

# Package ‘PBSmapping’

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**Depends** R (>= 3.5.0)

**Suggests** foreign, maptools, deldir

**SystemRequirements** C++11

**NeedsCompilation** yes

**Description** This software has evolved from fisheries research conducted at the Pacific Biological Station (PBS) in 'Nanaimo', British Columbia, Canada. It extends the R language to include two-dimensional plotting features similar to those commonly available in a Geographic Information System (GIS). Embedded C code speeds algorithms from computational geometry, such as finding polygons that contain specified point events or converting between longitude-latitude and Universal Transverse Mercator (UTM) coordinates. Additionally, we include 'C++' code developed by Angus Johnson for the 'Clipper' library, data for a global shoreline, and other data sets in the public domain. Under the user's R library directory '.libPaths()', specifically in './PBSmapping/doc', a complete user's guide is offered and should be consulted to use package functions effectively.

**License** GPL (>= 2)

**URL** <https://github.com/pbs-software/pbs-mapping>,  
<https://github.com/pbs-software/pbs-mapx>,  
<http://www.angusj.com/delphi/clipper.php>

**Repository** CRAN

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| addBubbles | <i>Add Bubbles to Maps</i> |
|------------|----------------------------|

---

### Description

Add bubbles proportional to some EventData's Z column (e.g., catch or effort) to an existing plot, where each unique EID describes a bubble.

### Usage

```
addBubbles(events, type=c("perceptual","surface","volume"),
  z.max=NULL, min.size=0, max.size=0.8, symbol.zero="+",
  symbol.fg=rgb(0,0,0,0.60), symbol.bg=rgb(0,0,0,0.30),
  legend.pos="bottomleft", legend.breaks=NULL,
  show.actual=FALSE, legend.type=c("nested","horiz","vert"),
  legend.title="Abundance", legend.cex=.8, neg.col="RYB", ...)
```

**Arguments**

|               |                                                                                                                                                                                                                                                                                                                                                   |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| events        | <a href="#">EventData</a> to use ( <i>required</i> ).                                                                                                                                                                                                                                                                                             |
| type          | character – scaling option for bubbles where "perceptual" emphasizes large z-values, "volume" emphasizes small z-values, and "surface" lies in between.                                                                                                                                                                                           |
| z.max         | numeric – maximum value for z (default = <code>max(events\$Z)</code> ); determines the largest bubble; keeps the same legend for different maps.                                                                                                                                                                                                  |
| min.size      | numeric – minimum size (inches) for a bubble representing <code>min(events\$Z)</code> . The legend may not actually include a bubble of this size because the calculated <code>legend.breaks</code> does not include the <code>min(events\$Z)</code> .                                                                                            |
| max.size      | numeric – maximum size (inches) for a bubble representing <code>z.max</code> . A legend bubble may exceed this size when <code>show.actual</code> is <code>FALSE</code> (on account of using <code>pretty(...)</code> ).                                                                                                                          |
| symbol.zero   | character – symbol to represent z-values equal to 0.                                                                                                                                                                                                                                                                                              |
| symbol.fg     | character – bubble outline (border) colour.                                                                                                                                                                                                                                                                                                       |
| symbol.bg     | character – bubble interior (fill) colour. If a vector, the first element represents <code>min(legend.breaks)</code> and the last element represents <code>max(legend.breaks)</code> ; colours are interpolated for values of <code>events\$Z</code> between those boundaries. For values outside of those boundaries, interiors remain unfilled. |
| legend.pos    | character numeric – position for the legend.                                                                                                                                                                                                                                                                                                      |
| legend.breaks | numeric – break values for categorizing the z-values. The automatic method should work if zeroes are present; otherwise, you can specify your own break values for the legend. If a single number, specifies the number of breaks; if a vector, specifies the breaks.                                                                             |
| show.actual   | logical – if <code>FALSE</code> , legend values are obtained using <code>pretty(...)</code> , and consequently, the largest bubble may be larger than <code>z.max</code> ; if <code>TRUE</code> , the largest bubble in the legend will correspond to <code>z.max</code> .                                                                        |
| legend.type   | character – display format for legend.                                                                                                                                                                                                                                                                                                            |
| legend.title  | character – title for legend.                                                                                                                                                                                                                                                                                                                     |
| legend.cex    | numeric – size of legend text.                                                                                                                                                                                                                                                                                                                    |
| neg.col       | character – bubble colour for any potential negative values.                                                                                                                                                                                                                                                                                      |
| ...           | dots – additional arguments for <code>points</code> function that plots zero-value symbols.                                                                                                                                                                                                                                                       |

**Details**

Modified from (and for the legend, strongly inspired by) Tanimura et al. (2006) by Denis Chabot to work with **PBSmapping**.

Furthermore, Chabot's modifications make it possible to draw several maps with bubbles that all have the same scale (instead of each bubble plot having a scale that depends on the maximum z-value for that plot). This is done by making `z.max` equal to the largest z-value from all maps that will be plotted.

The user can also add a legend in one of four corners (see [legend](#)) or at a specific `c(X, Y)` position. If `legend.pos` is `NULL`, no legend is drawn.

**Author(s)**

**Denis Chabot**, Research Scientist  
Maurice-Lamontagne Institute, Fisheries & Oceans Canada (DFO), Mont-Joli QC

Maintainer: **Rowan Haigh**, Program Head – Offshore Rockfish  
Pacific Biological Station (PBS), Fisheries & Oceans Canada (DFO), Nanaimo BC  
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Last modified Rd: 2021-01-11

**References**

Tanimura, S., Kuroiwa, C., and Mizota, T. (2006) Proportional symbol mapping in R. *Journal of Statistical Software* **15**(5).

**See Also**

In package **PBSmapping**:  
[addPolys](#), [EventData](#), [RGB2RYB](#), [surveyData](#)

**Examples**

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- common code for both examples below
  data(nepacLL,surveyData,envir=.PBSmapEnv)
  surveyData$Z <- surveyData$catch

  #--- plot a version that only varies the size
  plotMap(nepacLL, xlim=c(-131.8,-127.2), ylim=c(50.5,52.7),
    col="gainsboro",plt=c(.08,.99,.08,.99), cex.axis=1.2, cex.lab=1.5)
  addBubbles(surveyData, symbol.bg=rgb(.9,.5,0,.6),
    legend.type="nested", symbol.zero="+", col="grey")

  #--- plot a version that uses different symbol colours
  plotMap(nepacLL, xlim=c(-131.8,-127.2), ylim=c(50.5,52.7),
    col="gainsboro",plt=c(.08,.99,.08,.99), cex.axis=1.2, cex.lab=1.5)
  subset <- surveyData[surveyData$Z <= 1000, ]
  addBubbles(subset, symbol.bg=c("red", "yellow", "green"),
    legend.type="horiz", legend.breaks=pretty(range(subset$Z), n=11),
    symbol.zero=FALSE, col="grey", min.size=0.1, max.size=0.4)
  par(oldpar)
})
```

**Description**

Add a compass rose to an existing map, similar to those found on nautical charts showing both true north and magnetic north.

**Usage**

```
addCompass(X, Y, rot="magN", useWest=TRUE, year,
           cex=1, col.compass=c("gainsboro", "blue", "yellow", "black"), ...)
```

**Arguments**

|             |                                                                                                                                        |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------|
| X           | numeric – longitude coordinate (degrees N) for centroid of compass rose.                                                               |
| Y           | numeric – latitude coordinate (degrees W) for centroid of compass rose.                                                                |
| rot         | numeric character – Rotation (degrees) counterclockwise from 0 degrees (true North, see details).                                      |
| useWest     | logical – if TRUE, assumes longitude coordinates are centered on Greenwich extending westward to -180 and eastward to 180.             |
| year        | numeric – specific year to use from IGRF-13 (see details).                                                                             |
| cex         | numeric – character expansion to use in the display.                                                                                   |
| col.compass | character – colours for compass rose components (in order):<br>1=background compass, 2=rotated arms, 3=central button, 4=pch (border). |
| ...         | dots – additional parameters to pass to the text function.                                                                             |

**Details**

The basic idea comes from Jim Lemon (see References), but is modified here to reflect a compass rose used on BC nautical charts.

The default rotation ("magN") is a calculation of the initial bearing of a great-circle arc from the compass position to the north geomagnetic rot using the function [calcGCdist](#). The default year is the current year, but the user can choose years from 1900 to 2025 for approximate rot locations using model output from NOAA's IGRF-13 ([International Geomagnetic Reference Field](#)).

The user can also specify a fixed rotation (e.g. rot=-30) or no rotation (either rot=0 or rot="trueN").

**Value**

No value returned.

**Author(s)**

**Rowan Haigh**, Program Head – Offshore Rockfish  
Pacific Biological Station (PBS), Fisheries & Oceans Canada (DFO), Nanaimo BC  
*locus opus*: Regional Headquarters, Vancouver BC  
Last modified Rd: 2022-07-05

**References**

[R-sig-Geo] [How to display a compass rose on a map  
Magnetic North, Geomagnetic and Magnetic Poles](#)

**See Also**

[addBubbles](#), [addLabels](#), [addPoints](#), [addStipples](#), [calcGCdist](#)

**Examples**

```
local(envir=.PBSmapEnv,expr={
  data(nepacLL,envir=.PBSmapEnv)
  par(mfrow=c(1,1),mar=c(3,4,0.5,0.5))
  plotMap(nepacLL, xlim=c(-134.5,-124.5), ylim=c(48,55), plt=NULL,
    col="lightyellow", cex.axis=1.2, cex.lab=1.5)
  addCompass(-132, 49.5, rot=-12, cex=1.5)
})
```

---

|           |                                       |
|-----------|---------------------------------------|
| addLabels | <i>Add Labels to an Existing Plot</i> |
|-----------|---------------------------------------|

---

**Description**

Add the label column of data to the existing plot.

**Usage**

```
addLabels (data, xlim = NULL, ylim = NULL, polyProps = NULL,
  placement = "DATA", polys = NULL, rollup = 3,
  cex = NULL, col = NULL, font = NULL, ...)
```

**Arguments**

|           |                                                                                                                                                                |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| data      | <a href="#">EventData</a> or <a href="#">PolyData</a> to add ( <i>required</i> ).                                                                              |
| xlim      | range of X-coordinates.                                                                                                                                        |
| ylim      | range of Y-coordinates.                                                                                                                                        |
| polyProps | <a href="#">PolyData</a> specifying which labels to plot and their properties. <a href="#">par</a> parameters passed as direct arguments supersede these data. |
| placement | one of "DATA", "CENTROID", "MEAN_RANGE", or "MEAN_XY".                                                                                                         |
| polys     | <a href="#">PolySet</a> to use for calculating label placement.                                                                                                |
| rollup    | level of detail at which to process polys, and it should match that in data. 1 = PIDs only, 2 = outer contours only, and 3 = no roll-up.                       |
| cex       | vector describing character expansion factors (cycled by EID or PID).                                                                                          |
| col       | vector describing colours (cycled by EID or PID).                                                                                                              |
| font      | vector describing fonts (cycled by EID or PID).                                                                                                                |
| ...       | additional <a href="#">par</a> parameters for the <a href="#">text</a> function.                                                                               |

## Details

If data is [EventData](#), it must minimally contain the columns EID, X, Y, and label. Since the EID column does not match a column in polys, set placement = "DATA". The function plots each label at its corresponding X/Y coordinate.

If data is [PolyData](#), it must minimally contain the columns PID and label. If it also contains X and Y columns, set placement = "DATA" to plot labels at those coordinates. Otherwise, set placement to one of "CENTROID", "MEAN\_RANGE", or "MEAN\_XY". When placement != "DATA", supply a [PolySet](#) polys. Using this [PolySet](#), the function calculates a centroid, mean range, or mean X/Y coordinate for each polygon, and then links those [PolyData](#) with data by PID/SID to determine label coordinates.

If data contains both PID and EID columns, the function assumes it is [PolyData](#) and ignores the EID column.

For additional help on the arguments cex, col, and font, please see [par](#).

## Value

[EventData](#) or [PolyData](#) with X and Y columns that can subsequently reproduce the labels on the plot. Modify this data frame to tweak label positions.

## Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

## See Also

[addPoints](#), [calcCentroid](#), [calcMidRange](#), [calcSummary](#), [EventData](#), [plotPoints](#), [PolyData](#).

## Examples

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- create sample PolyData to label Vancouver Island
  labelData <- data.frame(PID=33, label="Vancouver Island");
  #--- load data
  if (!is.null(version$language) && (version$language == "R"))
    data(nepacLL,envir=.PBSmapEnv)
  #--- plot the map
  plotMap(nepacLL,xlim=c(-129,-122.6),ylim=c(48,51.1),col="lemonchiffon")
  #--- add the labels
  addLabels(labelData,placement="CENTROID",polys=nepacLL,cex=1.2,col=2,font=2)
  par(oldpar)
})
```



---

|          |                                                       |
|----------|-------------------------------------------------------|
| addLines | <i>Add a PolySet to an Existing Plot as Polylines</i> |
|----------|-------------------------------------------------------|

---

### Description

Add a [PolySet](#) to an existing plot, where each unique (PID, SID) describes a polyline.

### Usage

```
addLines (polys, xlim = NULL, ylim = NULL,  
          polyProps = NULL, lty = NULL, col = NULL, arrows = FALSE, ...)
```

### Arguments

|           |                                                                                                                                                                            |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| polys     | <a href="#">PolySet</a> to add ( <i>required</i> ).                                                                                                                        |
| xlim      | range of X-coordinates.                                                                                                                                                    |
| ylim      | range of Y-coordinates.                                                                                                                                                    |
| polyProps | <a href="#">PolyData</a> specifying which polylines to plot and their properties. <a href="#">par</a> parameters passed as direct arguments supersede these data.          |
| lty       | vector of line types (cycled by PID).                                                                                                                                      |
| col       | vector of colours (cycled by PID).                                                                                                                                         |
| arrows    | Boolean value; if TRUE, add arrows using the <a href="#">arrows</a> function and consider the arguments <code>angle</code> , <code>length</code> , and <code>code</code> . |
| ...       | additional <a href="#">par</a> parameters for the <a href="#">lines</a> function.                                                                                          |

### Details

The plotting routine does not connect the last vertex of each discrete polyline to the first vertex of that polyline. It clips polys to `xlim` and `ylim` before plotting.

For additional help on the arguments `lty` and `col`, please see [par](#).

### Value

[PolyData](#) consisting of the `PolyProps` used to create the plot.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

### See Also

[calcLength](#), [clipLines](#), [closePolys](#), [convLP](#), [fixBound](#), [fixPOS](#), [locatePolys](#), [plotLines](#),  
[thinPolys](#), [thickenPolys](#).

**Examples**

```

local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- create a PolySet to plot
  polys <- data.frame(PID=rep(1,4),POS=1:4,X=c(0,1,1,0),Y=c(0,0,1,1))
  polys <- as.PolySet(polys, projection=1)
  #--- plot the PolySet
  plotLines(polys, xlim=c(-.5,1.5), ylim=c(-.5,1.5), projection=1)
  #--- add the PolySet to the plot (in a different style)
  addLines(polys, lwd=5, col=3)
  par(oldpar)
})

```

---

addPoints

---

*Add EventData/PolyData to an Existing Plot as Points*


---

**Description**

Add [EventData/PolyData](#) to an existing plot, where each unique EID describes a point.

**Usage**

```

addPoints (data, xlim = NULL, ylim = NULL, polyProps = NULL,
          cex = NULL, col = NULL, pch = NULL, ...)

```

**Arguments**

|           |                                                                                                                                                             |
|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| data      | <a href="#">EventData</a> or <a href="#">PolyData</a> to add ( <i>required</i> ).                                                                           |
| xlim      | range of X-coordinates.                                                                                                                                     |
| ylim      | range of Y-coordinates.                                                                                                                                     |
| polyProps | <a href="#">PolyData</a> specifying which points to plot and their properties. <code>par</code> parameters passed as direct arguments supersede these data. |
| cex       | vector describing character expansion factors (cycled by EID or PID).                                                                                       |
| col       | vector describing colours (cycled by EID or PID).                                                                                                           |
| pch       | vector describing plotting characters (cycled by EID or PID).                                                                                               |
| ...       | additional <code>par</code> parameters for the <a href="#">points</a> function.                                                                             |

**Details**

This function clips data to `xlim` and `ylim` before plotting. It only adds [PolyData](#) containing X and Y columns.

For additional help on the arguments `cex`, `col`, and `pch`, please see [par](#).

**Value**

[PolyData](#) consisting of the `PolyProps` used to create the plot.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
 MacEwan University, Edmonton AB  
 Last modified Rd: 2013-04-10

**See Also**

[combineEvents](#), [convDP](#), [findPolys](#), [locateEvents](#), [plotPoints](#).

**Examples**

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- load the data (if using R)
  if (!is.null(version$language) && (version$language=="R"))
    data(nepacLL,surveyData,envir=.PBSmapEnv)
  #--- plot a map
  plotMap(nepacLL, xlim=c(-136, -125), ylim=c(48, 57))
  #--- add events
  addPoints(surveyData, col=1:7)
  par(oldpar)
})
```

---

 addPolys

---

*Add a PolySet to an Existing Plot as Polygons*


---

**Description**

Add a [PolySet](#) to an existing plot, where each unique (PID, SID) describes a polygon.

**Usage**

```
addPolys (polys, xlim = NULL, ylim = NULL, polyProps = NULL,
          border = NULL, lty = NULL, col = NULL, colHoles = NULL,
          density = NA, angle = NULL, ...)
```

**Arguments**

|           |                                                                                                                                                                  |
|-----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| polys     | <a href="#">PolySet</a> to add ( <i>required</i> ).                                                                                                              |
| xlim      | range of X-coordinates.                                                                                                                                          |
| ylim      | range of Y-coordinates.                                                                                                                                          |
| polyProps | <a href="#">PolyData</a> specifying which polygons to plot and their properties. <a href="#">par</a> parameters passed as direct arguments supersede these data. |
| border    | vector describing edge colours (cycled by PID).                                                                                                                  |
| lty       | vector describing line types (cycled by PID).                                                                                                                    |
| col       | vector describing fill colours (cycled by PID).                                                                                                                  |

|          |                                                                                                                                                                                                                                                                                                                                                                                                                         |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| colHoles | vector describing hole colours (cycled by PID). The default, NULL, should be used in most cases as it renders holes transparent. colHoles is designed solely to eliminate retrace lines when images are converted to PDF format. If colHoles is specified, underlying information (i.e., previously plotted shapes) will be obliterated. If NA is specified, only outer polygons are drawn, consequently filling holes. |
| density  | vector describing shading line densities (lines per inch, cycled by PID).                                                                                                                                                                                                                                                                                                                                               |
| angle    | vector describing shading line angles (degrees, cycled by PID).                                                                                                                                                                                                                                                                                                                                                         |
| ...      | additional <a href="#">par</a> parameters for the <a href="#">polygon</a> function.                                                                                                                                                                                                                                                                                                                                     |

### Details

The plotting routine connects the last vertex of each discrete polygon to the first vertex of that polygon. It supports both borders (`border`, `lty`) and fills (`col`, `density`, `angle`). It clips polys to `xlim` and `ylim` before plotting.

For additional help on the arguments `border`, `lty`, `col`, `density`, and `angle`, please see [polygon](#) and [par](#).

### Value

[PolyData](#) consisting of the PolyProps used to create the plot.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

### See Also

[addLabels](#), [addStipples](#), [clipPolys](#), [closePolys](#), [fixBound](#), [fixPOS](#), [locatePolys](#), [plotLines](#), [plotMap](#), [plotPoints](#), [plotPolys](#), [thinPolys](#), [thickenPolys](#).

### Examples

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- create a PolySet to plot
  polys <- data.frame(PID=rep(1,4),POS=1:4,X=c(0,1,1,0),Y=c(0,0,1,1))
  polys <- as.PolySet(polys, projection=1)
  #--- plot the PolySet
  plotPolys(polys,xlim=c(-.5,1.5),ylim=c(-.5,1.5),density=0,projection=1)
  #--- add the PolySet to the plot (in a different style)
  addPolys(polys,col="green",border="blue",lwd=3)
  par(oldpar)
})
```

---

addStipples                      *Add Stipples to an Existing Plot*

---

### Description

Add stipples to an existing plot.

### Usage

```
addStipples (polys, xlim=NULL, ylim=NULL, polyProps=NULL,  
            side=1, density=1, distance=4, ...)
```

### Arguments

|           |                                                                                                                                                                     |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| polys     | <a href="#">PolySet</a> that provides the stipple boundaries ( <i>required</i> ).                                                                                   |
| xlim      | range of X-coordinates.                                                                                                                                             |
| ylim      | range of Y-coordinates.                                                                                                                                             |
| polyProps | <a href="#">PolyData</a> specifying which polygons to stipple and their properties. <a href="#">par</a> parameters passed as direct arguments supersede these data. |
| side      | one of -1, 0, or 1, corresponding to outside, both sides, or inside, respectively.                                                                                  |
| density   | density of points, relative to the default.                                                                                                                         |
| distance  | distance to offset points, measured as a percentage of the absolute difference in xlim.                                                                             |
| ...       | additional <a href="#">par</a> parameters for the <a href="#">points</a> function.                                                                                  |

### Details

This function locates stipples based on the [PolySet](#) polys and does not stipple degenerate lines.

### Value

[PolyData](#) consisting of the PolyProps used to create the plot.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

### See Also

[addPoints](#), [addPolys](#), [plotMap](#), [plotPoints](#), [plotPolys](#), [points](#), [PolySet](#).

**Examples**

```

local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- load the data (if using R)
  if (!is.null(version$language) && (version$language=="R"))
    data(nepacLL,envir=.PBSmapEnv)
  #--- plot a map
  plotMap(nepacLL,xlim=c(-128.66,-122.83),ylim=c(48.00,51.16))
  #--- add stippling
  addStipples(nepacLL,col="purple",pch=20,cex=0.25,distance=2)
  par(oldpar)
})

```

---

appendPolys

*Append a Two-Column Matrix to a PolySet*


---

**Description**

Append a two-column matrix to a [PolySet](#), assigning PID and possibly SID values automatically or as specified in its arguments.

**Usage**

```
appendPolys (polys, mat, PID = NULL, SID = NULL, isHole = FALSE)
```

**Arguments**

|        |                                                                                                        |
|--------|--------------------------------------------------------------------------------------------------------|
| polys  | existing <a href="#">PolySet</a> ; if NULL, creates a new <a href="#">PolySet</a> ( <i>required</i> ). |
| mat    | two-column matrix to append ( <i>required</i> ).                                                       |
| PID    | new polygon's PID.                                                                                     |
| SID    | new polygon's SID.                                                                                     |
| isHole | Boolean value; if TRUE, mat represents a hole.                                                         |

**Details**

If the PID argument is NULL, the appended polygon's PID will be one greater than the maximum within polys (if defined); otherwise, it will be 1.

If polys contains an SID column and the SID argument equals NULL, this function uses the next available SID for the corresponding PID.

If polys does not contain an SID column and the caller passes an SID argument, all existing polygons will receive an SID of 1. The new polygon's SID will match the SID argument.

If isHole = TRUE, the polygon's POS values will appropriately represent a hole (reverse order of POS).

If (PID, SID) already exists in the [PolySet](#), the function will issue a warning and duplicate those identifiers.

**Value**

[PolySet](#) containing mat appended to polys. The function retains attributes from polys.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

**See Also**

[addPolys](#), [clipPolys](#), [closePolys](#), [convLP](#), [fixBound](#), [fixPOS](#), [joinPolys](#), [plotMap](#), [plotPolys](#).

**Examples**

```
local(envir=.PBSmapEnv,expr={
  #--- create two simple matrices
  a <- matrix(data=c(0,0,1,0,1,1,0,1),ncol=2,byrow=TRUE);
  b <- matrix(data=c(2,2,3,2,3,3,2,3), ncol=2,byrow=TRUE);
  #--- build a PolySet from them
  polys <- appendPolys(NULL, a);
  polys <- appendPolys(polys, b);
  #--- print the result
  print (polys);
})
```

---

bcBathymetry

*Data: Bathymetry Spanning BC Coast*

---

**Description**

Bathymetry data spanning British Columbia's coast.

**Usage**

```
data(bcBathymetry)
```

**Format**

Three-element list: x = vector of horizontal grid line locations, y = vector of vertical grid line locations, z = (x by y) matrix containing water depths measured in meters. Positive values indicate distance below sea level and negative values above it.

The functions 'graphics::contour' and 'grDevices::contourLines' expect data in this format. Function [convCP](#) converts the output from 'grDevices::contourLines' into a [PolySet](#).

**Note**

In R, the data must be loaded using the 'utils::data' function.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB

Maintainer: **Rowan Haigh**, Program Head – Offshore Rockfish  
Pacific Biological Station (PBS), Fisheries & Oceans Canada (DFO), Nanaimo BC  
*locus opus*: Regional Headquarters, Vancouver BC  
Last modified Rd: 2022-07-07

**Source**

Bathymetry data acquired from the Scripps Institution of Oceanography at the University of San Diego.

Using their online form, we requested bathymetry data for the complete `nepacLL` region. At forty megabytes, the data were not suitable for distribution in our mapping package. Therefore, we reduced the data to the range  $-140^\circ \leq x \leq -122^\circ$  and  $47^\circ \leq y \leq 61^\circ$ .

**References**

Smith, W.H.F. and Sandwell, D.T. (1997) **Global seafloor topography from satellite altimetry and ship depth soundings**. *Science* **277**, 1957-1962.

Website: [https://topex.ucsd.edu/www\\_html/mar\\_topo.html](https://topex.ucsd.edu/www_html/mar_topo.html)

**See Also**

In package **graphics**:

[contour](#)

In package **grDevices**:

[contourLines](#)

In package **PBSmapping**:

[convCP](#), [nepacLL](#), [nepacLLhigh](#)

---

calcArea

*Calculate the Areas of Polygons*

---

**Description**

Calculate the areas of polygons found in a [PolySet](#).

**Usage**

```
calcArea (polys, rollup = 3)
```



**Arguments**

|        |                                                                                                                                                                                    |
|--------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| polys  | <a href="#">PolySet</a> to use.                                                                                                                                                    |
| rollup | level of detail in the results; 1 = PIDs only, by summing all the polygons with the same PID, 2 = outer contours only, by subtracting holes from their parent, and 3 = no roll-up. |

**Details**

If rollup equals 1, the results contain an area for each unique PID only. When it equals 2, they contain entries for outer contours only. Finally, setting it to 3 prevents roll-up, and they contain areas for each unique (PID, SID).

Outer polygons have positive areas and inner polygons negative areas. When polygons are rolled up, the routine sums the positive and negative areas and consequently accounts for holes.

If the [PolySet](#)'s projection attribute equals "LL", the function projects the [PolySet](#) in UTM first. If the [PolySet](#)'s zone attribute exists, it uses it for the conversion. Otherwise, it computes the mean longitude and uses that value to determine the zone. The longitude range of zone  $i$  is  $-186 + 6i^\circ < x \leq -180 + 6i^\circ$ .

**Value**

[PolyData](#) with columns PID, SID (*may be missing*), and area. If the projection equals "LL" or "UTM", the units of area are square kilometres.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2022-09-06

**See Also**

[calcCentroid](#), [calcLength](#), [calcMidRange](#), [calcSummary](#), [locatePolys](#).

**Examples**

```
local(envir=.PBSmapEnv,expr={
  #--- load the data (if using R)
  if (!is.null(version$language) && (version$language == "R"))
    data(nepacLL,envir=.PBSmapEnv)
  #--- convert LL to UTM so calculation makes sense
  attr(nepacLL, "zone") <- 9
  nepacUTM <- convUL(nepacLL)
  #--- calculate and print the areas
  print(calcArea(nepacUTM))
})
```

---

calcCentroid                      *Calculate the Centroids of Polygons*

---

### Description

Calculate the centroids of polygons found in a [PolySet](#).

### Usage

```
calcCentroid (polys, rollup = 3)
```

### Arguments

|        |                                                                                                                                                                                     |
|--------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| polys  | <a href="#">PolySet</a> to use.                                                                                                                                                     |
| rollup | level of detail in the results; 1 = PIDs only, 2 = outer contours only, and 3 = no roll-up. When rollup equals 1 and 2, the function appropriately adjusts for polygons with holes. |

### Details

If rollup equals 1, the results contain a centroid for each unique PID only. When it equals 2, they contain entries for outer contours only. Finally, setting it to 3 prevents roll-up, and they contain a centroid for each unique (PID, SID).

### Value

[PolyData](#) with columns PID, SID (*may be missing*), X, and Y.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

### See Also

[calcArea](#), [calcLength](#), [calcMidRange](#), [calcSummary](#), [locateEvents](#), [locatePolys](#).

### Examples

```
local(envir=.PBSmapEnv,expr={
  #--- load the data (if using R)
  if (!is.null(version$language) && (version$language=="R"))
    data(nepacLL,envir=.PBSmapEnv)
  #--- calculate and print the centroids for several polygons
  print(calcCentroid(nepacLL[is.element(nepacLL$PID,c(33,39,47)),]))
})
```

---

|                |                                                      |
|----------------|------------------------------------------------------|
| calcConvexHull | <i>Calculate the Convex Hull for a Set of Points</i> |
|----------------|------------------------------------------------------|

---

### Description

Calculate the convex hull for a set of points.

### Usage

```
calcConvexHull (xydata, keepExtra=FALSE)
```

### Arguments

|           |                                                                                   |
|-----------|-----------------------------------------------------------------------------------|
| xydata    | a data frame with columns X and Y containing spatial coordinates.                 |
| keepExtra | logical: if TRUE, retain any additional columns from the input data frame xydata. |

### Details

This routine uses the function `chull()` in the package `grDevices`. By default, it ignores all columns other than X and Y; however, the user can choose to retain additional columns in xydata by specifying `keepExtra=TRUE`.

### Value

[PolySet](#) with columns PID, POS, X, Y, and additional columns in xydata if `keepExtra=TRUE`.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

### See Also

[addPoints](#), [addPolys](#), [calcArea](#), [calcCentroid](#), [calcMidRange](#), [calcSummary](#), [locateEvents](#), [plotMap](#), [plotPoints](#), [plotPolys](#).

### Examples

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  data(surveyData,envir=.PBSmapEnv)
  #--- plot the convex hull, and then plot the points
  plotMap(calcConvexHull(surveyData),col="moccasin")
  addPoints(surveyData,col="blue",pch=17,cex=.6)
  par(oldpar)
})
```

---

calcGCdist                      *Calculate Great-Circle Distance*

---

### Description

Calculate the great-circle distance between geographic (LL) coordinates. Also calculate the initial bearing of the great-circle arc (at its starting point).

### Usage

```
calcGCdist(lon1, lat1, lon2, lat2, R=6371.2)
```

### Arguments

|      |                                                    |
|------|----------------------------------------------------|
| lon1 | Longitude coordinate (degrees) of the start point. |
| lat1 | Latitude coordinate(degrees) of the start point.   |
| lon2 | Longitude coordinate(degrees) of the end point.    |
| lat2 | Latitude coordinate(degrees) of the end point.     |
| R    | Mean radius (km) of the Earth.                     |

### Details

The great-circle distance is calculated between two points along a spherical surface using the shortest distance and disregarding topography.

#### Method 1: Haversine Formula

$$a = \sin^2((\phi_2 - \phi_1)/2) + \cos(\phi_1) \cos(\phi_2) \sin^2((\lambda_2 - \lambda_1)/2)$$

$$c = 2 \operatorname{atan2}(\sqrt{a}, \sqrt{1-a})$$

$$d = Rc$$

where

$\phi$  = latitude (in radians),  
 $\lambda$  = longitude (in radians),  
 $R$  = radius (km) of the Earth,  
 $a$  = square of half the chord length between the points,  
 $c$  = angular distance in radians,  
 $d$  = great-circle distance (km) between two points.

#### Method 2: Spherical Law of Cosines

$$d = \operatorname{acos}(\sin(\phi_1) \sin(\phi_2) + \cos(\phi_1) \cos(\phi_2) \cos(\lambda_2 - \lambda_1))R$$

The initial bearing (aka forward azimuth) for the start point can be calculated using:

$$\theta = \operatorname{atan2}(\sin(\lambda_2 - \lambda_1) \cos(\phi_2), \cos(\phi_1) \sin(\phi_2) - \sin(\phi_1) \cos(\phi_2) \cos(\lambda_2 - \lambda_1))$$

**Value**

A list object containing:

- a – Haversine  $a$  = square of half the chord length between the points,
- c – Haversine  $c$  = angular distance in radians,
- d – Haversine  $d$  = great-circle distance (km) between two points,
- d2 – Law of Cosines  $d$  = great-circle distance (km) between two points,
- theta – Initial bearing  $\theta$  (degrees) for the start point.

**Note**

If one uses the north geomagnetic pole as an end point,  $\theta$  crudely approximates the magnetic declination.

**Author(s)**

**Rowan Haigh**, Program Head – Offshore Rockfish  
Pacific Biological Station (PBS), Fisheries & Oceans Canada (DFO), Nanaimo BC  
*opus locus*: Institute of Ocean Sciences (IOS), Sidney BC  
Last modified Rd: 2017-06-22

**References**

<http://www.movable-type.co.uk/scripts/latlong.html>

**See Also**

[addCompass](#), [calcArea](#), [calcCentroid](#), [calcLength](#)

**Examples**

```
local(envir=.PBSmapEnv,expr={
  #-- Distance between southern BC waters and north geomagnetic pole
  print(calcGCdist(-126.5,48.6,-72.7,80.4))
})
```

---

calcLength

*Calculate the Length of Polylines*

---

**Description**

Calculate the length of polylines found in a [PolySet](#).

**Usage**

```
calcLength (polys, rollup = 3, close = FALSE)
```

**Arguments**

|        |                                                                                                                                                                                                           |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| polys  | <a href="#">PolySet</a> to use.                                                                                                                                                                           |
| rollup | level of detail in the results; 1 = PIDs only, summing the lengths of each SID within each PID, and 3 = no roll-up. Note: rollup 2 has no meaning in this function and, if specified, will be reset to 3. |
| close  | Boolean value; if TRUE, include the distance between each polygon's last and first vertex, if necessary.                                                                                                  |

**Details**

If rollup equals 1, the results contain an entry for each unique PID only. Setting it to 3 prevents roll-up, and they contain an entry for each unique (PID, SID).

If the projection attribute equals "LL", this routine uses Great Circle distances to compute the surface length of each polyline. In doing so, the algorithm simplifies Earth to a sphere.

If the projection attribute equals "UTM" or 1, this routine uses Pythagoras' Theorem to calculate lengths.

**Value**

[PolyData](#) with columns PID, SID (*may be missing*), and length. If projection equals "UTM" or "LL", lengths are in kilometres. Otherwise, lengths are in the same unit as the input [PolySet](#).

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

**See Also**

[calcArea](#), [calcCentroid](#), [calcMidRange](#), [calcSummary](#), [locatePolys](#).

**Examples**

```
local(envir=.PBSmapEnv,expr={
  #--- load the data (if using R)
  if (!is.null(version$language) && (version$language=="R"))
    data(nepacLL,envir=.PBSmapEnv)
  #--- calculate the perimeter of Vancouver Island
  print(calcLength(nepacLL[nepacLL$PID==33, ]))
})
```

---

|              |                                                             |
|--------------|-------------------------------------------------------------|
| calcMidRange | <i>Calculate the Midpoint of the X/Y Ranges of Polygons</i> |
|--------------|-------------------------------------------------------------|

---

### Description

Calculate the midpoint of the X/Y ranges of polygons found in a [PolySet](#).

### Usage

```
calcMidRange (polys, rollup = 3)
```

### Arguments

|        |                                                                                             |
|--------|---------------------------------------------------------------------------------------------|
| polys  | <a href="#">PolySet</a> to use.                                                             |
| rollup | level of detail in the results; 1 = PIDs only, 2 = outer contours only, and 3 = no roll-up. |

### Details

If rollup equals 1, the results contain a mean range for each unique PID only. When it equals 2, they contain entries for outer contours only. Finally, setting it to 3 prevents roll-up, and they contain a mean range for each unique (PID, SID).

### Value

[PolyData](#) with columns PID, SID (*may be missing*), X, and Y.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

### See Also

[calcArea](#), [calcCentroid](#), [calcLength](#), [calcSummary](#).

### Examples

```
local(envir=.PBSmapEnv,expr={
  #--- load the data (if using R)
  if (!is.null(version$language) && (version$language=="R"))
    data(nepacLL,envir=.PBSmapEnv)
  #--- calculate and print the centroids for several polygons
  print(calcMidRange(nepacLL[is.element(nepacLL$PID,c(33,39,47)),]))
})
```

---

`calcSummary`*Apply Functions to Polygons in a PolySet*

---

**Description**

Apply functions to polygons in a [PolySet](#).

**Usage**

```
calcSummary (polys, rollup = 3, FUN, ...)
```

**Arguments**

|                     |                                                                                                                                                                                                                                                         |
|---------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>polys</code>  | <a href="#">PolySet</a> to use.                                                                                                                                                                                                                         |
| <code>rollup</code> | level of detail in the results; 1 = PIDs only, by removing the SID column, and then passing each PID into FUN, 2 = outer contours only, by making hole SIDs equal to their parent's SID, and then passing each (PID, SID) into FUN, and 3 = no roll-up. |
| <code>FUN</code>    | the function to apply; it must accept a vector and return a vector or scalar.                                                                                                                                                                           |
| <code>...</code>    | optional arguments for FUN.                                                                                                                                                                                                                             |

**Details**

If `rollup` equals 1, the results contain an entry for each unique PID only. When it equals 2, they contain entries for outer contours only. Finally, setting it to 3 prevents roll-up, and they contain an entry for each unique (PID, SID).

**Value**

[PolyData](#) with columns PID, SID (*may be missing*), X, and Y. If FUN returns a vector of length greater than 1 (say  $n$ ), names the columns X1, X2, ..., X $n$  and Y1, Y2, ..., Y $n$ .

**Author(s)**

[Nicholas M. Boers](#), Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

**See Also**

[calcArea](#), [calcCentroid](#), [calcConvexHull](#), [calcLength](#), [calcMidRange](#), [combineEvents](#), [findPolys](#), [locateEvents](#), [locatePolys](#), [makeGrid](#), [makeProps](#).



**Examples**

```

local(envir=.PBSmapEnv,expr={
  #--- load the data (if using R)
  if (!is.null(version$language) && (version$language=="R"))
    data(nepacLL,envir=.PBSmapEnv)
  #--- calculate and print the centroids for several polygons
  print(calcSummary(nepacLL[is.element(nepacLL$PID,c(33,39,47)),],
    rollup=3, FUN=mean))
})

```

---

calcVoronoi

*Calculate the Voronoi (Dirichlet) Tessellation for a Set of Points*


---

**Description**

Calculate the Voronoi (Dirichlet) tessellation for a set of points.

**Usage**

```
calcVoronoi (xydata, xlim = NULL, ylim = NULL, eps = 1e-09, frac = 0.0001)
```

**Arguments**

|        |                                                                                                                                                                                                     |
|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| xydata | a data frame with columns X and Y containing the points.                                                                                                                                            |
| xlim   | range of X-coordinates; a bounding box for the coordinates.                                                                                                                                         |
| ylim   | range of Y-coordinates; a bounding box for the coordinates.                                                                                                                                         |
| eps    | the value of epsilon used in testing whether a quantity is zero.                                                                                                                                    |
| frac   | used to detect duplicate input points, which meet the condition $ x_1 - x_2  < \text{frac} \times (\text{xmax} - \text{xmin})$ and $ y_1 - y_2  < \text{frac} \times (\text{ymax} - \text{ymin})$ . |

**Details**

This routine ignores all columns other than X and Y.

If the user leaves `xlim` and `ylim` unspecified, the function defaults to the range of the data with each extent expanded by ten percent of the range.

This function sets the attribute projection to 1 and the attribute zone to NULL as it assumes this projection in its calculations.

**Value**

[PolySet](#) with columns PID, POS, X, and Y.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
 MacEwan University, Edmonton AB  
 Last modified Rd: 2013-04-10

**See Also**

[addPoints](#), [addPolys](#), [calcArea](#), [calcCentroid](#), [calcConvexHull](#), [calcMidRange](#), [calcSummary](#), [locateEvents](#), [plotMap](#), [plotPoints](#), [plotPolys](#).

**Examples**

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- create some EventData
  events <- as.EventData(data.frame(
    EID=1:200, X=rnorm(200), Y=rnorm(200)), projection=1)
  #--- calculate the Voronoi tessellation
  polys <- calcVoronoi(events)
  #--- create PolyData to color it based on area
  polyData <- calcArea(polys)
  names(polyData)[is.element(names(polyData), "area")] <- "Z"
  colSeq <- seq(0.4, 0.95, length=4)
  polyData <- makeProps(polyData,
    breaks=quantile(polyData$Z,c(0,.25,.5,.75,1)),
    propName="col", propVals=rgb(colSeq,colSeq,colSeq))
  #--- plot the tessellation
  plotMap(polys, polyProps=polyData)
  #--- plot the points
  addPoints(events, pch=19)
  par(oldpar)
})
```

---

 clipLines

---

*Clip a PolySet as Polylines*


---

**Description**

Clip a [PolySet](#), where each unique (PID, SID) describes a polyline.

**Usage**

```
clipLines (polys, xlim, ylim, keepExtra = FALSE)
```

**Arguments**

|           |                                                                                          |
|-----------|------------------------------------------------------------------------------------------|
| polys     | <a href="#">PolySet</a> to clip.                                                         |
| xlim      | range of X-coordinates.                                                                  |
| ylim      | range of Y-coordinates.                                                                  |
| keepExtra | Boolean value; if TRUE, tries to carry forward any non-standard columns into the result. |

**Details**

For each discrete polyline, the function does not connect vertices 1 and N. It recalculates the POS values for each vertex, saving the old values in a column named oldPOS. For new vertices, it sets oldPOS to NA.

**Value**

[PolySet](#) containing the input data, with some points added or removed. A new column oldPOS records the original POS value for each vertex.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

**See Also**

[clipPolys](#), [fixBound](#).

**Examples**

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- create a triangle to clip
  polys <- data.frame(PID=rep(1, 3), POS=1:3, X=c(0,1,0), Y=c(0,0.5,1))
  #--- clip the triangle in the X direction, and plot the results
  plotLines(clipLines(polys, xlim=c(0,.75), ylim=range(polys[, "Y"])))
  par(oldpar)
})
```

---

clipPolys

---

*Clip a PolySet as Polygons*


---

**Description**

Clip a [PolySet](#), where each unique (PID, SID) describes a polygon.

**Usage**

```
clipPolys (polys, xlim, ylim, keepExtra = FALSE)
```

**Arguments**

|           |                                                                                          |
|-----------|------------------------------------------------------------------------------------------|
| polys     | <a href="#">PolySet</a> to clip.                                                         |
| xlim      | range of X-coordinates.                                                                  |
| ylim      | range of Y-coordinates.                                                                  |
| keepExtra | Boolean value; if TRUE, tries to carry forward any non-standard columns into the result. |

## Details

For each discrete polygon, the function connects vertices 1 and N. It recalculates the POS values for each vertex, saving the old values in a column named oldPOS. For new vertices, it sets oldPOS to NA.

## Value

[PolySet](#) containing the input data, with some points added or removed. A new column oldPOS records the original POS value for each vertex.

## Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

## See Also

[clipLines](#), [fixBound](#).

## Examples

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- create a triangle that will be clipped
  polys <- data.frame(PID=rep(1, 3), POS=1:3, X=c(0,1,.5), Y=c(0,0,1))
  #--- clip the triangle in the X direction, and plot the results
  plotPolys(clipPolys(polys,xlim=c(0,.75),ylim=range(polys[, "Y"])),col=2)
  par(oldpar)
})
```

---

closePolys

*Close a PolySet*

---

## Description

Close a [PolySet](#) of polylines to form polygons.

## Usage

```
closePolys (polys)
```

## Arguments

polys            [PolySet](#) to close.

## Details

Generally, run `fixBound` before this function. The ranges of a `PolySet`'s X and Y columns define the boundary. For each discrete polygon, this function determines if the first and last points lie on a boundary. If both points lie on the same boundary, it adds no points. However, if they lie on different boundaries, it may add one or two corners to the polygon.

When the boundaries are adjacent, one corner will be added as follows:

- top boundary + left boundary implies add top-left corner;
- top boundary + right boundary implies add top-right corner;
- bottom boundary + left boundary implies add bottom-left corner;
- bottom boundary + right boundary implies add bottom-right corner.

When the boundaries are opposite, it first adds the corner closest to a starting or ending polygon vertex. This determines a side (left-right or bottom-top) that connects the opposite boundaries. Then, it adds the other corner of that side to close the polygon.

## Value

`PolySet` identical to `polys`, except for possible additional corner points.

## Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

## See Also

`fixBound`, `fixPOS`.

## Examples

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- 4 corners
  polys <- data.frame(
    PID = c(1, 1, 2, 2, 3, 3, 4, 4),
    POS = c(1, 2, 1, 2, 1, 2, 1, 2),
    X   = c(0, 1, 2, 3, 0, 1, 2, 3),
    Y   = c(1, 0, 0, 1, 2, 3, 3, 2))
  plotPolys(closePolys(polys), col=2)

  #--- 2 corners and 1 opposite
  polys <- data.frame(
    PID = c(1, 1, 2, 2, 3, 3, 3),
    POS = c(1, 2, 1, 2, 1, 2, 3),
    X   = c(0, 1, 0, 1, 5, 6, 1.5),
    Y   = c(1, 0, 2, 3, 0, 1.5, 3))
  plotPolys(closePolys(polys), col=2)
  par(oldpar)
})
```

---

combineEvents      *Combine Measurements of Events*

---

### Description

Combine measurements associated with events that occur in the same polygon.

### Usage

```
combineEvents (events, locs, FUN, ..., bdryOK = TRUE)
```

### Arguments

|        |                                                                                                      |
|--------|------------------------------------------------------------------------------------------------------|
| events | <a href="#">EventData</a> with at least four columns (EID, X, Y, Z).                                 |
| locs   | <a href="#">LocationSet</a> usually resulting from a call to <a href="#">findPolys</a> .             |
| FUN    | a function that produces a scalar from a vector (e.g., <a href="#">mean</a> , <a href="#">sum</a> ). |
| ...    | optional arguments for FUN.                                                                          |
| bdryOK | Boolean value; if TRUE, include boundary points.                                                     |

### Details

This function combines measurements associated with events that occur in the same polygon. Each event (EID) has a corresponding measurement Z. The locs data frame (usually output from [findPolys](#)) places events within polygons. Thus, each polygon (PID, SID) determines a set of events within it, and a corresponding vector of measurements  $Z_v$ . The function returns  $FUN(Z_v)$ , a summary of measurements within each polygon.

### Value

[PolyData](#) with columns PID, SID (*if in* locs), and Z.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

### See Also

[findCells](#), [findPolys](#), [locateEvents](#), [locatePolys](#), [makeGrid](#), [makeProps](#).

## Examples

```
local(envir=.PBSmapEnv,expr={
  #--- create an EventData data frame: let each event have Z = 1
  events <- data.frame(EID=1:10, X=1:10, Y=1:10, Z=rep(1, 10))
  #--- example output from findPolys where 1 event occurred in the first
  #--- polygon, 3 in the second, and 6 in the third
  locs <- data.frame(EID=1:10,PID=c(rep(1,1),rep(2,3),rep(3,6)),Bdry=rep(0,10))
  #--- sum the Z column of the events in each polygon, and print the result
  print(combineEvents(events=events, locs=locs, FUN=sum))
})
```

---

combinePolys

*Combine Several Polygons into a Single Polygon*

---

## Description

Combine several polygons into a single polygon by modifying the PID and SID indices.

## Usage

```
combinePolys (polys)
```

## Arguments

polys [PolySet](#) with one or more polygons, each with possibly several components/holes.

## Details

This function accepts a [PolySet](#) containing one or more polygons (PIDs), each with one or more components or holes (SIDs). The SID column need not exist in the input. The function combines these polygons into a single polygon by simply renumbering the PID and SID indices. The resulting [PolySet](#) contains a single PID (with the value 1) and uses the SID value to differentiate between polygons, their components, and holes.

## Value

[PolySet](#), possibly with the addition of an SID column if it did not already exist. The function may also reorder columns such that PID, SID, POS, X and Y appear first, in that order.

## Author(s)

[Nicholas M. Boers](#), Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2007-06-06

## See Also

[dividePolys](#)

---

|        |                                             |
|--------|---------------------------------------------|
| convCP | <i>Convert Contour Lines into a PolySet</i> |
|--------|---------------------------------------------|

---

### Description

Convert output from [contourLines](#) into a [PolySet](#).

### Usage

```
convCP (data, projection = NULL, zone = NULL)
```

### Arguments

|            |                                                                          |
|------------|--------------------------------------------------------------------------|
| data       | contour line data, often from the <a href="#">contourLines</a> function. |
| projection | optional projection attribute to add to the PolySet.                     |
| zone       | optional zone attribute to add to the PolySet.                           |

### Details

data contains a list as described below. The [contourLines](#) function create a list suitable for the data argument.

A three-element list describes each contour. The named elements in this list include the scalar level, the vector x, and the vector y. Vectors x and y must have equal lengths. A higher-level list (data) contains one or more of these contours lists.

### Value

A list with two named elements [PolySet](#) and [PolyData](#). The [PolySet](#) element contains a [PolySet](#) representation of the contour lines. The [PolyData](#) element links each contour line (PID, SID) with a level.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

### See Also

[contour](#), [contourLines](#), [convLP](#), [makeTopography](#).



## Examples

```

local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- create sample data for the contourLines() function
  x <- seq(-0.5, 0.8, length=50); y <- x
  z <- outer(x, y, FUN = function(x,y) { sin(2*pi*(x^2+y^2))^2; } )
  data <- contourLines(x, y, z, levels=c(0.2, 0.8))
  #--- pass that sample data into convCP()
  result <- convCP(data)
  #--- plot the result
  plotLines(result$PolySet, projection=1)
  print(result$PolyData)
  par(oldpar)
})

```

---

 convDP

*Convert EventData/PolyData into a PolySet*


---

## Description

Convert [EventData](#)/[PolyData](#) into a [PolySet](#).

## Usage

```
convDP (data, xColumns, yColumns)
```

## Arguments

|          |                                                         |
|----------|---------------------------------------------------------|
| data     | <a href="#">PolyData</a> or <a href="#">EventData</a> . |
| xColumns | vector of X-column names.                               |
| yColumns | vector of Y-column names.                               |

## Details

This function expects data to contain several X- and Y-columns. For example, consider data with columns x1, y1, x2, and y2. Suppose xColumns = c("x1", "x2") and yColumns = c("y1", "y2"). The result will contain nrow(data) polygons. Each one will have two vertices, (x1, y1) and (x2, y2) and POS values 1 and 2, respectively. If data includes an SID column, so will the result.

If data contains an EID and not a PID column, the function uses the EIDs as PIDs.

If data contains both PID and EID columns, the function assumes it is [PolyData](#) and ignores the EID column.

## Value

[PolySet](#) with the same PIDs as those given in data. If data has an SID column, the result will include it.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
 MacEwan University, Edmonton AB  
 Last modified Rd: 2013-04-10

**See Also**

[addPoints](#), [plotPoints](#).

**Examples**

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- create sample PolyData
  polyData <- data.frame(PID=c(1, 2, 3),
    x1=c(1, 3, 5), y1=c(1, 3, 2),
    x2=c(1, 4, 5), y2=c(2, 4, 1),
    x3=c(2, 4, 6), y3=c(2, 3, 1))
  #--- print PolyData
  print(polyData)
  #--- make a PolySet from PolyData
  polys <- convDP(polyData,
    xColumns=c("x1", "x2", "x3"),
    yColumns=c("y1", "y2", "y3"))
  #--- print and plot the PolySet
  print(polys)
  plotLines(polys, xlim=c(0,7), ylim=c(0,5), col=2)
  par(oldpar)
})
```

---

 convLP

---

*Convert Polylines into a Polygon*


---

**Description**

Convert two polylines into a polygon.

**Usage**

```
convLP (polyA, polyB, reverse = TRUE)
```

**Arguments**

|         |                                                   |
|---------|---------------------------------------------------|
| polyA   | <a href="#">PolySet</a> containing a polyline.    |
| polyB   | <a href="#">PolySet</a> containing a polyline.    |
| reverse | Boolean value; if TRUE, reverse polyB's vertices. |

### Details

The resulting [PolySet](#) contains all the vertices from polyA in their original order. If `reverse = TRUE`, this function appends the vertices from polyB in the reverse order (`nrow(polyB):1`). Otherwise, it appends them in their original order. The PID column equals the PID of polyA. No SID column appears in the result. The resulting polygon is an exterior boundary.

### Value

[PolySet](#) with a single PID that is the same as polyA. The result contains all the vertices in polyA and polyB. It has the same projection and zone attributes as those in the input PolySets. If an input PolySet's attributes equal NULL, the function uses the other PolySet's. If the PolySet attributes conflict, the result's attribute equals NULL.

### Author(s)

[Nicholas M. Boers](#), Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

### See Also

[addLines](#), [appendPolys](#), [closePolys](#), [convCP](#), [joinPolys](#), [plotLines](#).

### Examples

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- create two polylines
  polyline1 <- data.frame(PID=rep(1,2),POS=1:2,X=c(1,4),Y=c(1,4))
  polyline2 <- data.frame(PID=rep(1,2),POS=1:2,X=c(2,5),Y=c(1,4))
  #--- create two plots to demonstrate the effect of `reverse`
  par(mfrow=c(2, 1))
  plotPolys(convLP(polyline1, polyline2, reverse=TRUE), col=2)
  plotPolys(convLP(polyline1, polyline2, reverse=FALSE), col=3)
  par(oldpar)
})
```

---

convUL

*Convert Coordinates between UTM and Lon/Lat*

---

### Description

Convert coordinates between UTM and Lon/Lat.

### Usage

```
convUL (xydata, km=TRUE, southern=NULL)
```

## Arguments

|          |                                                                                                                                                                                                                                                               |
|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| xydata   | numeric – data frame with columns X and Y.                                                                                                                                                                                                                    |
| km       | logical – if TRUE, UTM coordinates within xydata are in kilometres; otherwise, metres.                                                                                                                                                                        |
| southern | logical – if TRUE, forces conversions from UTM to longitude/latitude to produce coordinates within the southern hemisphere. For conversions from UTM, this argument defaults to FALSE. For conversions from LL, the function determines southern from xydata. |

## Details

The object xydata must possess a projection attribute that identifies the current projection. If the data frame contains UTM coordinates, it must also have a zone attribute equal to a number between 1 and 60 (inclusive). If it contains geographic (longitude/latitude) coordinates and the zone attribute is missing, the function computes the mean longitude and uses that value to determine the zone. The longitude range of zone  $i$  is  $-186 + 6i^\circ < x \leq -180 + 6i^\circ$ .

This function converts the X and Y columns of xydata from "LL" to "UTM" or vice-versa. If the data span more than **one** zone to the right or left of the intended central zone, the underlying algorithm may produce erroneous results. This limitation means that the user should use the most central zone of the mapped region, or allow the function to determine the central zone when converting from geographic to UTM coordinates. After the conversion, this routine adjusts the data frame's attributes accordingly.

## Value

A data frame identical to xydata, except that the X and Y columns contain the results of the conversion, and the projection attribute matches the new projection.

## Author(s)

**Nicholas M. Boers**, Associate Professor, MacEwan University, Edmonton AB  
 Maintainer: **Rowan Haigh**, Program Head – Offshore Rockfish  
 Pacific Biological Station (PBS), Fisheries & Oceans Canada (DFO), Nanaimo BC  
*locus opus*: Regional Headquarters, Vancouver BC  
 Last modified Rd: 2022-09-06

## References

Ordnance Survey. (2020) **A guide to coordinate systems in Great Britain**. Copyright Ordnance Survey 2018 (v3.6). Southampton, UK.

## See Also

[closePolys](#), [fixBound](#).

## Examples

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- load the data
  data(nepacLL,envir=.PBSmapEnv)
  #--- set the zone attribute
  #--- use a zone that is most central to the mapped region
  attr(nepacLL, "zone") <- 6
  #--- convert and plot the result
  nepacUTM <- convUL(nepacLL)
  plotMap(nepacUTM)
  par(oldpar)
})
```

---

dividePolys

*Divide a Single Polygon into Several Polygons*

---

## Description

Divide a single polygon (with several outer-contour components) into several polygons, a polygon for each outer contour, by modifying the PID and SID indices.

## Usage

```
dividePolys (polys)
```

## Arguments

polys            [PolySet](#) with one or more polygons, each with possibly several components/holes.

## Details

Given the input [PolySet](#), this function renumbers the PID and SID indices so that each outer contour has a unique PID and is followed by all of its holes, identifying them with SIDs greater than one.

## Value

[PolySet](#), possibly with the addition of an SID column if it did not already exist. The function may also reorder columns such that PID, SID, POS, X and Y appear first, in that order.

## Author(s)

[Nicholas M. Boers](#), Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2007-06-06

## See Also

[combinePolys](#).

---

 EventData

*EventData Objects*


---

### Description

An EventData object comprises a data frame with at least three fields named EID, X, and Y; each row specifies an event that occurs at a specific point.

**PBSmapping** functions that expect EventData will accept properly formatted data frames in their place (see 'Details').

`as.EventData` attempts to coerce a data frame to an object with class EventData.

`is.EventData` returns TRUE if its argument is of class EventData.

### Usage

```
as.EventData(x, projection = NULL, zone = NULL)
```

```
is.EventData(x, fullValidation = TRUE)
```

### Arguments

|                |                                                                                                |
|----------------|------------------------------------------------------------------------------------------------|
| x              | data frame to be coerced or tested.                                                            |
| projection     | optional projection attribute to add to EventData, possibly overwriting an existing attribute. |
| zone           | optional zone attribute to add to EventData, possibly overwriting an existing attribute.       |
| fullValidation | Boolean value; if TRUE, fully test x.                                                          |

### Details

Conceptually, an EventData object describes events (EID) that take place at specific points (X,Y) in two-dimensional space. Additional fields can specify measurements associated with these events. In a fishery context, EventData could describe fishing events associated with trawl tows, based on the fields:

- EID - fishing event (tow) identification number;
- X, Y - fishing location;
- Duration - length of time for the tow;
- Depth - average depth of the tow;
- Catch - biomass captured.

Like [PolyData](#), EventData can have attributes projection and zone, which may be absent. Inserting the string "EventData" as the class attribute's first element alters the behaviour of some functions, including `print` (if `PBSprint` is TRUE) and `summary`.

**Value**

The `as.EventData` method returns an object with classes "EventData" and "data.frame", in that order.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2015-04-23

**See Also**

[PolySet](#), [PolyData](#), [LocationSet](#)

---

|                 |                                        |
|-----------------|----------------------------------------|
| extractPolyData | <i>Extract PolyData from a PolySet</i> |
|-----------------|----------------------------------------|

---

**Description**

Extract [PolyData](#) from a [PolySet](#). Columns for the [PolyData](#) include those other than PID, SID, POS, oldPOS, X, and Y.

**Usage**

```
extractPolyData (polys)
```

**Arguments**

`polys` [PolySet](#) to use.

**Details**

This function identifies the [PolySet](#)'s extra columns and determines if those columns contain unique values for each (PID, SID). Where they do, the (PID, SID) will appear in the [PolyData](#) output with that unique value. Where they do not, the extra column will contain NAs for that (PID, SID).

**Value**

[PolyData](#) with columns PID, SID, and any extra columns.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

**See Also**

[makeProps](#), [PolyData](#), [PolySet](#).

**Examples**

```
local(envir=.PBSmapEnv,expr={
  #--- create a PolySet with an extra column
  polys <- data.frame(PID = c(rep(1, 10), rep(2, 10)),
    POS = c(1:10, 1:10),
    X = c(rep(1, 10), rep(1, 10)),
    Y = c(rep(1, 10), rep(1, 10)),
    colour = (c(rep("green", 10), rep("red", 10))))
  #--- extract the PolyData
  print(extractPolyData(polys))
})
```

---

 findCells

*Find Grid Cells that Contain Events*


---

**Description**

Find the grid cells in a [PolySet](#) that contain events specified in [EventData](#). Similar to [findPolys](#), except this function requires a [PolySet](#) resulting from [makeGrid](#). This restriction allows this function to calculate the result with greater efficiency.

**Usage**

```
findCells (events, polys, includeBdry=NULL)
```

**Arguments**

|             |                                                                                                                                                                                                                                                                                                                                                 |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| events      | <a href="#">EventData</a> to use.                                                                                                                                                                                                                                                                                                               |
| polys       | <a href="#">PolySet</a> to use.                                                                                                                                                                                                                                                                                                                 |
| includeBdry | numeric: determines how points on boundaries are handled:<br>if NULL then report all points on polygon boundaries (default behaviour);<br>if 0 then exclude all points on polygon boundaries;<br>if 1 then report only the first (lowest PID/SID) polygon boundary;<br>if 2, . . . , n then report the last (highest PID/SID) polygon boundary. |

**Details**

The resulting data frame, a [LocationSet](#), contains the columns EID, PID, SID (*if in polys*), and Bdry, where an event (EID) occurs in a polygon (PID, SID). The Boolean (0,1) variable Bdry indicates whether an event lies on a polygon's edge. Note that if an event lies properly outside of all the polygons, then a record with (EID, PID, SID) does not occur in the output. It may happen, however, that an event occurs in multiple polygons (i.e., on two or more boundaries). Thus, the same EID can occur more than once in the output.



If an event happens to lie at the boundary intersection of four (or two) grid cells then one EID will be associated with four (or two) grid cells. A user can choose to manipulate this result by setting the argument `includeBdry` to a numeric value that constrains the association of a boundary event to 0 or 1 grid cell (see argument description above).

### Value

[LocationSet](#) that links events with polygons.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2014-12-15

### See Also

[findPolys](#), [makeGrid](#), [combineEvents](#), [locateEvents](#), [locatePolys](#), [LocationSet](#).

### Examples

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- create some EventData: points in a diagonal line
  events <- data.frame(EID=1:11, X=seq(0, 2, length=11),
    Y=seq(0, 2, length=11))
  events <- as.EventData(events, projection=1);
  #--- create a PolySet (a grid)
  polys <- makeGrid (x=seq(0, 2, by=0.50), y=seq(0, 2, by=0.50), projection=1)
  #--- show a picture
  plotPolys(polys, xlim=range(polys$X)+c(-0.1, 0.1),
    ylim=range(polys$Y)+c(-0.1, 0.1), projection=1)
  addPoints(events, col=2)
  #--- run findCells and print the results
  fc <- findCells(events, polys)
  fc <- fc[order(fc$EID, fc$PID, fc$SID), ]
  fc$label <- paste(fc$PID, fc$SID, sep=", ")
  print (fc)
  #--- add labels to the graph
  addLabels(as.PolyData(fc[!duplicated(paste(fc$PID,fc$SID))], ],
    projection=1), placement="CENTROID",
    polys=as.PolySet(polys, projection=1), col=4)
  par(oldpar)
})
```

---

`findPolys`*Find Polygons that Contain Events*

---

**Description**

Find the polygons in a [PolySet](#) that contain events specified in [EventData](#).

**Usage**

```
findPolys (events, polys, maxRows = 1e+05, includeBdry=NULL)
```

**Arguments**

|                          |                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>events</code>      | <a href="#">EventData</a> to use.                                                                                                                                                                                                                                                                                                               |
| <code>polys</code>       | <a href="#">PolySet</a> to use.                                                                                                                                                                                                                                                                                                                 |
| <code>maxRows</code>     | estimated maximum number of rows in the output <a href="#">LocationSet</a> .                                                                                                                                                                                                                                                                    |
| <code>includeBdry</code> | numeric: determines how points on boundaries are handled:<br>if NULL then report all points on polygon boundaries (default behaviour);<br>if 0 then exclude all points on polygon boundaries;<br>if 1 then report only the first (lowest PID/SID) polygon boundary;<br>if 2, . . . , n then report the last (highest PID/SID) polygon boundary. |

**Details**

The resulting data frame, a [LocationSet](#), contains the columns EID, PID, SID (*if in polys*), and Bdry, where an event (EID) occurs in a polygon (PID, SID) and SID does not correspond to an inner boundary. The Boolean variable Bdry indicates whether an event lies on a polygon's edge. Note that if an event lies properly outside of all the polygons, then a record with (EID, PID, SID) does not occur in the output. It may happen, however, that an event occurs in multiple polygons. Thus, the same EID can occur more than once in the output.

If an event happens to lie at the boundary intersection of two or more polygons then one EID will be associated with two or more polygons. A user can choose to manipulate this result by setting the argument `includeBdry` to a numeric value that constrains the association of a boundary event to 0 or 1 polygon (see argument description above).

**Value**

[LocationSet](#) that links events with polygons.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2014-12-15

**See Also**

[combineEvents](#), [findCells](#), [locateEvents](#), [locatePolys](#), [LocationSet](#), [makeGrid](#).

**Examples**

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- create some EventData: a column of points at X = 0.5
  events <- data.frame(EID=1:10, X=.5, Y=seq(0, 2, length=10))
  events <- as.EventData(events, projection=1)
  #--- create a PolySet: two squares with the second above the first
  polys <- data.frame(PID=c(rep(1, 4), rep(2, 4)), POS=c(1:4, 1:4),
    X=c(0, 1, 1, 0, 0, 1, 1, 0),
    Y=c(0, 0, 1, 1, 1, 1, 2, 2))
  polys <- as.PolySet(polys, projection=1)
  #--- show a picture
  plotPolys(polys, xlim=range(polys$X)+c(-0.1, 0.1),
    ylim=range(polys$Y)+c(-0.1, 0.1), projection=1);
  addPoints(events, col=2);
  #--- run findPolys and print the results
  print(findPolys(events, polys))
  par(oldpar)
})
```

---

 fixBound

*Fix the Boundary Points of a PolySet*


---

**Description**

The ranges of a [PolySet](#)'s X and Y columns define its boundary. This function fixes a [PolySet](#)'s vertices by moving vertices near a boundary to the actual boundary.

**Usage**

```
fixBound (polys, tol)
```

**Arguments**

|       |                                                                                                                                                                                                                                                                                                 |
|-------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| polys | <a href="#">PolySet</a> to fix.                                                                                                                                                                                                                                                                 |
| tol   | vector (length 1 or 2) specifying a percentage of the ranges to use in defining <i>near</i> to a boundary. If tol has two elements, the first specifies the tolerance for the x-axis and the second the y-axis. If it has only one element, the function uses the same tolerance for both axes. |

**Details**

When moving vertices to a boundary, the function moves them strictly horizontally or vertically, as appropriate.

**Value**

[PolySet](#) identical to the input, except for possible changes in the X and Y columns.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

**See Also**

[closePolys](#), [fixPOS](#), [isConvex](#), [isIntersecting](#), [PolySet](#).

**Examples**

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- set up a long horizontal and long vertical line to extend the plot's
  #--- limits, and then try fixing the bounds of a line in the top-left
  #--- corner and a line in the bottom-right corner
  polys <- data.frame(PID=c(1, 1, 2, 2, 3, 3, 4, 4),
    POS=c(1, 2, 1, 2, 1, 2, 1, 2),
    X = c(0, 10, 5, 5, 0.1, 4.9, 5.1, 9.9),
    Y = c(5, 5, 0, 10, 5.1, 9.9, 0.1, 4.9))
  polys <- fixBound(polys, tol=0.0100001)
  plotLines(polys)
  par(oldpar)
})
```

---

 fixPOS

---

*Fix the POS Column of a PolySet*


---

**Description**

Fix the POS column of a [PolySet](#) by recalculating it using sequential integers.

**Usage**

```
fixPOS (polys, exteriorCCW = NA)
```

**Arguments**

|             |                                                                                                                                                                                   |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| polys       | <a href="#">PolySet</a> to fix.                                                                                                                                                   |
| exteriorCCW | Boolean value; if TRUE, orders exterior polygon vertices in a counter-clockwise direction. If FALSE, orders them in a clockwise direction. If NA, maintains their original order. |

## Details

This function recalculates the POS values of each (PID, SID) as either 1 to N or N to 1, depending on the order of POS (ascending or descending) in the input data. POS values in the input must be properly ordered (ascending or descending), but they may contain fractional values. For example, POS = 2.5 might correspond to a point manually added between POS = 2 and POS = 3. If exteriorCCW = NA, all other columns remain unchanged. Otherwise, it orders the X and Y columns according to exteriorCCW.

## Value

[PolySet](#) with the same columns as the input, except for possible changes to the POS, X, and Y columns.

## Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

## See Also

[closePolys](#), [fixBound](#), [isConvex](#), [isIntersecting](#), [PolySet](#).

## Examples

```
local(envir=.PBSmapEnv,expr={
  #--- create a PolySet with broken POS numbering
  polys <- data.frame(PID = c(rep(1, 10), rep(2, 10)),
    POS = c(seq(2, 10, length = 10), seq(10, 2, length = 10)),
    X = c(rep(1, 10), rep(1, 10)),
    Y = c(rep(1, 10), rep(1, 10)))
  #--- fix the POS numbering
  polys <- fixPOS(polys)
  #--- print the results
  print(polys)
})
```

---

importEvents

*Import EventData from a Text File*

---

## Description

Import a text file and convert into EventData.

## Usage

```
importEvents(EventData, projection=NULL, zone=NULL)
```

**Arguments**

|            |                                                    |
|------------|----------------------------------------------------|
| EventData  | filename of EventData text file.                   |
| projection | optional projection attribute to add to EventData. |
| zone       | optional zone attribute to add to EventData.       |

**Value**

An imported EventData.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2008-08-25

**See Also**

[importPolys](#), [importLocs](#), [importGSHHS](#), [importShapefile](#)

---

importGSHHS

---

*Import Data from a GSHHS Database*


---

**Description**

Import data from a GSHHS database and convert data into a PolySet with a PolyData attribute. The database was originally called ‘Global Self-consistent, Hierarchical, High-resolution Shoreline’ (GSHHS, Wessel and Smith 1996), but ‘Shoreline’ was subsequently expanded to include more ‘Geography’ (GSHHG).

**Usage**

```
importGSHHS(gshhsDB, xlim, ylim, maxLevel=4, n=0, useWest=FALSE)
```

**Arguments**

|          |                                                                                                                                                          |
|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------|
| gshhsDB  | path name to binary GSHHS database. If unspecified, looks for gshhs_f.b in the root of the <b>PBSmapping</b> library directory.                          |
| xlim     | range of X-coordinates (for clipping). The range should be between 0 and 360, starting at the Greenwich meridian and wrapping eastward around the globe. |
| ylim     | range of Y-coordinates (for clipping).                                                                                                                   |
| maxLevel | maximum level of polygons to import: 1 (land), 2 (lakes on land), 3 (islands in lakes), or 4 (ponds on islands); ignored when importing lines.           |
| n        | minimum number of vertices that must exist in a line/polygon in order for it to be imported.                                                             |
| useWest  | logical: if TRUE, convert the X-coordinates (longitude) to °W (western hemisphere -180 to 0, i.e., west of the Greenwich meridian).                      |

## Details

This routine requires a binary GSHHG (Global Self-consistent, Hierarchical, High-resolution Geography) database file. The **GSHHG database** has been released in the public domain. At the time of writing, the most recent binary database was the archive file called `gshhg-bin-2.3.7.zip`.

The archive contains multiple binary files that contain geographical coordinates for shorelines (`gshhs`), rivers (`wdb_rivers`), and borders (`wdb_borders`). The latter two come from **World Data-Bank II** (WDBII). The five resolutions available are: full (f), high (h), intermediate (i), low (l), and coarse (c).

This routine returns a PolySet object with an associated PolyData attribute. The attribute contains four fields: (a) PID, (b) SID, (c) Level, and (d) Source. Each record corresponds to a line/polygon in the PolySet. The Level indicates the line's/polygon's level (1=land, 2=lake, 3=island, 4=pond). The Source identifies the data source (1=WVS, 0=CIA (WDBII)).

## Value

A PolySet with a PolyData attribute.

## Note

The function calls a C routine, also called `importGSHHS`, which returns a set of map coordinates that is not always predictably laid out. This issue stems from how the world is divided at the Greenwich meridian and at the International Date Line. The unpredictability occurs when user-specified X-limits span either of the longitudinal meridians  $(0^\circ, 360^\circ)$  or  $(-180^\circ, 180^\circ)$ .

This version of the R function attempts to stitch together the overlapping edges of `gshhs` that run from  $-20^\circ$  to  $360^\circ$  (see example map 5 below). At present, no attempt has been made to deal with the overlap at the International Date Line where Russia overlaps the Aleutian Islands of Alaska. To some extent, the C-code can deal with this, but not in all cases.

Therefore, the user will likely experience some limitations when using `importGSHHS`. The solution is to import the whole dataset with this function using `xlim=c(0, 360)`, and then apply the function `refocusWorld` with user-desired X-limits. The Y-limits are generally not problematic unless the user wants to focus on either pole.

## Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB

Maintainer: **Rowan Haigh**, Program Head – Offshore Rockfish  
Pacific Biological Station (PBS), Fisheries & Oceans Canada (DFO), Nanaimo BC  
*locus opus*: Institute of Ocean Sciences (IOS), Sidney BC  
Last modified Rd: 2021-01-11

## References

Wessel, P., and Smith, W.H.F. (1996) **A Global Self-consistent, Hierarchical, High-resolution Shore-line Database**. *J. Geophys. Res.* **101** 8741-8743.

**See Also**

In package **PBSmapping**:

[importEvents](#), [importLocs](#), [importPolys](#), [importShapefile](#)

**Examples**

```
## Not run:
useWest=FALSE
useVers=c("2.2.0","2.2.3","2.3.0","2.3.4") # GSHHG versions
mapswitch = 5
for (i in c("land","rivers","borders"))
  if (exists(i)) eval(parse(text=paste0("rm(",i,")")))
switch( mapswitch,
# 1. Canada-----
  {vN=4; useWest=T; xlim=c(-150,-50)+360;ylim=c(40,75)},
# 2. NW Canada & America-----
  {vN=4; useWest=T;xlim=c(-136,-100)+360;ylim=c(40,75)},
# 3. Black Sea (user Ivailo)-----
  {vN=4; xlim=c(27.5, 34.3); ylim=c(40.9, 46.7)},
# 4. W Europe, NW Africa (user Uli)-----
  {vN=4; xlim=c(-20,10); ylim=c(20,50)},
# 5. W Europe + Iceland-----
  {vN=4; xlim=c(-25, 20); ylim=c(40, 68)},
# 6. New Zealand-----
  {vN=4; xlim=c(163, 182); ylim=c(-48,-34)},
# 7. Australia-----
  {vN=4; xlim=c(112,155); ylim=c(-44,-10)},
# 8. Japan-----
  {vN=4; xlim=c(127,148); ylim=c(30,47)},
# 9. Central America-----
  {vN=4; useWest=T; xlim=c(-95,-60)+360;ylim=c(-10,25)},
#10. North Pacific-----
  {vN=4; useWest=T; xlim=c(150,220); ylim=c(45,80)},
#11. Pacific Ocean-----
  {vN=4; xlim=c(112,240); ylim=c(-48,80)},
#12. North Atlantic (world coordinates)-----
  {vN=4; xlim=c(285,360); ylim=c(40,68)},
#13. North Atlantic (western hemisphere coordinates)-----
  {vN=4; xlim=c(-75,0); ylim=c(40,68)},
#14. Atlantic Ocean-----
  {vN=4; xlim=c(285,380); ylim=c(-50,68)},
#15. Northern hemisphere-----
  {vN=4; xlim=c(-180,180); ylim=c(0,85)},
#16. Asia-----
  {vN=4; xlim=c(0,180); ylim=c(0,80)},
#17. North America-----
  {vN=4; xlim=c(-180,0); ylim=c(0,80)},
#18. International date line-----
  {vN=4; xlim=c(45,315); ylim=c(0,80)},
#19. Indian Ocean-----
  {vN=4; xlim=c(20,130); ylim=c(-40,40)},
#20. Moose County ("400 miles north of everywhere")-----
```



```
        {vN=4; xlim=c(272.5,280.5); ylim=c(43,47.5)}
    )
    db=paste0("gshhg-bin-",useVers[vN])      # database version folder
    gshhg  = paste0("C:/Ruser/GSHHG/",db,"/") # directory with binary files
    land   = importGSHHS(paste0(gshhg,"gshhs_i.b"),
        xlim=xlim,ylim=ylim,maxLevel=4,useWest=useWest)
    rivers = importGSHHS(paste0(gshhg,"wdb_rivers_i.b"),
        xlim=xlim,ylim=ylim,useWest=useWest)
    borders = importGSHHS(paste0(gshhg,"wdb_borders_i.b"),
        xlim=xlim,ylim=ylim,useWest=useWest,maxLevel=1)
    if(exists("land")){
        plotMap(land,xlim=xlim-ifelse(useWest,360,0),ylim=ylim,
            col="lemonchiffon",bg="aliceblue")
        if(!is.null(rivers)) addLines(rivers,col="blue")
        if(!is.null(borders)) addLines(borders,col="red",lwd=2)
    }

    ## End(Not run)
```

---

importLocs

*Import LocationSet from a text file*

---

## Description

Import a text file and convert into a LocationSet.

## Usage

```
importLocs(LocationSet)
```

## Arguments

LocationSet      filename of LocationSet text file.

## Value

An imported LocationSet.

## Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2007-06-06

## See Also

[importPolys](#), [importEvents](#), [importGSHHS](#), [importShapefile](#)

---

|             |                                        |
|-------------|----------------------------------------|
| importPolys | <i>Import PolySet from a text file</i> |
|-------------|----------------------------------------|

---

**Description**

Import a text file and convert into a PolySet with optional PolyData attribute.

**Usage**

```
importPolys(PolySet, PolyData=NULL, projection=NULL, zone=NULL)
```

**Arguments**

|            |                                                    |
|------------|----------------------------------------------------|
| PolySet    | filename of PolySet text file.                     |
| PolyData   | optional filename of PolyData text file.           |
| projection | optional projection attribute to add to EventData. |
| zone       | optional zone attribute to add to EventData.       |

**Value**

An imported PolySet with optional PolyData attribute.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2007-06-06

**See Also**

[importEvents](#), [importLocs](#), [importGSHHS](#), [importShapefile](#)

---

|                 |                                 |
|-----------------|---------------------------------|
| importShapefile | <i>Import an ESRI Shapefile</i> |
|-----------------|---------------------------------|

---

**Description**

Import an ESRI shapefile (.shp) into either a [PolySet](#) or [EventData](#).

**Usage**

```
importShapefile (fn, readDBF=TRUE, projection=NULL, zone=NULL,  
mininverts=3, placeholes=FALSE, show.progress=FALSE)
```

**Arguments**

|               |                                                                                                                                                            |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| fn            | character – file name of the shapefile to import; specifying the extension is optional.                                                                    |
| readDBF       | logical – if TRUE, import the associated ".dbf" (database containing feature attributes) and add as an attribute to the output PolySet   EventData object. |
| projection    | character – optional projection attribute to override the internally derived value.                                                                        |
| zone          | numeric – optional zone attribute to override the default value of NULL.                                                                                   |
| minverts      | numeric – minimum number of vertices required for a polygon representing a hole to be retained (does not affect solids).                                   |
| placeholes    | logical – if TRUE then for every PID identify solids and holes, and place holes under appropriate solids.                                                  |
| show.progress | logical – if TRUE, display on the command console the progress of placing holes under solids.                                                              |

**Details**

This routine imports an ESRI shapefile (.shp) into either a PolySet or EventData, depending on the type of shapefile. It supports types 1 (Point), 3 (PolyLine), and 5 (Polygon) and imports type 1 into EventData and types 3 and 5 into a PolySet. In addition to the shapefile (.shp), it requires the related index file (.shx).

If a database containing feature attributes (.dbf) exists, it also imports this database by default. For EventData, it binds the database columns to the EventData object. For a PolySet, it saves the database in a PolyData object and attaches that object to the PolySet in an attribute named "PolyData".

If a .prj file exists, this information is attached as an attribute. If the first 3 characters are 'GEO', then a geographic projection is assumed and projection="LL". If the first 4 characters are 'PROJ', and 'UTM' occurs elsewhere in the string, then the Universal Transverse Mercator projection is assumed and projection="UTM". Otherwise, projection=1.

If an .xml file exists, this information is attached as an attribute.

Shapes of numeric shape type 5 exported from **ArcView** in geographic projection identify solids as polygons with vertices following a clockwise path and holes as polygons that follow a counter-clockwise path. Unfortunately, either the export from **ArcView** or the import using a C-routine from the package **maptools** often does not report solids followed by their holes. We employ a new R function placeHoles to do this for us. Ideally, this routine should be rendered in C, but for now we use this function if the user sets the argument placeholes=TRUE. Depending on the size and complexity of your shapefile, the computation may take a while.

**Value**

For points, EventData with columns EID, X, and Y, possibly with other columns from the attribute database. For polylines and polygons, a PolySet with columns PID, SID, POS, X, Y and attribute projection. Other attributes that may or may not be attached: parent.child (boolean vector from original input), shpType (numeric shape type: 1, 3, or 5), prj (projection information from .prj file, xml (metadata from an .xml file), PolyData (data from the attribute database .dbf), and zone (UTM zone).

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB

**Rowan Haigh**, Program Head – Offshore Rockfish  
Pacific Biological Station (PBS), Fisheries & Oceans Canada (DFO), Nanaimo BC  
*opus locus*: Institute of Ocean Sciences (IOS), Sidney BC  
Last modified Rd: 2018-09-07

**See Also**

[importGSHHS](#), [importEvents](#), [importLocs](#), [importPolys](#), [placeHoles](#)

---

isConvex

*Determine Whether Polygons are Convex*

---

**Description**

Determine whether polygons found in a [PolySet](#) are convex.

**Usage**

isConvex (polys)

**Arguments**

polys            [PolySet](#) to use.

**Details**

Convex polygons do not self-intersect. In a convex polygon, only the first and last vertices may share the same coordinates (i.e., the polygons are optionally closed).

The function does not give special consideration to holes. It returns a value for each unique (PID, SID), regardless of whether a contour represents a hole.

**Value**

[PolyData](#) with columns PID, SID (*may be missing*), and convex. Column convex contains Boolean values.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

**See Also**

[isIntersecting](#), [PolySet](#).

**Examples**

```
local(envir=.PBSmapEnv,expr={
  #--- load the data (if using R)
  if (!is.null(version$language) && (version$language=="R"))
    data(nepacLL,envir=.PBSmapEnv)
  #--- calculate then print the polygons that are convex
  p <- isConvex(nepacLL);
  #--- nepacLL actually contains no convex polygons
  print(p[p$convex,])
})
```

---

|                |                                                         |
|----------------|---------------------------------------------------------|
| isIntersecting | <i>Determine Whether Polygons are Self-Intersecting</i> |
|----------------|---------------------------------------------------------|

---

**Description**

Determine whether polygons found in a [PolySet](#) are self-intersecting.

**Usage**

```
isIntersecting (polys, numericResult = FALSE)
```

**Arguments**

`polys`            [PolySet](#) to use.  
`numericResult`   Boolean value; if TRUE, returns the number of intersections.

**Details**

When `numericResult = TRUE`, this function counts intersections as the algorithm processes them. It counts certain types (i.e., those involving vertices and those where an edge retraces over an edge) more than once.

The function does not give special consideration to holes. It returns a value for each unique (PID, SID), regardless of whether a contour represents a hole.

**Value**

[PolyData](#) with columns PID, SID (*may be missing*), and `intersecting`. If `numericResult` is TRUE, `intersecting` contains the number of intersections. Otherwise, it contains a Boolean value.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
 MacEwan University, Edmonton AB  
 Last modified Rd: 2013-04-10

**See Also**

[isConvex](#), [PolySet](#).

**Examples**

```
local(envir=.PBSmapEnv,expr={
  #--- load the data (if using R)
  if (!is.null(version$language) && (version$language=="R"))
  data(nepacLL,envir=.PBSmapEnv)
  #--- calculate then print the polygons that are self-intersecting
  p <- isIntersecting(nepacLL, numericResult = FALSE)
  print(p[p$selfintersecting,])
})
```

---

joinPolys

*Join One or Two PolySets using a Logic Operation*


---

**Description**

Join one or two PolySets using a logic operation.

**Usage**

```
joinPolys(polysA, polysB=NULL, operation="INT")
```

**Arguments**

|           |                                                                                                                        |
|-----------|------------------------------------------------------------------------------------------------------------------------|
| polysA    | <a href="#">PolySet</a> to join.                                                                                       |
| polysB    | optional second <a href="#">PolySet</a> with which to join.                                                            |
| operation | one of "DIFF", "INT", "UNION", or "XOR", representing difference, intersection, union, and exclusive-or, respectively. |

**Details**

This function interfaces with the [Clipper library](#), specifically version 6.2.1 released 2014-10-31, developed by Angus Johnson. Prior to 2013-03-23, 'joinPolys' used the General Polygon Clipper library by Alan Murta at the University of Manchester. We keep this historic reference to GPC because 'joinPolys' remains faithful to Murta's definition of a generic polygon, which we describe below.

Murta (2004) defines a *generic polygon* (or *polygon set*) as zero or more disjoint boundaries of arbitrary configuration. He relates a *boundary* to a contour, where each may be convex, concave or self-intersecting. In a PolySet, the polygons associated with each unique PID loosely correspond to a generic polygon, as they can represent both inner and outer boundaries. Our use of the term *generic polygon* includes the restrictions imposed by a PolySet. For example, the polygons for a given PID cannot be arranged arbitrarily.

If 'polysB' is NULL, this function sequentially applies the logic 'operation' between the generic polygons in 'polysA'. For example, suppose 'polysA' contains three generic polygons (A, B, C). The function outputs the PolySet containing ((A op B) op C).

If 'polysB' is not NULL, this function applies the logic 'operation' between each generic polygon in 'polysA' and each one in 'polysB'. For example, suppose 'polysA' contains two generic polygons (A, B) and 'polysB' contains two generic polygons (C, D). The function's output is the concatenation of A op C, B op C, A op D, B op D, with PIDs 1 to 4, respectively. Generally there are  $n$  times  $m$  comparisons, where  $n$  = number of polygons in 'polysA' and  $m$  = number of polygons in 'polysB'. If 'polysB' contains only one generic polygon, the function maintains the PIDs from 'polysA'. It also maintains them when 'polysA' contains only one generic polygon and the 'operation' is "DIFF" (difference). Otherwise, if 'polysA' contains only one generic polygon, it maintains the PIDs from 'polysB'.

### Value

If 'polysB' is NULL, the resulting PolySet contains a single generic polygon (one PID), possibly with several components (SIDs). The function recalculates the PID and SID columns.

If 'polysB' is not NULL, the resulting PolySet contains one or more generic polygons (PIDs), each with possibly several components (SIDs). The function recalculates the SID column, and depending on the input, it may recalculate the PID column.

### Author(s)

C code: [Angus Johnson](#), Computer Programmer

Implementation: [Nicholas M. Boers](#), Associate Professor – Computer Science  
MacEwan University, Edmonton AB

Maintainer: [Rowan Haigh](#), Program Head – Offshore Rockfish  
Pacific Biological Station (PBS), Fisheries & Oceans Canada (DFO), Nanaimo BC  
*locus opus*: Institute of Ocean Sciences (IOS), Sidney BC  
Last modified Rd: 2021-01-11

### References

Murta, A. (2004) *A General Polygon Clipping Library*. Accessed: Jul 29, 2004.

Johnson, A. (2014) *Clipper* – an open source freeware library for clipping and offsetting lines and polygons. Accessed: Oct 31, 2014.

### See Also

In package **PBSmapping**:

[addPolys](#), [appendPolys](#), [clipPolys](#), [closePolys](#), [fixBound](#), [fixPOS](#), [locatePolys](#), [plotMap](#),  
[plotPoints](#), [thickenPolys](#), [thinPolys](#)

### Examples

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- load the data (if using R)
```

```

if (!is.null(version$language) && (version$language=="R"))
  data(nepacLL,envir=.PBSmapEnv)

### Example 1. Cut a triangle out of Vancouver Island
par(mfrow=c(1,1))
#--- create a triangle to use in clipping
polysB <- data.frame(PID=rep(1, 3), POS=1:3,
  X=c(-127.5, -124.5, -125.6), Y = c(49.2, 50.3, 48.6))
#--- intersect nepacLL with the single polygon, and plot the result
plotMap(joinPolys(nepacLL, polysB), col="cyan")
#--- add nepacLL in a different line type to emphasize the intersection
addPolys(nepacLL, border="purple", lty=3, density=0)
box()

### Example 2. Cut Texada and Lasqueti Islands out of Boxes
xlim = list(box1=c(-124.8, -124), box2=c(-124, -123.9))
ylim = list(box1=c(49.4, 49.85), box2=c(49.85, 49.9))
Xlim = extendrange(xlim); Ylim=extendrange(ylim)
polyA = as.PolySet(data.frame(
  PID = rep(1:2, each=4), POS = rep(1:4, 2),
  X = as.vector(sapply(xlim, function(x){x[c(1,1,2,2)]})),
  Y = as.vector(sapply(ylim, function(x){x[c(1,2,2,1)]})))
), projection="LL")
data(nepacLLhigh,envir=.PBSmapEnv)
polyB = nepacLLhigh[is.element(nepacLLhigh$PID,c(736,1912)),]
polyC = joinPolys(polyA, polyB, "DIFF")
par(mfrow=c(2,2), cex=1, mgp=c(2, 0.5, 0))
plotMap(polyA, col="lightblue", xlim=Xlim, ylim=Ylim)
addPolys(polyB, col="gold");
text(mean(Xlim)-0.05, Ylim-0.04, "Boxes (A,B) and Isles (C,D)")
labs = calcCentroid(polyA)
labs[1,c("X", "Y")] = labs[2,c("X", "Y")] + c(-0.1, -0.05)
text(labs[, "X"], labs[, "Y"], c("A", "B"), font=2)
plotMap(polyC[is.element(polyC$PID, 1), ], col="pink", xlim=Xlim, ylim=Ylim)
text(mean(Xlim)-0.05, Ylim-0.04, "Box A \"DIFF\" Isle C")
plotMap(polyC[is.element(polyC$PID, 3), ], col="green", xlim=Xlim, ylim=Ylim)
text(mean(Xlim)-0.05, Ylim-0.04, "Box A \"DIFF\" Isle D")
plotMap(polyC[is.element(polyC$PID, c(1,3)), ], col="cyan", xlim=Xlim, ylim=Ylim)
text(mean(Xlim)-0.05, Ylim-0.04, "Box A \"DIFF\" Isles (C,D)")
par(oldpar)
})

```

---

locateEvents

*Locate Events on the Current Plot*


---

### Description

Locate events on the current plot (using the [locator](#) function).

### Usage

```
locateEvents (EID, n = 512, type = "p", ...)
```



**Arguments**

|      |                                                                                                                               |
|------|-------------------------------------------------------------------------------------------------------------------------------|
| EID  | vector of event IDs ( <i>optional</i> ).                                                                                      |
| n    | maximum number of events to locate.                                                                                           |
| type | one of "n", "p", "l", or "o". If "p" or "o", then the points are plotted; if "l" or "o", then the points are joined by lines. |
| ...  | additional <a href="#">par</a> parameters for the <a href="#">locator</a> function.                                           |

**Details**

This function allows its user to define events with mouse clicks on the current plot via the [locator](#) function. The arguments n and type are the usual parameters of the [locator](#) function. If EID is not missing, then  $n = \text{length}(\text{EID})$ .

On exit from [locator](#), suppose the user defined  $m$  events. If EID was missing, then the output data frame will contain  $m$  events. However, if EID exists, then the output data frame will contain  $\text{length}(\text{EID})$  events, and both X and Y will be NA for events  $\text{EID}[(m+1):n]$ . The [na.omit](#) function can remove rows with NAs.

**Value**

[EventData](#) with columns EID, X, and Y, and projection attribute equal to the map's projection. The function does not set the zone attribute.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2007-06-06

**See Also**

[addPoints](#), [combineEvents](#), [convDP](#), [EventData](#), [findCells](#), [findPolys](#), [plotPoints](#).

**Examples**

```
#--- define five events on the current plot, numbering them 10 to 14
## Not run: events <- locateEvents(EID = 10:14)
```

---

locatePolys

*Locate Polygons on the Current Plot*


---

**Description**

Locate polygons on the current plot (using the [locator](#) function).

**Usage**

```
locatePolys (pdata, n = 512, type = "o", ...)
```

**Arguments**

|                    |                                                                                                                                                                                            |
|--------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>pdata</code> | <a href="#">PolyData</a> ( <i>optional</i> ) with columns <code>PID</code> and <code>SID</code> ( <i>optional</i> ), with two more optional columns <code>n</code> and <code>type</code> . |
| <code>n</code>     | maximum number of points to locate.                                                                                                                                                        |
| <code>type</code>  | one of "n", "p", "l", or "o". If "p" or "o", then the points are plotted; if "l" or "o", then the points are joined by lines.                                                              |
| <code>...</code>   | additional <a href="#">par</a> parameters for the <a href="#">locator</a> function.                                                                                                        |

**Details**

This function allows its user to define polygons with mouse clicks on the current plot via the [locator](#) function. The arguments `n` and `type` are the usual parameters for the [locator](#) function, but the user can specify them for each individual (`PID`, `SID`) in a `pdata` object.

If a `pdata` object exists, the function ignores columns other than `PID`, `SID`, `n`, and `type`. If `pdata` includes `n`, then an outer boundary has  $n > 0$  and an inner boundary has  $n < 0$ .

On exit from [locator](#), suppose the user defined  $m$  vertices for a given polygon. For that polygon, the `X` and `Y` columns will contain NAs where  $POS = (m+1):n$  for outer-boundaries and  $POS = (|n|-m):1$  for inner-boundaries. The [na.omit](#) function can remove rows with NAs.

If a `pdata` object does not exist, the output contains only one polygon with a `PID` equal to 1. One inner-boundary polygon (`POS` goes from `n` to 1) can be generated by supplying a negative `n`.

If `type = "o"` or `type = "l"`, the function draws a line connecting the last and first vertices.

**Value**

[PolySet](#) with projection attribute equal to the map's projection. The function does not set the zone attribute.

**Author(s)**

[Nicholas M. Boers](#), Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2007-06-06

**See Also**

[addPolys](#), [appendPolys](#), [clipPolys](#), [closePolys](#), [findCells](#), [findPolys](#), [fixPOS](#), [joinPolys](#), [plotMap](#), [plotPolys](#), [thickenPolys](#), [thinPolys](#).

**Examples**

```
#--- define one polygon with up to 5 vertices on the current plot
## Not run: polys <- locatePolys(n = 5)
```

## Description

A LocationSet comprises a data frame that summarises which EventData points (EID) lie in which PolySet polygons (PID) or (PID, SID). Events not located in target polygons are not reported. If an event lies on a polygon boundary, an additional LocationSet field called Bdry is set to TRUE. One event can also occur in multiple polygons.

**PBSmapping** functions that expect LocationSet's will accept properly formatted data frames in their place (see 'Details').

`as.LocationSet` attempts to coerce a data frame to an object with class LocationSet.

`is.LocationSet` returns TRUE if its argument is of class LocationSet.

## Usage

```
as.LocationSet(x)
is.LocationSet(x, fullValidation = TRUE)
```

## Arguments

`x` data frame to be coerced or tested.  
`fullValidation` Boolean value; if TRUE, fully test `x`.

## Details

A [PolySet](#) can define regional boundaries for drawing a map, and [EventData](#) can give event points on the map. Which events occur in which regions? Our function [findPolys](#) resolves this problem. The output lies in a LocationSet, a data frame with three or four columns (EID, PID, SID, Bdry), where SID may be missing. One row in a LocationSet means that the event EID occurs in the polygon (PID, SID). The boundary (Bdry) field specifies whether (Bdry=T) or not (Bdry=F) the event lies on the polygon boundary. If SID refers to an inner polygon boundary, then EID occurs in (PID, SID) only if Bdry=T. An event may occur in multiple polygons. Thus, the same EID can occur in multiple records. If an EID does not fall in any (PID, SID), or if it falls within a hole, it does not occur in the output LocationSet. Inserting the string "LocationSet" as the first element of a LocationSet's class attribute alters the behaviour of some functions, including [print](#) (if [PBSprint](#) is TRUE) and [summary](#).

## Value

The `as.LocationSet` method returns an object with classes "LocationSet" and "data.frame", in that order.

**Author(s)**

Nicholas M. Boers, Associate Professor – Computer Science  
 MacEwan University, Edmonton AB  
 Last modified Rd: 2015-04-23

**See Also**

[PolySet](#), [PolyData](#), [EventData](#)

---

 makeGrid

---

*Make a Grid of Polygons*


---

**Description**

Make a grid of polygons, using PIDs and SIDs according to the input arguments.

**Usage**

```
makeGrid(x, y, byrow=TRUE, addSID=TRUE,
         projection=NULL, zone = NULL, type="rectangle")
```

**Arguments**

|            |                                                                                                                                                                                                                                                                                                                              |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| x          | numeric – vector of X-coordinates (of length $m$ ).                                                                                                                                                                                                                                                                          |
| y          | numeric – vector of Y-coordinates (of length $n$ ).                                                                                                                                                                                                                                                                          |
| byrow      | logical – if TRUE <i>and</i> type='rectangle', increment PID along X (column-wise);<br>– if TRUE <i>and</i> type='hexagon', create flat-topped hexagons contiguous by column and increment PID by column;<br>– if FALSE <i>and</i> type='hexagon', create pointy-topped hexagons contiguous by row and increment PID by row. |
| addSID     | logical – if TRUE, include an SID field in the resulting <a href="#">PolySet</a> , incremented by the alternative dimension used by PID.                                                                                                                                                                                     |
| projection | character – optional projection attribute to add to the <a href="#">PolySet</a> .                                                                                                                                                                                                                                            |
| zone       | numeric – optional zone attribute to add to the <a href="#">PolySet</a> .                                                                                                                                                                                                                                                    |
| type       | character – type of regular tessellation; choices: "rectangle" or "hexagon".                                                                                                                                                                                                                                                 |

**Details**

This function makes a grid of polygons, labeling them according to byrow and addSID.

For rectangular tessellations (grid cells), the variables  $i$  and  $j$  indicate column and row numbers, respectively, where the lower-left cell of the grid is (1, 1):

- byrow = TRUE and addSID = FALSE implies  $PID = i + (j - 1) \times (m - 1)$
- byrow = FALSE and addSID = FALSE implies  $PID = j + (i - 1) \times (n - 1)$

- byrow = TRUE and addSID = TRUE implies PID =  $i$ , SID =  $j$
- byrow = FALSE and addSID = TRUE implies PID =  $j$ , SID =  $i$

For hexagonal tessellations (grid cells),  $i$  indicates columns for flat-topped hexagons and rows for pointy-topped hexagons. The reverse is true for  $j$ . Stemming from their six-sided nature, hexagons will adjoin along a long-edge by row when their orientation is such that one vertex is higher than all the others. Hexagons will adjoin along a long-edge by column when their orientation shows two uppermost vertices.

### Value

**PolySet** with columns PID, SID (*if* addSID=TRUE), POS, X, and Y.

The PolySet is a set of rectangular grid cells when type='rectangle', with vertices:

$(x_i, y_j), (x_{i+1}, y_j), (x_{i+1}, y_{j+1}), (x_i, y_{j+1})$ .

The PolySet is a set of hexagonal grid cells when type='hexagon'.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB

**Rowan Haigh**, Program Head – Offshore Rockfish  
Pacific Biological Station (PBS), Fisheries & Oceans Canada (DFO), Nanaimo BC  
*locus opus*: Institute of Ocean Sciences (IOS), Sidney BC  
Last modified Rd: 2019-01-04

### See Also

[addPolys](#), [clipPolys](#), [combineEvents](#), [findCells](#), [findPolys](#), [thickenPolys](#).

### Examples

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  ##--- make a 10 x 10 grid
  polyGrid <- makeGrid(x=0:10, y=0:10)
  ##--- plot the grid
  plotPolys(polyGrid, density=0, projection=1)
  par(oldpar)
})
```

---

makeProps

*Make Polygon Properties*

---

### Description

Append a column for a polygon property (e.g., border or lty) to **PolyData** based on measurements in the **PolyData**'s Z column.

**Usage**

```
makeProps(pdata, breaks, propName="col", propVals=1:(length(breaks)-1))
```

**Arguments**

|          |                                                                                                      |
|----------|------------------------------------------------------------------------------------------------------|
| pdata    | <a href="#">PolyData</a> with a Z column.                                                            |
| breaks   | either a vector of cut points or a scalar denoting the number of intervals that Z is to be cut into. |
| propName | name of the new column to append to pdata.                                                           |
| propVals | vector of values to associate with Z breaks.                                                         |

**Details**

This function acts like the [cut](#) function to produce [PolyData](#) suitable for the `polyProps` plotting argument (see [addLabels](#), [addLines](#), [addPoints](#), [addPolys](#), [addStipples](#), [plotLines](#), [plotMap](#), [plotPoints](#), and [plotPolys](#)). The Z column of `pdata` is equivalent to the data vector `x` of the `cut` function.

**Value**

[PolyData](#) with the same columns as `pdata` plus an additional column `propName`.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

**See Also**

[addLabels](#), [addLines](#), [addPoints](#), [addPolys](#), [addStipples](#), [plotLines](#), [plotMap](#), [plotPoints](#), [plotPolys](#), [PolyData](#), [PolySet](#).

**Examples**

```
local(envir=.PBSmapEnv, expr={
  #--- create a PolyData object
  pd <- data.frame(PID=1:10, Z=1:10)

  #--- using 3 intervals, create a column named `col` and populate it with
  #--- the supplied values
  makeProps(pdata=pd, breaks=3, propName="col", propVals=c(1:3))
})
```

makeTopography

*Make Topography Data from Online Source***Description**

Make topography data suitable for the 'graphics::contour' and 'grDevices::contourLines' functions using freely available global seafloor topography data.

**Usage**

```
makeTopography (dat, digits=2, func=NULL)
```

**Arguments**

|        |                                                                                                            |
|--------|------------------------------------------------------------------------------------------------------------|
| dat    | data.frame – data with three optionally-named columns: x, y, and z. The columns must appear in that order. |
| digits | numeric – integer indicating the precision to be used by the function round on (x,y) values.               |
| func   | function – to summarize z if (x,y) points are duplicated. Defaults to mean() if no function is specified.  |

**Details**

Suitable data can be obtained through the [Topex acquisition form](#). The function 'utils::read.table' will import downloaded ASCII files into R, creating objects suitable for the argument 'dat' in 'makeTopography'.

When creating data for regions with longitude values spanning -180° to 0°, consider subtracting 360 from the result's longitude coordinates (x).

When creating bathymetry data, consider negating the result's elevations (z) to give depths positive values.

Combinations of (x,y) do not need to be complete (z[x,y]=NA) or unique (z[x,y] = func(z[x,y])).

**Value**

List with elements x, y, and z. Elements x and y are vectors, while z is a matrix with rownames x and colnames y. The functions 'graphics::contour' and 'grDevices::contourLines' expect data conforming to this list format.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB

Maintainer: **Rowan Haigh**, Program Head – Offshore Rockfish  
Pacific Biological Station (PBS), Fisheries & Oceans Canada (DFO), Nanaimo BC  
*locus opus*: Institute of Ocean Sciences (IOS), Sidney BC  
Last modified Rd: 2021-01-11

**See Also**

In package **graphics**:

[contour](#)

In package **grDevices**:

[contourLines](#)

In package **PBSmapping**:

[convCP](#)

**Examples**

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- Example 1: Sample data frame and conversion.
  file <- data.frame(X=c(1,1,2,2),Y=c(3,4,3,4),Z=c(5,6,7,8))
  print(makeTopography(file))

  #--- Example 2: Aleutian Islands bathymetry
  isob <- c(100,500,1000,2500,5000)
  icol <- rgb(0,0,seq(255,100,len=length(isob)),max=255)
  afile <- paste(system.file(package="PBSmapping"),
    "/Extra/aleutian.txt",sep="")
  aleutian <- read.table(afile, header=FALSE, col.names=c("x","y","z"))
  aleutian$x <- aleutian$x - 360
  aleutian$z <- -aleutian$z
  alBathy <- makeTopography(aleutian)
  alCL <- contourLines(alBathy,levels=isob)
  alCP <- convCP(alCL)
  alPoly <- alCP$PolySet
  attr(alPoly,"projection") <- "LL"
  plotMap(alPoly, type="n", cex.axis=1.2, cex.lab=1.5)
  addLines(alPoly,col=icol)
  data(nepacLL,envir=.PBSmapEnv)
  addPolys(nepacLL,col="gold")
  legend(x="topleft",bty="n",col=icol,lwd=2,legend=as.character(isob))
  par(oldpar)
})
```

---

 nepacLL

---

*Data: Shorelines of the NE Pacific Ocean and of the World*


---

**Description**

[PolySet](#) of polygons for the shorelines of the northeast Pacific Ocean and of the world, both in normal and high resolution.

**Usage**

```
data(nepacLL)
data(nepacLLhigh)
```



```
data(worldLL)
data(worldLLhigh)
```

### Format

Data frame consisting of 4 columns: PID = primary polygon ID, POS = position of each vertex within a given polygon, X = longitude coordinate, and Y = latitude coordinate. Attributes: projection = "LL".

### Note

In R, the data must be loaded using the `data` function.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2015-01-22

### Source

Polygon data from the GSHHG (Global Self-consistent, Hierarchical, High-resolution Geography) Database.  
Download the native binary files of shoreline polygons, rivers, and borders contained in the latest zip archive (version 2.3.4 ) at <http://www.soest.hawaii.edu/pwessel/gshhg/>.

```
nepacLL <- importGSHHS("gshhs_h.b", xlim=c(-190,-110), ylim=c(34,72),
  level=1, n=15, xoff=-360)

nepacLLhigh <- importGSHHS("gshhs_f.b", xlim=c(-190,-110),
  ylim=c(34,72), level=1, n=0, xoff=-360)
nepacLLhigh <- thinPolys(nepacLLhigh, tol=0.1, filter=3)

worldLL <- importGSHHS("gshhs_l.b", xlim=c(-20,360), ylim=c(-90,90),
  level=1, n=15, xoff=0)
worldLL <- .fixGSHHSWorld(worldLL)

worldLLhigh <- importGSHHS("gshhs_i.b", xlim=c(-20,360),
  ylim=c(-90,90), level=1, n=15, xoff=0)
worldLLhigh <- .fixGSHHSWorld(worldLLhigh)
```

### References

Wessel, P. and Smith, W.H.F. (1996) A global, self-consistent, hierarchical, high-resolution shore-line database. *Journal of Geophysical Research* **101**, 8741–8743.  
[http://www.soest.hawaii.edu/pwessel/gshhg/Wessel+Smith\\_1996\\_JGR.pdf](http://www.soest.hawaii.edu/pwessel/gshhg/Wessel+Smith_1996_JGR.pdf)

**See Also**

Data:

[bcBathymetry](#), [surveyData](#), [towData](#)

Functions:

[importGSHHS](#), [importShapefile](#), [plotMap](#), [plotPolys](#), [addPolys](#), [clipPolys](#), [refocusWorld](#), [thickenPolys](#), [thinPolys](#)

---

**PBSmapping***PBS Mapping: Draw Maps and Implement Other GIS Procedures*

---

**Description**

This software has evolved from fisheries research conducted at the Pacific Biological Station (PBS) in Nanaimo, British Columbia, Canada. It extends the R language to include two-dimensional plotting features similar to those commonly available in a Geographic Information System (GIS). Embedded C code speeds algorithms from computational geometry, such as finding polygons that contain specified point events or converting between longitude-latitude and Universal Transverse Mercator (UTM) coordinates. It includes data for a global shoreline and other data sets in the public domain.

For a complete user's guide, see the file `PBSmapping-UG.pdf` in the R directory `.../library/PBSmapping/doc`.

PBSmapping includes 10 demos that appear as figures in the User's Guide. To see them, run the function `.PBSfigs()`.

More generally, a user can view all demos available from locally installed packages with the function `runDemos()` in our related (and recommended) package `PBSmodelling`.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2008-09-03

---

**PBSprint***Specify Whether to Print Summaries*

---

**Description**

Specify whether PBS Mapping should print object summaries or not. If not, data objects are displayed as normal.

**Usage**

```
PBSprint
```

**Details**

If `PBSprint = TRUE`, the mapping software will print summaries rather than the data frames for `EventData`, `LocationSet`, `PolyData`, and `PolySet` objects. If `PBSprint = FALSE`, it will print the data frames.

This variable's default value is `FALSE`.

**Value**

`TRUE` or `FALSE`, depending on the user's preference.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2007-06-06

**See Also**

[summary](#).

---

placeHoles

*Place Holes Under Solids*

---

**Description**

Place secondary polygons identified as holes (inner contours) under primary polygons identified as solids (outer contours) if the vertices of the holes lie completely within the vertices of the solids. This operation is performed for each primary polygon until all holes have been assigned.

**Usage**

```
placeHoles(polyset, minVerts=3,
           orient=FALSE, show.progress=FALSE, unique.pid=FALSE)
```

**Arguments**

|                            |                                                                                                                                                                                                                             |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>polyset</code>       | a valid <b>PBSmapping</b> <code>PolySet</code> .                                                                                                                                                                            |
| <code>minVerts</code>      | numeric – minimum number of vertices required for a polygon representing a hole to be retained (does not affect solids).                                                                                                    |
| <code>orient</code>        | logical – if <code>TRUE</code> , use each polygon's rotation to determine its nature: clockwise = solid (outer contour), counter-clockwise = hole (inner contour).                                                          |
| <code>show.progress</code> | logical – if <code>TRUE</code> , display on the command console the progress of placing holes under solids.                                                                                                                 |
| <code>unique.pid</code>    | logical – if <code>TRUE</code> , ignore the input PIDs and redefine them from 1 to the number of solids; this inherently destroys the previous organisation that a creator may have intended for the <code>PolySet</code> . |

## Details

The algorithm identifies outer contours (solids) and inner contours (holes) using either the default PBSmapping method (solids = increasing "POS", holes = decreasing "POS") or the rotational direction of the polygons (solids = clockwise, holes = counter-clockwise).

It then systematically starts matching holes with solids based on their vertices being completely within the boundaries of the solid. If a hole happens to match a current solid completely (all vertices on the boundary), then the hole is not matched to this solid because it is a hole in another solid that creates space for the current solid.

To facilitate computation, the algorithm assumes that once a hole is located in a solid, it will not occur in any other solid. This means that for each successive solid, the number of candidate holes will either decrease or stay the same.

This function makes use of the PBSmapping hidden function ".is.in" which uses the C code "findPolys". The latter only returns events found in a polygon (or on the boundary) but .is.in evaluates all events and returns a list containing:

"e.in" – events within the polygon,

"e.out" – events outside the polygon,

"all.in" – logical value of whether all events are in the polygon,

"all.out" – logical value of whether all events are outside the polygon,

"all.bdry" – logical value of whether all events occur on the boundary of the polygon

## Value

Returns the input PolySet where holes have been arranged beneath appropriate solids for each PID (original or redefined).

## Author(s)

**Rowan Haigh**, Program Head – Offshore Rockfish  
Pacific Biological Station (PBS), Fisheries & Oceans Canada (DFO), Nanaimo BC  
*locus opus*: Institute of Ocean Sciences (IOS), Sidney BC  
Last modified Rd: 2019-03-14

## See Also

In package **PBSmapping**:  
[findPolys](#), [importShapefile](#), [is.PolySet](#) in [PolySet](#)

---

plotLines

*Plot a PolySet as PolyLines*

---

## Description

Plot a [PolySet](#) as polylines.

**Usage**

```
plotLines (polys, xlim = NULL, ylim = NULL, projection = FALSE,
          plt = c(0.11, 0.98, 0.12, 0.88), polyProps = NULL,
          lty = NULL, col = NULL, bg = 0, axes = TRUE,
          tckLab = TRUE, tck = 0.014, tckMinor = 0.5 * tck, ...)
```

**Arguments**

|            |                                                                                                                                                                                                                                                                                                                              |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| polys      | <a href="#">PolySet</a> to plot ( <i>required</i> ).                                                                                                                                                                                                                                                                         |
| xlim       | range of X-coordinates.                                                                                                                                                                                                                                                                                                      |
| ylim       | range of Y-coordinates.                                                                                                                                                                                                                                                                                                      |
| projection | desired projection when <a href="#">PolySet</a> lacks a projection attribute; one of "LL", "UTM", or a numeric value. If Boolean, specifies whether to check polys for a projection attribute.                                                                                                                               |
| plt        | four element numeric vector (x1, x2, y1, y2) giving the coordinates of the plot region measured as a fraction of the figure region. Set to NULL if mai in par is desired.                                                                                                                                                    |
| polyProps  | <a href="#">PolyData</a> specifying which polylines to plot and their properties. <a href="#">par</a> parameters passed as direct arguments supersede these data.                                                                                                                                                            |
| lty        | vector describing line types (cycled by PID).                                                                                                                                                                                                                                                                                |
| col        | vector describing colours (cycled by PID).                                                                                                                                                                                                                                                                                   |
| bg         | background colour of the plot.                                                                                                                                                                                                                                                                                               |
| axes       | Boolean value; if TRUE, plot axes.                                                                                                                                                                                                                                                                                           |
| tckLab     | Boolean vector (length 1 or 2); if TRUE, label the major tick marks. If given a two-element vector, the first element describes the tick marks on the x-axis and the second element describes those on the y-axis.                                                                                                           |
| tck        | numeric vector (length 1 or 2) describing the length of tick marks as a fraction of the smallest dimension. If tckLab = TRUE, these tick marks will be automatically labelled. If given a two-element vector, the first element describes the tick marks on the x-axis and the second element describes those on the y-axis. |
| tckMinor   | numeric vector (length 1 or 2) describing the length of tick marks as a fraction of the smallest dimension. These tick marks can not be automatically labelled. If given a two-element vector, the first element describes the tick marks on the x-axis and the second element describes those on the y-axis.                |
| ...        | additional <a href="#">par</a> parameters, or the arguments main, sub, xlab, or ylab for the <a href="#">title</a> function.                                                                                                                                                                                                 |

**Details**

This function plots a [PolySet](#), where each unique (PID, SID) describes a polyline. It does not connect each polyline's last vertex to its first. Unlike [plotMap](#), the function ignores the aspect ratio. It clips polys to xlim and ylim before plotting.

The function creates a blank plot when polys equals NULL. In this case, the user must supply both xlim and ylim arguments. Alternatively, it accepts the argument type = "n" as part of ..., which

is equivalent to specifying `polys = NULL`, but requires a [PolySet](#). In both cases, the function's behaviour changes slightly. To resemble the `plot` function, it plots the border, labels, and other parts according to `par` parameters such as `col`.

For additional help on the arguments `lty` and `col`, please see [par](#).

### Value

[PolyData](#) consisting of the `PolyProps` used to create the plot.

### Note

To satisfy the aspect ratio, this plotting routine resizes the plot region. Consequently, `par` parameters such as `plt`, `mai`, and `mar` will change. When the function terminates, these changes persist to allow for additions to the plot.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

### See Also

[addLines](#), [calcLength](#), [clipLines](#), [closePolys](#), [convLP](#), [fixBound](#), [fixPOS](#),  
[locatePolys](#), [thinPolys](#), [thickenPolys](#).

### Examples

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- create a PolySet to plot
  polys <- data.frame(PID=rep(1,4),POS=1:4,X=c(0,1,1,0),Y=c(0,0,1,1))
  #--- plot the PolySet
  plotLines(polys, xlim=c(-.5,1.5), ylim=c(-.5,1.5))
  par(oldpar)
})
```

---

plotMap

*Plot a PolySet as a Map*

---

### Description

Plot a [PolySet](#) as a map, using the correct aspect ratio.

**Usage**

```
plotMap (polys, xlim = NULL, ylim = NULL, projection = TRUE,
        plt = c(0.11, 0.98, 0.12, 0.88), polyProps = NULL,
        border = NULL, lty = NULL, col = NULL, colHoles = NULL,
        density = NA, angle = NULL, bg = 0, axes = TRUE,
        tckLab = TRUE, tck = 0.014, tckMinor = 0.5 * tck, ...)
```

**Arguments**

|            |                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| polys      | <a href="#">PolySet</a> to plot ( <i>required</i> ).                                                                                                                                                                                                                                                                                                                                                                    |
| xlim       | range of X-coordinates.                                                                                                                                                                                                                                                                                                                                                                                                 |
| ylim       | range of Y-coordinates.                                                                                                                                                                                                                                                                                                                                                                                                 |
| projection | desired projection when <a href="#">PolySet</a> lacks a projection attribute; one of "LL", "UTM", or a numeric value. If Boolean, specifies whether to check polys for a projection attribute.                                                                                                                                                                                                                          |
| plt        | four element numeric vector (x1, x2, y1, y2) giving the coordinates of the plot region measured as a fraction of the figure region. Set to NULL if mai in par is desired.                                                                                                                                                                                                                                               |
| polyProps  | <a href="#">PolyData</a> specifying which polygons to plot and their properties. <a href="#">par</a> parameters passed as direct arguments supersede these data.                                                                                                                                                                                                                                                        |
| border     | vector describing edge colours (cycled by PID).                                                                                                                                                                                                                                                                                                                                                                         |
| lty        | vector describing line types (cycled by PID).                                                                                                                                                                                                                                                                                                                                                                           |
| col        | vector describing fill colours (cycled by PID).                                                                                                                                                                                                                                                                                                                                                                         |
| colHoles   | vector describing hole colours (cycled by PID). The default, NULL, should be used in most cases as it renders holes transparent. colHoles is designed solely to eliminate retrace lines when images are converted to PDF format. If colHoles is specified, underlying information (i.e., previously plotted shapes) will be obliterated. If NA is specified, only outer polygons are drawn, consequently filling holes. |
| density    | vector describing shading line densities (lines per inch, cycled by PID).                                                                                                                                                                                                                                                                                                                                               |
| angle      | vector describing shading line angles (degrees, cycled by PID).                                                                                                                                                                                                                                                                                                                                                         |
| bg         | background colour of the plot.                                                                                                                                                                                                                                                                                                                                                                                          |
| axes       | Boolean value; if TRUE, plot axes.                                                                                                                                                                                                                                                                                                                                                                                      |
| tckLab     | Boolean vector (length 1 or 2); if TRUE, label the major tick marks. If given a two-element vector, the first element describes the tick marks on the x-axis and the second element describes those on the y-axis.                                                                                                                                                                                                      |
| tck        | numeric vector (length 1 or 2) describing the length of tick marks as a fraction of the smallest dimension. If tckLab = TRUE, these tick marks will be automatically labelled. If given a two-element vector, the first element describes the tick marks on the x-axis and the second element describes those on the y-axis.                                                                                            |
| tckMinor   | numeric vector (length 1 or 2) describing the length of tick marks as a fraction of the smallest dimension. These tick marks can not be automatically labelled. If given a two-element vector, the first element describes the tick marks on the x-axis and the second element describes those on the y-axis.                                                                                                           |

... additional [par](#) parameters, or the arguments `main`, `sub`, `xlab`, or `ylab` for the `title` function.

### Details

This function plots a [PolySet](#), where each unique (PID, SID) describes a polygon. It connects each polygon's last vertex to its first. The function supports both borders (`border`, `lty`) and fills (`col`, `density`, `angle`). When supplied with the appropriate arguments, it can draw only borders or only fills. Unlike [plotLines](#) and [plotPolys](#), it uses the aspect ratio supplied in the projection attribute of `polys`. If this attribute is missing, it attempts to use its projection argument. In the absence of both, it uses a default aspect ratio of 1:1. It clips `polys` to `xlim` and `ylim` before plotting.

The function creates a blank plot when `polys` equals `NULL`. In this case, the user must supply both `xlim` and `ylim` arguments. Alternatively, it accepts the argument `type = "n"` as part of `...`, which is equivalent to specifying `polys = NULL`, but requires a [PolySet](#). In both cases, the function's behaviour changes slightly. To resemble the [plot](#) function, it plots the border, labels, and other parts according to [par](#) parameters such as `col`.

For additional help on the arguments `border`, `lty`, `col`, `density`, and `angle`, please see [polygon](#) and [par](#).

### Value

[PolyData](#) consisting of the `PolyProps` used to create the plot.

### Note

To satisfy the aspect ratio, this plotting routine resizes the plot region. Consequently, [par](#) parameters such as `plt`, `mai`, and `mar` will change. When the function terminates, these changes persist to allow for additions to the plot.

### Author(s)

[Nicholas M. Boers](#), Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

### See Also

[addLabels](#), [addPolys](#), [addStipples](#), [clipPolys](#), [closePolys](#), [fixBound](#), [fixPOS](#), [locatePolys](#), [plotLines](#), [plotPoints](#), [thinPolys](#), [thickenPolys](#).

### Examples

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- create a PolySet to plot
  polys <- data.frame(PID=rep(1,4),POS=1:4,X=c(0,1,1,0),Y=c(0,0,1,1))
  #--- plot the PolySet
  plotMap(polys,xlim=c(-.5,1.5),ylim=c(-.5,1.5),density=0,projection=1)
  par(oldpar)
})
```



---

plotPoints *Plot EventData/PolyData as Points*

---

### Description

Plot [EventData/PolyData](#), where each unique EID or (PID, SID) describes a point.

### Usage

```
plotPoints (data, xlim = NULL, ylim = NULL, projection = FALSE,
           plt = c(0.11, 0.98, 0.12, 0.88), polyProps = NULL,
           cex = NULL, col = NULL, pch = NULL, axes = TRUE,
           tckLab = TRUE, tck = 0.014, tckMinor = 0.5 * tck, ...)
```

### Arguments

|            |                                                                                                                                                                                                                                                                                                                              |
|------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| data       | <a href="#">EventData</a> or <a href="#">PolyData</a> to plot ( <i>required</i> ).                                                                                                                                                                                                                                           |
| xlim       | range of X-coordinates.                                                                                                                                                                                                                                                                                                      |
| ylim       | range of Y-coordinates.                                                                                                                                                                                                                                                                                                      |
| projection | desired projection when <a href="#">PolySet</a> lacks a projection attribute; one of "LL", "UTM", or a numeric value. If Boolean, specifies whether to check polys for a projection attribute.                                                                                                                               |
| plt        | four element numeric vector (x1, x2, y1, y2) giving the coordinates of the plot region measured as a fraction of the figure region. Set to NULL if mai in par is desired.                                                                                                                                                    |
| polyProps  | <a href="#">PolyData</a> specifying which points to plot and their properties. <a href="#">par</a> parameters passed as direct arguments supersede these data.                                                                                                                                                               |
| cex        | vector describing character expansion factors (cycled by EID or PID).                                                                                                                                                                                                                                                        |
| col        | vector describing colours (cycled by EID or PID).                                                                                                                                                                                                                                                                            |
| pch        | vector describing plotting characters (cycled by EID or PID).                                                                                                                                                                                                                                                                |
| axes       | Boolean value; if TRUE, plot axes.                                                                                                                                                                                                                                                                                           |
| tckLab     | Boolean vector (length 1 or 2); if TRUE, label the major tick marks. If given a two-element vector, the first element describes the tick marks on the x-axis and the second element describes those on the y-axis.                                                                                                           |
| tck        | numeric vector (length 1 or 2) describing the length of tick marks as a fraction of the smallest dimension. If tckLab = TRUE, these tick marks will be automatically labelled. If given a two-element vector, the first element describes the tick marks on the x-axis and the second element describes those on the y-axis. |
| tckMinor   | numeric vector (length 1 or 2) describing the length of tick marks as a fraction of the smallest dimension. These tick marks can not be automatically labelled. If given a two-element vector, the first element describes the tick marks on the x-axis and the second element describes those on the y-axis.                |
| ...        | additional <a href="#">par</a> parameters, or the arguments main, sub, xlab, or ylab for the <a href="#">title</a> function.                                                                                                                                                                                                 |

## Details

This function clips data to `xlim` and `ylim` before plotting. It only adds [PolyData](#) containing X and Y columns.

The function creates a blank plot when `polys` equals `NULL`. In this case, the user must supply both `xlim` and `ylim` arguments. Alternatively, it accepts the argument `type = "n"` as part of `...`, which is equivalent to specifying `polys = NULL`, but requires a [PolySet](#). In both cases, the function's behaviour changes slightly. To resemble the [plot](#) function, it plots the border, labels, and other parts according to [par](#) parameters such as `col`.

For additional help on the arguments `cex`, `col`, and `pch`, please see [par](#).

## Value

[PolyData](#) consisting of the `PolyProps` used to create the plot.

## Note

To satisfy the aspect ratio, this plotting routine resizes the plot region. Consequently, [par](#) parameters such as `plt`, `mai`, and `mar` will change. When the function terminates, these changes persist to allow for additions to the plot.

## Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

## See Also

[addPoints](#), [combineEvents](#), [convDP](#), [findPolys](#), [locateEvents](#).

## Examples

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- load the data (if using R)
  if (!is.null(version$language) && (version$language=="R"))
    data(nepacLL,surveyData,envir=.PBSmapEnv)
  #--- plot a map
  plotMap(nepacLL, xlim=c(-136, -125), ylim=c(48, 57))
  #--- add events
  addPoints(surveyData, col=1:7)
  par(oldpar)
})
```

---

|           |                                   |
|-----------|-----------------------------------|
| plotPolys | <i>Plot a PolySet as Polygons</i> |
|-----------|-----------------------------------|

---

**Description**

Plot a [PolySet](#) as polygons.

**Usage**

```
plotPolys (polys, xlim = NULL, ylim = NULL, projection = FALSE,
           plt = c(0.11, 0.98, 0.12, 0.88), polyProps = NULL,
           border = NULL, lty = NULL, col = NULL, colHoles = NULL,
           density = NA, angle = NULL, bg = 0, axes = TRUE,
           tckLab = TRUE, tck = 0.014, tckMinor = 0.5 * tck, ...)
```

**Arguments**

|            |                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| polys      | <a href="#">PolySet</a> to plot ( <i>required</i> ).                                                                                                                                                                                                                                                                                                                                                                    |
| xlim       | range of X-coordinates.                                                                                                                                                                                                                                                                                                                                                                                                 |
| ylim       | range of Y-coordinates.                                                                                                                                                                                                                                                                                                                                                                                                 |
| projection | desired projection when <a href="#">PolySet</a> lacks a projection attribute; one of "LL", "UTM", or a numeric value. If Boolean, specifies whether to check polys for a projection attribute.                                                                                                                                                                                                                          |
| plt        | four element numeric vector (x1, x2, y1, y2) giving the coordinates of the plot region measured as a fraction of the figure region. Set to NULL if mai in par is desired.                                                                                                                                                                                                                                               |
| polyProps  | <a href="#">PolyData</a> specifying which polygons to plot and their properties. <a href="#">par</a> parameters passed as direct arguments supersede these data.                                                                                                                                                                                                                                                        |
| border     | vector describing edge colours (cycled by PID).                                                                                                                                                                                                                                                                                                                                                                         |
| lty        | vector describing line types (cycled by PID).                                                                                                                                                                                                                                                                                                                                                                           |
| col        | vector describing fill colours (cycled by PID).                                                                                                                                                                                                                                                                                                                                                                         |
| colHoles   | vector describing hole colours (cycled by PID). The default, NULL, should be used in most cases as it renders holes transparent. colHoles is designed solely to eliminate retrace lines when images are converted to PDF format. If colHoles is specified, underlying information (i.e., previously plotted shapes) will be obliterated. If NA is specified, only outer polygons are drawn, consequently filling holes. |
| density    | vector describing shading line densities (lines per inch, cycled by PID).                                                                                                                                                                                                                                                                                                                                               |
| angle      | vector describing shading line angles (degrees, cycled by PID).                                                                                                                                                                                                                                                                                                                                                         |
| bg         | background colour of the plot.                                                                                                                                                                                                                                                                                                                                                                                          |
| axes       | Boolean value; if TRUE, plot axes.                                                                                                                                                                                                                                                                                                                                                                                      |

|          |                                                                                                                                                                                                                                                                                                                              |
|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| tckLab   | Boolean vector (length 1 or 2); if TRUE, label the major tick marks. If given a two-element vector, the first element describes the tick marks on the x-axis and the second element describes those on the y-axis.                                                                                                           |
| tck      | numeric vector (length 1 or 2) describing the length of tick marks as a fraction of the smallest dimension. If tckLab = TRUE, these tick marks will be automatically labelled. If given a two-element vector, the first element describes the tick marks on the x-axis and the second element describes those on the y-axis. |
| tckMinor | numeric vector (length 1 or 2) describing the length of tick marks as a fraction of the smallest dimension. These tick marks can not be automatically labelled. If given a two-element vector, the first element describes the tick marks on the x-axis and the second element describes those on the y-axis.                |
| ...      | additional <code>par</code> parameters, or the arguments <code>main</code> , <code>sub</code> , <code>xlab</code> , or <code>ylab</code> for the <code>title</code> function.                                                                                                                                                |

### Details

This function plots a [PolySet](#), where each unique (PID, SID) describes a polygon. It connects each polygon's last vertex to its first. The function supports both borders (`border`, `lty`) and fills (`col`, `density`, `angle`). When supplied with the appropriate arguments, it can draw only borders or only fills. Unlike [plotMap](#), it ignores the aspect ratio. It clips polys to `xlim` and `ylim` before plotting.

This function creates a blank plot when polys equals NULL. In this case, the user must supply both `xlim` and `ylim` arguments. Alternatively, it accepts the argument `type = "n"` as part of `...`, which is equivalent to specifying `polys = NULL`, but requires a [PolySet](#). In both cases, the function's behaviour changes slightly. To resemble the [plot](#) function, it plots the border, labels, and other parts according to `par` parameters such as `col`.

For additional help on the arguments `border`, `lty`, `col`, `density`, and `angle`, please see [polygon](#) and [par](#).

### Value

[PolyData](#) consisting of the `PolyProps` used to create the plot.

### Note

To satisfy the aspect ratio, this plotting routine resizes the plot region. Consequently, `par` parameters such as `plt`, `mai`, and `mar` will change. When the function terminates, these changes persist to allow for additions to the plot.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

### See Also

[addLabels](#), [addPolys](#), [addStipples](#), [clipPolys](#), [closePolys](#), [fixBound](#), [fixPOS](#), [locatePolys](#), [plotLines](#), [plotMap](#), [plotPoints](#), [thinPolys](#), [thickenPolys](#).

**Examples**

```

local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- create a PolySet to plot
  polys <- data.frame(PID=rep(1,4),POS=1:4,X=c(0,1,1,0),Y=c(0,0,1,1))
  #--- plot the PolySet
  plotPolys(polys, xlim=c(-.5,1.5), ylim=c(-.5,1.5), density=0)
  par(oldpar)
})

```

PolyData

*PolyData Objects***Description**

A PolyData object comprises a data frame that summarises information for each polyline/polygon in a PolySet; each PolyData record is defined by a unique PID or (PID, SID combination).

**PBSmapping** functions that expect PolyData will accept properly formatted data frames in their place (see 'Details').

`as.PolyData` attempts to coerce a data frame to an object with class PolyData.

`is.PolyData` returns TRUE if its argument is of class PolyData.

**Usage**

```

as.PolyData(x, projection = NULL, zone = NULL)
is.PolyData(x, fullValidation = TRUE)

```

**Arguments**

|                             |                                                                                               |
|-----------------------------|-----------------------------------------------------------------------------------------------|
| <code>x</code>              | data frame to be coerced or tested.                                                           |
| <code>projection</code>     | optional projection attribute to add to PolyData, possibly overwriting an existing attribute. |
| <code>zone</code>           | optional zone attribute to add to PolyData, possibly overwriting an existing attribute.       |
| <code>fullValidation</code> | Boolean value; if TRUE, fully test x.                                                         |

**Details**

We define PolyData as a data frame with a first column named PID and (optionally) a second column named SID. Unlike a [PolySet](#), where each contour has many records corresponding to the vertices, a PolyData object must have only one record for each PID or each (PID, SID) combination. Conceptually, this object associates data with contours, where the data correspond to additional fields in the data frame. The R language conveniently allows data frames to contain fields of various atomic modes ("logical", "numeric", "complex", "character", and "null"). For example, PolyData with the fields (PID, PName) might assign character names to a set of primary polygons. Additionally, if fields X and Y exist (perhaps representing locations for placing labels), consider

adding attributes `zone` and `projection`. Inserting the string "PolyData" as the class attribute's first element alters the behaviour of some functions, including `print` (if `PBSprint` is TRUE) and `summary`.

Our software particularly uses PolyData to set various plotting characteristics. Consistent with graphical parameters used by the R/S functions `lines` and `polygon`, column names can specify graphical properties:

- `lty` - line type in drawing the border and/or shading lines;
- `col` - line or fill colour;
- `border` - border colour;
- `density` - density of shading lines;
- `angle` - angle of shading lines.

When drawing polylines (as opposed to closed polygons), only `lty` and `col` have meaning.

### Value

The `as.PolyData` method returns an object with classes "PolyData" and "data.frame", in that order.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2015-04-23

### See Also

[PolySet](#), [EventData](#), [LocationSet](#)

---

PolySet

*PolySet Objects*

---

### Description

A PolySet object comprises a data frame that defines a collection of polygonal contours (i.e., line segments joined at vertices). These contours can be open-ended (polylines) or closed (polygons).

**PBSmapping** functions that expect PolySet's will accept properly formatted data frames in their place (see 'Details').

`as.PolySet` attempts to coerce a data frame to an object with class PolySet.

`is.PolySet` returns TRUE if its argument is of class PolySet.

### Usage

```
as.PolySet(x, projection = NULL, zone = NULL)
is.PolySet(x, fullValidation = TRUE)
```

## Arguments

|                |                                                                                                  |
|----------------|--------------------------------------------------------------------------------------------------|
| x              | data frame to be coerced or tested.                                                              |
| projection     | optional projection attribute to add to the PolySet, possibly overwriting an existing attribute. |
| zone           | optional zone attribute to add to the PolySet, possibly overwriting an existing attribute.       |
| fullValidation | Boolean value; if TRUE, fully test x.                                                            |

## Details

In our software, a PolySet data frame defines a collection of polygonal contours (i.e., line segments joined at vertices), based on four or five numerical fields:

- PID - the primary identification number for a contour;
- SID - optional, the secondary identification number for a contour;
- POS - the position number associated with a vertex;
- X - the horizontal coordinate at a vertex;
- Y - the vertical coordinate at a vertex.

The simplest PolySet lacks an SID column, and each PID corresponds to a different contour. By analogy with a child's "follow the dots" game, the POS field enumerates the vertices to be connected by straight lines. Coordinates (X, Y) specify the location of each vertex. Thus, in familiar mathematical notation, a contour consists of  $n$  points  $(x_i, y_i)$  with  $i = 1, \dots, n$ , where  $i$  corresponds to the POS index. A PolySet has two potential interpretations. The first associates a line segment with each successive pair of points from 1 to  $n$ , giving a *polyline* (in GIS terminology) composed of the sequential segments. The second includes a final line segment joining points  $n$  and 1, thus giving a *polygon*.

The secondary ID field allows us to define regions as composites of polygons. From this point of view, each primary ID identifies a collection of polygons distinguished by secondary IDs. For example, a single management area (PID) might consist of two fishing areas, each defined by a unique SID. A secondary polygon can also correspond to an inner boundary, like the hole in a doughnut. We adopt the convention that POS goes from 1 to  $n$  along an outer boundary, but from  $n$  to 1 along an inner boundary, regardless of rotational direction. This contrasts with other GIS software, such as ArcView (ESRI 1996), in which outer and inner boundaries correspond to clockwise and counter-clockwise directions, respectively.

The SID field in a PolySet with secondary IDs must have integer values that appear in ascending order for a given PID. Furthermore, inner boundaries must follow the outer boundary that encloses them. The POS field for each contour (PID, SID) must similarly appear as integers in strictly increasing or decreasing order, for outer and inner boundaries respectively. If the POS field erroneously contains floating-point numbers, `fixPOS` can renumber them as sequential integers, thus simplifying the insertion of a new point, such as point 3.5 between points 3 and 4.

A PolySet can have a `projection` attribute, which may be missing, that specifies a map projection. In the current version of PBS Mapping, projection can have character values "LL" or "UTM", referring to "Longitude-Latitude" and "Universal Transverse Mercator". We explain these projections more completely below. If projection is numeric, it specifies the aspect ratio  $r$ , the number of  $x$  units per  $y$  unit. Thus,  $r$  units of  $x$  on the graph occupy the same distance as one unit of  $y$ . Another

optional attribute zone specifies the UTM zone (if projection="UTM") or the preferred zone for conversion from Longitude-Latitude (if projection="LL").

A data frame's class attribute by default contains the string "data.frame". Inserting the string "PolySet" as the class vector's first element alters the behaviour of some functions. For example, the [summary](#) function will print details specific to a PolySet. Also, when [PBSprint](#) is TRUE, the print function will display a PolySet's summary rather than the contents of the data frame.

### Value

The `as.PolySet` method returns an object with classes "PolySet" and "data.frame", in that order.

### Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2022-09-06

### References

Environmental Systems Research Institute (ESRI). (1996) *ArcView GIS: The Geographic Information System for Everyone*. ESRI Press, Redlands, California. 340 pp.

### See Also

[PolyData](#), [EventData](#), [LocationSet](#)

---

print

*Print PBS Mapping Objects*

---

### Description

This function displays information about a PBS Mapping object.

Functions 'summary.EventData', 'summary.LocationSet', 'summary.PolyData', and 'summary.PolySet' produce an object with class 'summary.PBS'.

### Usage

```
## S3 method for class 'EventData'
print(x, ...)
## S3 method for class 'LocationSet'
print(x, ...)
## S3 method for class 'PolyData'
print(x, ...)
## S3 method for class 'PolySet'
print(x, ...)
## S3 method for class 'summary.PBS'
print(x, ...)
```



**Arguments**

`x` object – a PBS Mapping object of appropriate class.  
`...` dots – additional arguments to [print](#).

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
 MacEwan University, Edmonton AB  
 Last modified Rd: 2019-03-14

**See Also**

In package **PBSmapping**:  
 Data structures: [EventData](#), [LocationSet](#), [PolyData](#), [PolySet](#)  
 Functions: [PBSprint](#), [summary](#)

**Examples**

```
local(envir=.PBSmapEnv,expr={
  #--- load the data (if using R)
  if (!is.null(version$language) && (version$language=="R"))
    data(nepacLL,envir=.PBSmapEnv)
  #--- change to summary printing style
  PBSprint <- TRUE
  #--- print the PolySet
  print(nepacLL)
})
```

---

 pythagoras

*Data: Pythagoras' Theorem Diagram PolySet*


---

**Description**

[PolySet](#) of shapes to prove Pythagoras' Theorem:  $a^2 + b^2 = c^2$ .

**Usage**

```
data(pythagoras)
```

**Format**

4 column data frame: PID = primary polygon ID, POS = position of each vertex within a given polyline, X = X-coordinate, and Y = Y-coordinate. Attributes: projection = 1.

**Note**

In R, the data must be loaded using the [data](#) function.

**Author(s)**

Nicholas M. Boers, Associate Professor – Computer Science  
 MacEwan University, Edmonton AB  
 Last modified Rd: 2022-09-06

**Source**

An artificial construct to illustrate the proof of Pythagoras' Theorem using trigonometry.

**See Also**

[addPolys](#), [plotPolys](#), [plotMap](#), [PolySet](#).

---

 refocusWorld

*Refocus the worldLL/worldLLhigh Data Sets*


---

**Description**

Refocus the worldLL/worldLLhigh data sets, e.g., refocus them so that Eastern Canada appears to the west of Western Europe.

**Usage**

```
refocusWorld (polys, xlim=NULL, ylim=NULL, clip.AN=TRUE)
```

**Arguments**

|         |                                                                                                                                       |
|---------|---------------------------------------------------------------------------------------------------------------------------------------|
| polys   | PolySet – object with one or more polygons; typically worldLL or worldLLhigh ( <i>required</i> ).                                     |
| xlim    | numeric – range of X-coordinates.                                                                                                     |
| ylim    | numeric – range of Y-coordinates.                                                                                                     |
| clip.AN | logical – if TRUE, clip expanded Antarctica to 'xlim' of refocused polygons other than Antarctica and to user-defined/default 'ylim'. |

**Details**

This function accepts a [PolySet](#) containing one or more polygons with X-coordinates that collectively span approximately 360 degrees. The function effectively joins the [PolySet](#) into a cylinder and then splits it at an arbitrary longitude according to the user-specified limits. Modifications in the resulting [PolySet](#) are restricted to shifting X-coordinates by +/- multiples of 360 degrees, and instead of clipping polygons, the return value simply omits out-of-range polygons.

**Value**

[PolySet](#), likely a subset of the input [PolySet](#), which retains the same PID/SID values.

**Note**

The Antarctic polygon is treated as a special case in that it is expanded longitudinally by duplicating it to the West and East of the base polygon. The expanded Antarctica is then clipped to the limits of the plot, or not if 'clip.NA=FALSE'.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB

**Rowan Haigh**, Program Head – Offshore Rockfish  
Pacific Biological Station (PBS), Fisheries & Oceans Canada (DFO), Nanaimo BC  
*locus opus*: Institute of Ocean Sciences (IOS), Sidney BC  
Last modified Rd: 2018-10-26

**See Also**

[joinPolys](#)

**Examples**

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- load appropriate data
  data(worldLL,envir=.PBSmapEnv)
  #--- set limits
  xlim <- c(-100,25)
  ylim <- c(0,90)
  #--- refocus and plot the world
  polys <- refocusWorld(worldLL, xlim, ylim)
  plotMap(polys, xlim, ylim)
  par(oldpar)
})
```

---

RGB2RYB

*Convert RGB to RYB and RYB to RGB*

---

**Description**

Convert RGB (red-green-blue) colours to RYB (red-yellow-blue) colours, and vice versa. Algorithm based on Sugita and Takahashi (2015, 2017)

**Usage**

```
RGB2RYB(GBmat)
RYB2RGB(RYBmat)
```

### Arguments

|        |                                                                                                                                                                                                                                       |
|--------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RGBmat | numeric – matrix of red-green-blue primary colors by column, where rows are individual records of the three primary (RGB) colours. User can specify RGB in terms of 0-1 or 0-255; however, the algorithm converts the latter to 0-1.  |
| RYBmat | numeric – matrix of red-yellow-blue primary colors by column, where rows are individual records of the three primary (RYB) colours. User can specify RYB in terms of 0-1 or 0-255; however, the algorithm converts the latter to 0-1. |

### Details

The RYB colour wheel is more commonly used by artists, and provides a more intuitive system when blending colours – red and yellow makes orange, yellow and blue makes green, blue and red makes purple. On the RYB colour wheel, red lies opposite green, but on the RGB colour wheel, red lies opposite cyan.

### Value

Matrix of RGB or RYB primary colour intensities, where rows are records and columns are primary colours.

### Note

Opposite colours calculated in RYB space (1-RYB) are not always what one expects. For example the colour "purple", RGB {160, 32, 240}, might better be specified as RGB {126, 0, 255} before converting to RYB and inverting.

### Author(s)

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Pacific Biological Station (PBS), Fisheries & Oceans Canada (DFO), Nanaimo BC  
*locus opus*: Regional Headquarters, Vancouver BC  
Last modified Rd: 2022-07-06

### References

- Sugita, J. and Takahashi, T. (2017) **Computational RYB Color Model and its Applications**. *IEEE Transactions on Image Electronics and Visual Computing* 5(2): 110-122.
- Sugita, J. and Takahashi, T. (2015) **RYB Color Compositing**. International Workshop on Applications in Information Technology, October 8-10, 2015.

### See Also

In package **PBSmapping**:  
[addBubbles](#)

In package **grDevices**:  
[col2rgb](#), [rgb](#), [rgb2hsv](#)

---

 rotatePolys                      *Rotate Polygons and Events*


---

**Description**

Rotate a PolySet (or an EventData set) clockwise by a specified angle around a fixed point.

**Usage**

```
rotatePolys(polys, angle=40, centroid=c(500,5700),
            proj.out, zone, xlim=c(-135,-121.5), ylim=c(47,56),
            plot=FALSE, keep.extra=FALSE, ...)
```

```
rotateEvents(data, angle=40, centroid=c(500,5700),
            proj.out, zone, plot=FALSE, keep.extra=FALSE, ...)
```

**Arguments**

|            |                                                                                                                                                                                                                                              |
|------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| polys      | PolySet – data frame with fields 'PID', 'SID', 'POS', 'X', 'Y', and attribute 'projection' set to either "LL" or "UTM".                                                                                                                      |
| data       | EventData – data frame with fields 'EID', 'POS', 'X', 'Y', and attribute 'projection' set to either "LL" or "UTM".                                                                                                                           |
| angle      | numeric – angle between 0 and 360 degrees for map rotation in a clockwise direction.                                                                                                                                                         |
| centroid   | numeric – fixed UTM point, specified in km, around which the map will be rotated. Rotation is performed in UTM space regardless of the input and output projections. If user specifies 'NULL' or 'NA', the centroid of the map will be used. |
| proj.out   | character – desired output projection, where choices are 'LL' or 'UTM'. If 'proj.out' is not specified, the output projection will be the same as the projection of the input object.                                                        |
| zone       | numeric – UTM zone used for rotation; if not supplied, the zone is set to 9.                                                                                                                                                                 |
| xlim       | numeric – two-element vector specifying the limits of X using units (degrees or km) that match the input projection.                                                                                                                         |
| ylim       | numeric – two-element vector specifying the limits of Y using units (degrees or km) that match the input projection.                                                                                                                         |
| plot       | logical – if TRUE, plot the results of the rotation.                                                                                                                                                                                         |
| keep.extra | logical – if TRUE, keep the coordinates of initial and intermediate steps in the rotation process in addition to the final rotated coordinates of the desired projection.                                                                    |
| ...        | dots – additional arguments for 'plotMap' (in 'rotatePolys') or 'plotPoints' (in 'rotateEvents').                                                                                                                                            |

## Details

Map rotation returns coordinates that are no longer meaningful with respect to the original coordinate system. When displaying rotated maps, the user might wish to turn off axis labels using `xaxt="n"` and `yaxt="n"`.

## Value

Rotated PolySet or EventData set where 'X' and 'Y' are the rotated coordinates in the projection specified by 'proj.out'. The returned object has an attribute list object named 'rotation' that contains:

- angle – angle of clockwise rotation in degrees
- radian – angle of rotation in radians:  $\pi * (-\text{angle})/180$
- centroid – fixed point in UTM coordinates (km) around which map is rotated in UTM projection
- R – **rotation matrix** (2-dimensional)
- xlim – list object to keep track of 'xlim', 'ylim' and a bounding box 'xybox'.
- projection – projection of the rotated PolySet or EventData set
- zone – zone of the rotated PolySet or EventData set

When `keep.extra=TRUE`, the returned object will contain additional fields calculated by the rotational algorithm:

- (X0, Y0) – original coordinates of the input PolySet | EventData set
- (uX0, uY0) – original coordinates converted to UTM (only if original projection is 'LL')
- (aX, aY) – UTM coordinates adjusted by subtracting the UTM centroid
- (tX, tY) – adjusted UTM coordinates transformed by multiplying the rotational matrix
- (rX, rY) – rotated UTM coordinates re-centered by adding the UTM centroid

Note:

If `proj.out="UTM"`, the coordinates  $c(rX, rY)$  are used as the final rotated coordinates. If `proj.out="LL"`, the coordinates  $c(rX, rY)$  are transformed back into projection 'LL' as the final rotated coordinates.

Additionally, 'xlim' in the 'rotation' list attribute contains intermediary bounding box objects. For instance, if the input PolySet | EventData object has projection 'LL', the 'xlim' object contains:

- LL – original (X, Y) limits ('xlim', 'ylim', 'xybox')
- UTM – original (X, Y) limits transformed to UTM coordinates
- rot – rotated UTM (X, Y) limits
- out – final projection (X, Y) limits

## Note

The map rotation algorithm is not heavily tested at this time. Report any issues to the package maintainer.

**Author(s)**

**Rowan Haigh**, Program Head – Offshore Rockfish  
 Pacific Biological Station (PBS), Fisheries & Oceans Canada (DFO), Nanaimo BC  
*locus opus*: Institute of Ocean Sciences (IOS), Sidney BC  
 Last modified Rd: 2019-03-14

**References**

[Academo – 2D Rotation about a point](#)  
[Wikipedia – Rotation matrix](#)

**See Also**

In package **PBSmapping**:  
 as.PolySet in [PolySet](#), [clipPolys](#), [nepacLL](#), [plotMap](#), [plotPoints](#), [refocusWorld](#), [surveyData](#)

---

 summary

*Summarize PBS Mapping Objects*


---

**Description**

summary method for PBS Mapping classes.

**Usage**

```
## S3 method for class 'EventData'
summary(object, ...)
## S3 method for class 'LocationSet'
summary(object, ...)
## S3 method for class 'PolyData'
summary(object, ...)
## S3 method for class 'PolySet'
summary(object, ...)
```

**Arguments**

object            object – a PBSmapping object: EventData, LocationSet, PolyData, or PolySet.  
 ...                dots – further arguments passed to or from other methods.

**Details**

After creating a list of summary statistics, this function assigns the class 'summary.PBS' to the output in order to accomplish formatted printing via `print.summary.PBS`.

**Value**

A list of summary statistics.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2019-03-14

**See Also**

In package **PBSmapping**:  
[EventData](#), [LocationSet](#), [PolyData](#), [PolySet](#), [PBSprint](#)

**Examples**

```
local(envir=.PBSmapEnv,expr={
  #--- load the data (if using R)
  if (!is.null(version$language) && (version$language=="R"))
    data(surveyData,envir=.PBSmapEnv)
  print(summary(surveyData))
})
```

---

surveyData

*Data: Tow Information from Pacific Ocean Perch Survey*

---

**Description**

[EventData](#) of Pacific ocean perch (POP) tow information (1966-89).

**Usage**

```
data(surveyData)
```

**Format**

Data frame consisting of 9 columns: PID = primary polygon ID, POS = position of each vertex within a given polygon, X = longitude coordinate, Y = latitude coordinate, trip = trip ID, tow = tow number in trip, catch = catch of POP (kg), effort = tow effort (minutes), depth = fishing depth (m), and year = year of survey trip. Attributes: projection = "LL", zone = 9.

**Note**

In R, the data must be loaded using the [data](#) function.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2008-09-03



**Source**

The GFBio database, maintained at the Pacific Biological Station (Fisheries and Oceans Canada, Nanaimo, BC V9T 6N7), archives catches and related biological data from commercial groundfish fishing trips and research/assessment cruises off the west coast of British Columbia (BC).

The POP (*Sebastes alutus*) survey data were extracted from GFBio. The data extraction covers bottom trawl surveys that focus primarily on POP biomass estimation: 1966-89 for the central BC coast and 1970-85 for the west coast of Vancouver Island. Additionally, a 1989 cruise along the entire BC coast concentrated on the collection of biological samples. Schnute et al. (2001) provide a more comprehensive history of POP surveys including the subset of data presented here.

**References**

Schnute, J.T., Haigh, R., Krishka, B.A. and Starr, P. (2001) Pacific ocean perch assessment for the west coast of Canada in 2001. *Canadian Science Advisory Secretariat, Research Document 2001/138*, 90 pp.

**See Also**

[addPoints](#), [combineEvents](#), [EventData](#), [findPolys](#), [makeGrid](#), [plotPoints](#).

---

|              |                                      |
|--------------|--------------------------------------|
| thickenPolys | <i>Thicken a PolySet of Polygons</i> |
|--------------|--------------------------------------|

---

**Description**

Thicken a [PolySet](#), where each unique (PID, SID) describes a polygon.

**Usage**

```
thickenPolys (polys, tol = 1, filter = 3, keepOrig = TRUE,
             close = TRUE)
```

**Arguments**

|          |                                                                                                                  |
|----------|------------------------------------------------------------------------------------------------------------------|
| polys    | <a href="#">PolySet</a> to thicken.                                                                              |
| tol      | tolerance (in kilometres when proj is "LL" and "UTM"; otherwise, same units as polys).                           |
| filter   | minimum number of vertices per result polygon.                                                                   |
| keepOrig | Boolean value; if TRUE, keep the original points in the <a href="#">PolySet</a> .                                |
| close    | Boolean value; if TRUE, create intermediate vertices between each polygon's last and first vertex, if necessary. |

## Details

This function thickens each polygon within polys according to the input arguments.

If keepOrig = TRUE, all of the original vertices appear in the result. It calculates the distance between two sequential original vertices, and if that distance exceeds tol, it adds a sufficient number of vertices spaced evenly between the two original vertices so that the distance between vertices no longer exceeds tol. If cclose = TRUE, it adds intermediate vertices between the last and first vertices when necessary.

If keepOrig = FALSE, only the first vertex of each polygon is guaranteed to appear in the results. From this first vertex, the algorithm walks the polygon summing the distance between vertices. When this cumulative distance exceeds tol, it adds a vertex on the line segment under inspection. After doing so, it resets the distance sum, and walks the polygon from this new vertex. If cclose = TRUE, it will walk the line segment from the last vertex to the first.

## Value

[PolySet](#) containing the thickened data. The function recalculates the POS values for each polygon.

## Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

## See Also

[thinPolys](#).

## Examples

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- load the data (if using R)
  if (!is.null(version$language) && (version$language=="R"))
    data(nepacLL,envir=.PBSmapEnv)
  #--- plot Vancouver Island
  plotMap(nepacLL[nepacLL$PID == 33, ])
  #--- calculate a thickened version using a 30 kilometres tolerance,
  #--- without keeping the original points
  p <- thickenPolys(nepacLL[nepacLL$PID == 33, ], tol = 30, keepOrig = FALSE)
  #--- convert the PolySet to EventData by dropping the PID column and
  #--- renaming POS to EID
  p <- p[-1]; names(p)[1] <- "EID"
  #--- convert the now invalid PolySet into a data frame, and then into
  #--- EventData
  p <- as.EventData(as.data.frame(p), projection="LL")
  #--- plot the results
  addPoints(p, col=2, pch=19)
  par(oldpar)
})
```

thinPolys

*Thin a PolySet of Polygons***Description**

Thin a [PolySet](#), where each unique (PID, SID) describes a polygon.

**Usage**

```
thinPolys (polys, tol = 1, filter = 3)
```

**Arguments**

|        |                                                                                        |
|--------|----------------------------------------------------------------------------------------|
| polys  | <a href="#">PolySet</a> to thin.                                                       |
| tol    | tolerance (in kilometres when proj is "LL" and "UTM"; otherwise, same units as polys). |
| filter | minimum number of vertices per result polygon.                                         |

**Details**

This function executes the Douglas-Peucker line simplification algorithm on each polygon within polys.

**Value**

[PolySet](#) containing the thinned data. The function recalculates the POS values for each polygon.

**Author(s)**

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2013-04-10

**See Also**

[thickenPolys](#).

**Examples**

```
local(envir=.PBSmapEnv,expr={
  oldpar = par(no.readonly=TRUE)
  #--- load the data (if using R)
  if (!is.null(version$language) && (version$language=="R"))
    data(nepacLL,envir=.PBSmapEnv)
  #--- plot a thinned version of Vancouver Island (3 km tolerance)
  plotMap(thinPolys(nepacLL[nepacLL$PID == 33, ], tol = 3))
  #--- add the original Vancouver Island in a different line type to
  #--- emphasize the difference
```

```
addPolys(nepacLL[nepacLL$PID == 33, ], border=2, lty=8, density=0)
par(oldpar)
})
```

---

towData

*Data: Tow Information from Longspine Thornyhead Survey*

---

## Description

[PolyData](#) of tow information for a longspine thornyhead survey (2001).

## Usage

```
data(towData)
```

## Format

Data frame consisting of 8 columns: PID = primary polygon ID, POS = position of each vertex within a given polygon, X = longitude coordinate, Y = latitude coordinate, depth = fishing depth (m), effort = tow effort (minutes), distance = tow track distance (km), catch = catch of longspine thornyhead (kg), and year = year of survey. Attributes: projection = "LL", zone = 9.

## Note

In R, the data must be loaded using the [data](#) function.

## Author(s)

**Nicholas M. Boers**, Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2008-09-03

## Source

The GFBio database, maintained at the Pacific Biological Station (Fisheries and Oceans Canada, Nanaimo, BC V9T 6N7), archives catches and related biological data from commercial groundfish fishing trips and research/assessment cruises off the west coast of British Columbia (BC). The longspine thornyhead (*Sebastolobus altivelis*) survey data were extracted from GFBio. Information on the first 45 tows from the 2001 survey (Starr et al. 2002) are included here. Effort is time (minutes) from winch lock-up to winch release.

## References

Starr, P.J., Krishka, B.A. and Choromanski, E.M. (2002) Trawl survey for thornyhead biomass estimation off the west coast of Vancouver Island, September 15 - October 2, 2001. *Canadian Technical Report of Fisheries and Aquatic Sciences* **2421**, 60 pp.

## See Also

[makeProps](#), [PolyData](#), [towTracks](#).

---

towTracks

*Data: Tow Track Polylines from Longspine Thornyhead Survey*

---

### Description

[PolySet](#) of geo-referenced polyline tow track data from a longspine thornyhead survey (2001).

### Usage

```
data(towTracks)
```

### Format

Data frame consisting of 4 columns: PID = primary polygon ID, POS = position of each vertex within a given polyline, X = longitude coordinate, and Y = latitude coordinate. Attributes: projection = "LL", zone = 9.

### Note

In R, the data must be loaded using the [data](#) function.

### Author(s)

[Nicholas M. Boers](#), Associate Professor – Computer Science  
MacEwan University, Edmonton AB  
Last modified Rd: 2008-09-03

### Source

The longspine thornyhead (*Sebastolobus altivelis*) tow track spatial coordinates are available at the Pacific Biological Station (Fisheries and Oceans Canada, Nanaimo, BC V9T 6N7). The geo-referenced coordinates of the first 45 tows from the 2001 survey (Starr et al. 2002) are included here. Coordinates are recorded once per minute between winch lock-up and winch release.

### References

Starr, P.J., Krishka, B.A. and Choromanski, E.M. (2002) Trawl survey for thornyhead biomass estimation off the west coast of Vancouver Island, September 15 - October 2, 2001. *Canadian Technical Report of Fisheries and Aquatic Sciences* **2421**, 60 pp.

### See Also

[addLines](#), [calcLength](#), [clipLines](#), [plotLines](#), [PolySet](#), [towData](#).

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