE) # H
p5 <- Polygon(cbind(x=c(22, 22, 28, 28, 22), y=c(22, 28, 28, 22, 22)),
 hole=FALSE) # I
p6 <- Polygon(cbind(x=c(23, 23, 27, 27, 23), y=c(23, 27, 27, 23, 23)),
 hole=TRUE) # H
p7 <- Polygon(cbind(x=c(13, 13, 17, 17, 13), y=c(13, 17, 17, 13, 13)),
 hole=FALSE) # I
p10 <- Polygon(cbind(x=c(24, 24, 26, 26, 24), y=c(24, 26, 26, 24, 24)),
 hole=FALSE) # I
p11 <- Polygon(cbind(x=c(24.25, 24.25, 25.75, 25.75, 24.25),
 y=c(24.25, 25.75, 25.75, 24.25, 24.25)), hole=TRUE) # H
p12 <- Polygon(cbind(x=c(24.5, 24.5, 25.5, 25.5, 24.5),
 y=c(24.5, 25.5, 25.5, 24.5, 24.5)), hole=FALSE) # I
p13 <- Polygon(cbind(x=c(24.75, 24.75, 25.25, 25.25, 24.75),
```

```
 y=c(24.75, 25.25, 25.25, 24.75, 24.75)), hole=TRUE) # H

lp <- list(p1, p2, p13, p7, p6, p5, p4, p3, p8, p11, p12, p9, p10)
#           1   2    3   4   5   6   7   8   9   10   11  12   13
#           0   1   11   0   6   0   8   0   1   13    0   1    0
#           I   H    H   I   H   I   H   I   H    H    I   H    I
pls <- Polygons(lp, ID="1")
comment(pls)

comment(pls) = createPolygonsComment(pls)
comment(pls)


plot(SpatialPolygons(list(pls)), col="magenta", pbg="cyan")
 title(xlab="Hole slot values before checking")
## Not run:
# running this illustration may be time-consuming
require(maptools)
data(wrld_simpl)
usa <- wrld_simpl[wrld_simpl$ISO3=="USA",]
lapply(slot(usa, "polygons"), comment)
gIsValid(usa, reason=TRUE)
comment(slot(usa, "polygons")[[1]]) <- NULL
lapply(slot(usa, "polygons"), comment)
gIsValid(usa)
any(c(sapply(slot(usa, "polygons"),
 function(x) sapply(slot(x, "Polygons"), slot, "hole"))))
lapply(slot(createSPComment(usa), "polygons"), comment)
usa1 <- usa
Pls <- slot(usa1, "polygons")
pls <- slot(Pls[[1]], "Polygons")
pls1 <- lapply(pls, function(p) {slot(p, "hole") <- FALSE; return(p)})
slot(Pls[[1]], "Polygons") <- pls1
slot(usa1, "polygons") <- Pls
any(c(sapply(slot(usa1, "polygons"),
 function(x) sapply(slot(x, "Polygons"), slot, "hole"))))
lapply(slot(createSPComment(usa1), "polygons"), comment)
gIsValid(usa1, reason=TRUE)
Pls <- slot(usa1, "polygons")
Pls1 <- lapply(Pls, checkPolygonsHoles)
slot(usa1, "polygons") <- Pls1
lapply(slot(usa1, "polygons"), comment)
gIsValid(usa1, reason=TRUE)

## End(Not run)
```

RGEOS Utility Functions

RGEOS Utility Functions

Description

Utility functions for the RGEOS package

Usage

```
getScale()
setScale(scale=100000000)
translate(spgeom)
checkP4S(p4s)
        version_GEOS()
        version_GEOS0()
        set_RGEOS_polyThreshold(value)
        get_RGEOS_polyThreshold()
        set_RGEOS_warnSlivers(value)
        get_RGEOS_warnSlivers()
        set_RGEOS_dropSlivers(value)
        get_RGEOS_dropSlivers()
```

Arguments

`scale`	Numeric value determining the precision of translated geometries
`spgeom`	sp object as defined in package sp
`p4s`	Either a character string or an object of class `CRS`
`value`	the value to be passed to an RGEOS option in its environment

Details

getScale and setScale are used to get and set the scale option in the rgeos environment. This option is used to determine the precision of coordinates when translating to and from GEOS C objects. Precision is defined as 1 / scale. The final example is a use case reported by Mao-Gui Hu, who has also made the objects available, where the default scale defeats an intended line intersection operation; changing the scale temporarily resoves the issue.

In order to permit polygon slivers to be detected, reported and dropped, the user may set a numeric value for polyThreshold and logical values for warnSlivers and dropSlivers. By default, the threshold is 0.0, and warning and dropping are FALSE. To detect slivers, the threshold may be set to a small value and warnSlivers set to TRUE. To drop slivers from returned Polygons and Polygon objects, set dropSlivers to TRUE for a non-zero threshold.

translate is a testing function which translates the sp object into a GEOS C object and then back into an sp object and is used extensively in the translation unit tests. In all cases it is expected that `spgeom` and `translate(spgeom)` should be identical.

checkP4S is a validation function for proj4strings and is used in testing.

version_GEOS returns the full runtime version string, and version_GEOS0 only the GEOS version number.

Author(s)

Roger Bivand & Colin Rundel

Examples

```
readWKT("POINT(1.5 1.5)")

# With scale set to 1, the following point will be rounded
setScale(1)
readWKT("POINT(1.5 1.5)")

setScale(10)
readWKT("POINT(1.5 1.5)")

getScale()
# Set scale option back to default
setScale()



# scale option only affect objects when they are translated through rgeos
setScale(1)
library(sp)
SpatialPoints(data.frame(x=1.5,y=1.5))
translate( SpatialPoints(data.frame(x=1.5,y=1.5)) )

setScale()

        # added example of scale impact on intersection 120905
sline1 <- readWKT(readLines(system.file("wkts/sline1.wkt", package="rgeos")))
sline2 <- readWKT(readLines(system.file("wkts/sline2.wkt", package="rgeos")))
rslt <- gIntersection(sline1, sline2)
class(rslt)
getScale()
setScale(1e+6)
rslt <- gIntersection(sline1, sline2)
class(rslt)
sapply(slot(rslt, "lines"), function(x) length(slot(x, "Lines")))
rslt <- gLineMerge(rslt, byid=TRUE)
sapply(slot(rslt, "lines"), function(x) length(slot(x, "Lines")))
setScale()
get_RGEOS_dropSlivers()
get_RGEOS_warnSlivers()
get_RGEOS_polyThreshold()
# Robert Hijmans difficult intersection case
load(system.file("test_cases/polys.RData", package="rgeos"))
try(res <- gIntersection(a, b, byid=TRUE))
res <- gIntersection(a, b, byid=TRUE, drop_lower_td=TRUE)
sort(unlist(sapply(slot(res, "polygons"), function(p) sapply(slot(p, "Polygons"), slot, "area"))))
oT <- get_RGEOS_polyThreshold()
oW <- get_RGEOS_warnSlivers()
oD <- get_RGEOS_dropSlivers()
set_RGEOS_polyThreshold(1e-3)
set_RGEOS_warnSlivers(TRUE)
res1 <- gIntersection(a, b, byid=TRUE, drop_lower_td=TRUE)
sort(unlist(sapply(slot(res, "polygons"), function(p) sapply(slot(p, "Polygons"), slot, "area"))))
```

```
set_RGEOS_dropSlivers(TRUE)
res2 <- gIntersection(a, b, byid=TRUE, drop_lower_td=TRUE)
sort(unlist(sapply(slot(res, "polygons"), function(p) sapply(slot(p, "Polygons"), slot, "area"))))
set_RGEOS_dropSlivers(FALSE)
oo <- gUnaryUnion(res1, c(rep("1", 3), "2", "3", "4"))
unlist(sapply(slot(oo, "polygons"), function(p) sapply(slot(p, "Polygons"), slot, "area")))
ooo <- gIntersection(b, oo, byid=TRUE)
gArea(ooo, byid=TRUE)
unlist(sapply(slot(ooo, "polygons"), function(p) sapply(slot(p, "Polygons"), slot, "area")))
set_RGEOS_dropSlivers(TRUE)
ooo <- gIntersection(b, oo, byid=TRUE)
gArea(ooo, byid=TRUE)
unlist(sapply(slot(ooo, "polygons"), function(p) sapply(slot(p, "Polygons"), slot, "area")))
set_RGEOS_polyThreshold(oT)
set_RGEOS_warnSlivers(oW)
set_RGEOS_dropSlivers(oD)
```

RGEOS WKT Functions *RGEOS WKT Functions*

Description

Functions for reading and writing Well Known Text (WKT)

Usage

```
readWKT(text, id = NULL, p4s = NULL)
writeWKT(spgeom, byid = FALSE)
```

Arguments

text	character string of WKT
id	character vector of unique ids to label geometries. Length must match the number of subgeometries in the WKT
p4s	Either a character string or an object of class CRS
spgeom	sp object as defined in package sp
byid	Logical determining if the function should be applied across subgeometries (TRUE) or the entire object (FALSE)

Details

readWKT processes the given WKT string and returns an appropriate sp geometry object. If id is not specified then geometries will be labeled by their index position. Because no sp Spatial object may be empty, readWKT is not permitted to create an empty object.

writeWKT converts an sp geometry object to a GEOS C object which is then written out as a WKT string. If byid is TRUE then each subgeometry is individually converted to a WKT string.

Author(s)

Colin Rundel

References

Additional information on WKT Simple Feature Specification can be found at the following locations:

http://www.opengeospatial.org/standards/sfs

http://en.wikipedia.org/wiki/Well-known_text

http://en.wikipedia.org/wiki/Simple_Features

Examples

```
g1=readWKT("POINT(6 10)")
g2=readWKT("LINESTRING(3 4,10 50,20 25)")
g3=readWKT("POLYGON((1 1,5 1,5 5,1 5,1 1),(2 2,2 3,3 3,3 2,2 2))")
g4=readWKT("MULTIPOINT((3.5 5.6),(4.8 10.5))")
g5=readWKT("MULTILINESTRING((3 4,10 50,20 25),(-5 -8,-10 -8,-15 -4))")
g6=readWKT("MULTIPOLYGON(((1 1,5 1,5 5,1 5,1 1),(2 2,2 3,3 3,3 2,2 2)),((6 3,9 2,9 4,6 3)))")
try(readWKT("POINT EMPTY"))
try(readWKT("MULTIPOLYGON EMPTY"))
g9=readWKT("GEOMETRYCOLLECTION(POINT(4 6),LINESTRING(4 6,7 10))")

writeWKT(g1)
writeWKT(g2)
writeWKT(g3)
writeWKT(g4)
writeWKT(g5)
writeWKT(g6)
writeWKT(g9,byid=FALSE)
writeWKT(g9,byid=TRUE)
```

Ring-class *Class "Ring"*

Description

class for linear ring

Objects from the Class

Objects can be created by calls to the function Ring

Slots

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

`ID`: Object of class `"character"`; unique identifier string

Methods

Methods defined with class "Ring" in the signature:

bbox `signature(obj = "Ring")`: retrieves the bbox element

coordinates `signature(object = "Ring")`: retrieves the coords element from Ring objects in rings slot

coordnames `signature(object = "Ring")`: retrieves coordinate names

coerce `signature(from = "Ring", to = "SpatialPoints")`: ...

Author(s)

Colin Rundel

See Also

Ring

Examples

```
#NONE
```

`SpatialCollections` *create SpatialCollections*

Description

create object of class `SpatialCollections`

Usage

```
SpatialCollections(points=NULL, lines=NULL, rings=NULL, polygons=NULL,
 plotOrder=c(4,3,2,1), proj4string=CRS(as.character(NA)))
```

Arguments

`points`	list with objects of class SpatialPoints-class
`lines`	list with objects of class SpatialLines-class
`rings`	list with objects of class SpatialRings-class
`polygons`	list with objects of class SpatialPolygons-class
`plotOrder`	numeric vector of length 4 that determines the order in which the geometries will be plotted. By default polygons will be plotted followed by rings, then lines and finally points.
`proj4string`	Object of class `"CRS"` holding a valid proj4 string

Value

`SpatialCollections` returns object of class `SpatialCollections`

See Also

SpatialCollections-class SpatialPoints-class SpatialLines-class SpatialRings-class SpatialPolygons-class

---

`SpatialCollections-class`

Class "SpatialCollections"

Description

class to hold SpatialPoints, SpatialLines, SpatialRings, and SpatialPolygons (without attributes)

Objects from the Class

Objects can be created by calls to the function SpatialCollections

Slots

`pointobj`: Object of class SpatialPoints or NULL

`lineobj`: Object of class SpatialLines or NULL

`ringobj`: Object of class SpatialRings or NULL

`polyobj`: Object of class SpatialPolygons or NULL

`plotOrder`: Numeric vector of length 4

Extends

Class `"Spatial"`, directly.

Methods

Methods defined with class "SpatialCollections" in the signature:

plot `signature(x = "SpatialCollections", y = "missing")`: plot objects within the SpatialCollections object in the order specified by plotOrder slot

row.names `signature(object = "SpatialCollections")`: retrieves the ID elements from non-NULL geometry slots

Author(s)

Colin Rundel

See Also

SpatialCollections SpatialPoints SpatialLines SpatialRings SpatialPolygons

Examples

```
#NONE
```

SpatialRings *create SpatialRings or SpatialRingsDataFrame*

Description

create objects of class SpatialRings or SpatialRingsDataFrame

Usage

```
Ring(coords,ID=as.character(NA))
SpatialRings(RingList, proj4string=CRS(as.character(NA)))
SpatialRingsDataFrame(sr, data, match.ID = TRUE)
```

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
ID	character vector of length one with identifier
RingList	list with objects of class Ring-class
proj4string	Object of class "CRS" holding a valid proj4 string
sr	object of class SpatialRings-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

Value

Ring returns object of class Ring SpatialRings returns object of class SpatialRings SpatialRingsDataFrame returns object of class SpatialRingsDataFrame

See Also

Ring-class SpatialRings-class SpatialRingsDataFrame-class

SpatialRings-class *Class "SpatialRings"*

Description

class to hold linear ring topology (without attributes)

Objects from the Class

Objects can be created by calls to the function SpatialRings

Slots

`rings`: Object of class `"list"`; list elements are all of class Ring-class

`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 "SpatialRings" in the signature:

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

plot `signature(x = "SpatialRings", y = "missing")`: plot rings in SpatialRings object

bbox `signature(obj = "SpatialRings")`: retrieves the bbox element

coordinates `signature(object = "SpatialRings")`: retrieves the coords element from Ring objects in rings slot

coordnames `signature(object = "SpatialRings")`: retrieves coordinate names

row.names `signature(object = "SpatialRings")`: retrieves the ID element from Ring objects in rings slot

spChFIDs `signature(obj="SpatialRings", x="character")`: replaces ID element

coerce `signature(from = "SpatialRings", to = "SpatialPoints")`: ...

Author(s)

Colin Rundel

See Also

SpatialRings Ring-class

Examples

```
#NONE
```

`SpatialRingsDataFrame-class`
Class "SpatialRingsDataFrame"

Description

class to hold linear ring topology (without attributes)

Objects from the Class

Objects can be created by calls to the function SpatialRingsDataFrame

Slots

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

`rings`: Object of class `"list"`; list elements are all of class Ring-class

`bbox`: Object of class `"matrix"`; see Spatial-class

`proj4string`: Object of class `"CRS"`; see CRS-class

Extends

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

Methods

Methods defined with class "SpatialRingsDataFrame" in the signature:

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

plot `signature(x = "SpatialRingsDataFrame", y = "missing")`: plot rings in SpatialRingsDataFrame object

bbox `signature(obj = "SpatialRingsDataFrame")`: retrieves the bbox element

coordinates `signature(object = "SpatialRingsDataFrame")`: retrieves the coords element from Ring objects in rings slot

coordnames `signature(object = "SpatialRingsDataFrame")`: retrieves coordinate names

row.names `signature(object = "SpatialRingsDataFrame")`: retrieves the ID element from Ring objects in rings slot

spChFIDs `signature(obj="SpatialRingsDataFrame", x="character")`: replaces ID element

names `signature(object = "SpatialRingsDataFrame")`: retrieves names from data element

dim `signature(object = "SpatialRingsDataFrame")`: retrieves dimensions of data element

coerce `signature(from = "SpatialRingsDataFrame", to = "SpatialPoints")`: ...

coerce `signature(from = "SpatialRingsDataFrame", to = "SpatialRings")`: ...

coerce `signature(from = "SpatialRingsDataFrame", to = "data.frame")`: ...

Author(s)

Colin Rundel

See Also

SpatialRingsDataFrame Ring-class SpatialRings-class

Examples

```
#NONE
```

Index