Package 'rgplates'

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Type Package

Title R Interface for the GPlates Web Service and Desktop Application

Version 0.4.0

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Description Query functions to the GPlates <https://www.gplates.org/> Desktop Application and the GPlates Web Service <https://gws.gplates.org/> allow users to reconstruct past positions of geographic entities based on user-selected rotation models without leaving the R running environment. The online method (GPlates Web Service) makes the rotation of static plates, coastlines, and a low number of geographic coordinates available using nothing but an internet connection. The offline method requires an external installation of the GPlates Desktop Application, but allows the efficient batch rotation of thousands of coordinates, Simple Features (sf) and Spatial (sp) objects with custom reconstruction trees and partitioning polygons. Examples of such plate tectonic models are accessible via the chronosphere <https://cran.r-project.org/package=chronosphere>. This R extension is developed under the umbrella of the DFG (Deutsche Forschungsgemeinschaft) Research Unit TERSANE2 (For 2332, TEmperature Related Stressors in ANcient Extinctions).

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URL https://adamtkocsis.com/rgplates/

BugReports https://github.com/adamkocsis/rgplates/issues

Encoding UTF-8

LazyData true

Depends R (>= 3.5.0), sf

Imports methods, utils

NeedsCompilation no

RoxygenNote 7.3.1

Suggests knitr, rmarkdown, chronosphere, httr2, geojsonsf, sp

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R topics documented:

`gws` *Valid reconstructable feature collections of the GPlates Web Service*

Description

The object contains valid returns as of 2024-02-02.

Usage

```
data(gws)
```

Format

A `data.frame` with 4 variables and 17 observations.

Details

The valid return combinations for selected models and feature collections are copied from https://gwsdoc.gplates.org/models.

`model` The name of the reconstruction model.

`feature` The name of the feature collection.

`from` The oldest reconstruction age accepted by the model to return the feature collection.

`to` The youngest reconstruction age accepted by the model to return the feature collection.

mapedge *Function to quickly draft the edge of the equirectangular projection*

Description

Function to plot the edge of a map with different projections.

Usage

```
mapedge(
  x = 360,
  y = 180,
  xmin = -180,
  xmax = 180,
  ymin = -90,
  ymax = 90,
  out = "sf"
)
```

Arguments

x	(numeric) Number of segments in the x (longitude) dimension.
y	(numeric) Number of segments in the y (latitude) dimension.
xmin	(numeric) Minimum value of x (longitude).
xmax	(numeric) Minimum value of x (longitude).
ymin	(numeric) Maximum value of y (latitude).
ymax	(numeric) Maximum value of y (latitude).
out	(character) Output format, either "sf" or "sp". The default "sf" returns simple feature geometries, "sp" returns SpatialPolygons from the sp package.

Value

An sfc-, or SpatialPolygons-class object.

Examples

```
# requires rgdal
edge <- mapedge()
molledge <- st_transform(edge, "ESRI:54009")
plot(molledge)
```

platemodel-class *Class of objects representing plate tectonic models*

Description

Meta-object containing paths to a unique plate tectonic model

Usage

```
## S4 method for signature 'platemodel'
initialize(
  .Object,
  rotation = NULL,
  features = NULL,
  name = NULL,
  polygons = NULL
)
```

Arguments

.Object	Constructor argument (not needed).
rotation	(character) The path to the rotation file.
features	(character) Named vector of features with the paths to the individual files.
name	(character) (Optional) name of the model.
polygons	(character) (Deprecated) The path to the static plate polygon file.

Value

A platemodel class object.

Examples

```
# path to provided archive
archive <- file.path(
  system.file("extdata", package="rgplates"),
  "paleomap_v3.zip")
# extract to temporary directory
unzip(archive, exdir=tempdir())
# path to the rotation file
rotPath <- file.path(tempdir(),
  "PALEOMAP_PlateModel.rot")
# path to the polygons
polPath <- file.path(tempdir(),
  "PALEOMAP_PlatePolygons.gpml")
# register in R - to be used in reconstruct()
model <- platemodel(rotation=rotPath, features=c("static_polygons"=polPath))
```

reconstruct *Reconstruct geographic features*

Description

Reconstruct the geographic locations from present day coordinates and spatial objects back to their paleo-positions. Each location will be assigned a plate id and moved back in time using the chosen reconstruction model.

Usage

```
reconstruct(x, ...)

## S4 method for signature 'matrix'
reconstruct(
  x,
  age = 0,
  model = "MERDITH2021",
  from = 0,
  listout = TRUE,
  verbose = FALSE,
  enumerate = TRUE,
  chunk = NULL,
  reverse = FALSE,
  path.gplates = NULL,
  cleanup = TRUE,
  dir = NULL,
  plateperiod = NULL,
  partitioning = "static_polygons",
  check = TRUE,
  warn = TRUE,
  anchor = 0,
  validtime = TRUE
)

## S4 method for signature 'data.frame'
reconstruct(x, ...)

## S4 method for signature 'numeric'
reconstruct(x, ...)

## S4 method for signature 'character'
reconstruct(
  x,
  age,
  model = "MERDITH2021",
  listout = TRUE,
```

```
  verbose = FALSE,
  path.gplates = NULL,
  cleanup = TRUE,
  dir = NULL,
  partitioning = "static_polygons",
  check = TRUE,
  anchor = 0
)

## S4 method for signature 'Spatial'
reconstruct(
  x,
  age,
  model,
  listout = TRUE,
  verbose = FALSE,
  path.gplates = NULL,
  cleanup = TRUE,
  dir = NULL,
  plateperiod = NULL,
  partitioning = "static_polygons",
  check = TRUE,
  validtime = TRUE
)

## S4 method for signature 'sf'
reconstruct(
  x,
  age,
  model,
  listout = TRUE,
  verbose = FALSE,
  path.gplates = NULL,
  cleanup = TRUE,
  dir = NULL,
  plateperiod = NULL,
  gmeta = FALSE,
  partitioning = "static_polygons",
  check = TRUE,
  validtime = TRUE
)
```

Arguments

x	The features to be reconstructed. Can be a vector with longitude and latitude representing a single point or a matrix/dataframe with the first column as longitude and second column as latitude. For the online subroutine, the character strings "static_polygons", "coastlines" and "plate_polygons" return static plate polygons, rotated present-day coastlines and topological plates, re-

spectively. For the offline subroutine, it can be a name of the feature set defined in the `model` object. Some `Spatial*` and `sf` classes are also accepted, although this input is still experimental.

`...` arguments passed to class-specific methods.

`age` (`numeric`) is the target age in Ma at which the feature will be reconstructed. Defaults to 0 Ma.

`model` (`character` or `platemodel`) The reconstruction model. The class of this argument selects the submodule used for reconstruction, a `character` value will invoke the remote reconstruction submodule and will submit `x` to the GPlates Web Service. A `platemodel` class object will call the local-reconstruction submodule. The default is `"PALEOMAP"`. See details for available models.

`from` (`numeric`) The original age of the features to be reconstructed. A single value, defaults to 0Ma. Only used with the online reconstruction module.

`listout` (`logical`)If multiple ages are given, the output can be returned as a `list` if `listout = TRUE`.

`verbose` (`logical`) Should call URLs (remote submodule) or console feedback (local-submodule) be printed?

`enumerate` (`logical`) Should be all coordinate/age combinations be enumerated and reconstructed (set to `TRUE` by default)? `FALSE` is applicable only if the number of rows in `x` is equal to the number elementes in `age`. Then a point will be reconstructed to the age that has the same index in `age` as the row of the coordinates in `x`. List output is not available in this case.

`chunk` (`numeric`) Deprected argument of the online reconstruction method. Ignored.

`reverse` (`logical`) Argument of the remote reconstruction submodule. The flag to control the direction of reconstruction. If `reverse = TRUE`, the function will calculate the present-day coordinates of the given paleo-coordinates, with age setting the target. Not recommended, kept only for compatibility with the GPlates Web Service. Using `from` instead of `age` will automatically trigger reverse reconstruction.

`path.gplates` (`character`) Argument of the local reconstruction submodule. In case the GPlates executable file is not found at the coded default location, the full path to the executable (gplates-<ver>.exe on Windows) can be entered here. e.g. `"C:/gplates_2.3.0_win64/gplates.`

`cleanup` (`logical`) Argument of the local reconstruction submodule. Should the temporary files be deleted immediately after reconstructions?

`dir` (`character`) Argument of the local reconstruction submodule. Directory where the temporary files of the reconstruction are stored (defaults to a temporary directory created by R). Remember to toggle `cleanup` if you want to see the files.

`plateperiod` (`logical`) Deprecated argument, renamed to `validtime` for higher compatibility with the GPlates Web Service.

`partitioning` (`character`) Argument of the local reconstruction submodule, which feature collection of the tectonic model should be used to assing plate IDs to the features? It defaults to `"static_polygons"`.

`check` (`logical`) Should the validity of the entries for the GWS checked with the information stored in `gws`? (default: `TRUE`)

warn (character) Argument of the online reconstruction submodule, used in reverse-reconstructions (calculation of present-day coordinates from paleocoordinates). If set to 'TRUE' (default), the function will produce a warning when paleocoordinates are not assigned to any of the paritioning polygons (missing values are returned for these). When set to 'FALSE', the warnings will not be displayed.

anchor (character) Argument of the online reconstruction submodule. The Plate ID of the anchored plate. This is the 'anchored_plate_id' parameter of the GPlates Web Service.

validtime (logical) Argument of the local reconstuction submodule. Should the durations of the plates be forced on the partitioned feature? If these are set to TRUE and the plate duration estimates are long, then you might lose some data. This is the inverse of the ignore.valid.time argument of the GWS.

gmeta (logical) Argument of the local reconstruction submodule, in the case, when sf objects are supplied. Should the metadata produced by GPlates be included in the output object?

Details

The function implements two reconstruction submodules, which are selected with the model argument:

If model is a character entry, then the reconstruct() function uses the GPlates Web Service (https://gwsdoc.gplates.org/, remote reconstruction submodule). The available reconstruction models for this submodule are (as of 2024-02-02):

- "TorsvikCocks2017" (Torsvik and Cocks, 2017) for coastlines (0-540 Ma). Uses a mantle reference frame by default. For climatically sensitive analyses use a paleomagnetic reference frame, which you can toggle by setting the anchor parameter to 1 from the default 0.
- "SETON2012" (Seton et al., 2012) for coastlines and topological plate polygons (0-200 Ma).
- "RODINIA2013" (Li et al., 2012) for coastlines (530-1100 Ma).
- "MULLER2016" (Muller et al., 2016) for coastlines and topological plate polygons (0-230 Ma).
- "GOLONKA" (Wright et al. 2013) for coastlines only (0-550 Ma).
- "PALEOMAP" (Scotese, 2016) for coastlines only (0-1100 Ma).
- "MATTHEWS2016_mantle_ref" (Matthews et al., 2016) for coastlines and topological plate polygons (0-410 Ma).
- "MATTHEWS2016_pmag_ref" (Matthews et al., 2016) for coastlines and topological plate polygons (0-410 Ma).
- "MULLER2019" (Müller et al., 2019) for coastlines and static plate polygons. (0-250 Ma).
- "MERDITH2021" (Merdith et al., 2021, default) for coastlines and static plate polygons (0-1000 Ma).
- "MULLER2022" (Müller et al., 2022) for coastlines and static plate polygons (0-1000 Ma).

If model is a platemodel class object, then the function will try to use the GPLates desktop application (https://www.gplates.org/) to reconstruct the coordinates (local reconstruction submodule). Plate models are available in chronosphere with the fetch function. See datasets for

the available models. The function will try to find the main GPlates executable in its default installation directory. If this does not succeed, use `path.gplates` to enter the full path to the GPlates executable as a `character` string.

Value

A `numeric` matrix if `x` is a `numeric`, `matrix` or `data.frame`, or `Spatial*` class objects, depending on input. `NULL` in case no model is specified.

References

Matthews, K. J., Maloney, K. T., Zahirovic, S., Williams, S. E., Seton, M., & Müller, R. D. (2016). Global plate boundary evolution and kinematics since the late Paleozoic. Global and Planetary Change, 146, 226–250. https://doi.org/10.1016/j.gloplacha.2016.10.002

Andrew S. Merdith, Simon E. Williams, Alan S. Collins, Michael G. Tetley, Jacob A. Mulder, Morgan L. Blades, Alexander Young, Sheree E. Armistead, John Cannon, Sabin Zahirovic, R. Dietmar Müller, (2021). Extending full-plate tectonic models into deep time: Linking the Neoproterozoic and the Phanerozoic, Earth-Science Reviews, Volume 214, 2021, 103477, ISSN 0012-8252, https://doi.org/10.1016/j.earscirev.2020.103477.

Müller, R. D., Seton, M., Zahirovic, S., Williams, S. E., Matthews, K. J., Wright, N. M., ... Cannon, J. (2016). Ocean Basin Evolution and Global-Scale Plate Reorganization Events Since Pangea Breakup. Annual Review of Earth and Planetary Sciences, 44(1), 107–138. https://doi.org/10.1146/annurev-earth-060115-012211

Müller, R. D., Zahirovic, S., Williams, S. E., Cannon, J., Seton, M., Bower, D. J., Tetley, M. G., Heine, C., Le Breton, E., Liu, S., Russell, S. H. J., Yang, T., Leonard, J., and Gurnis, M. (2019), A global plate model including lithospheric deformation along major rifts and orogens since the Triassic. Tectonics, vol. 38, https://doi.org/10.1029/2018TC005462.

Müller, R. D., Flament, N., Cannon, J., Tetley, M. G., Williams, S. E., Cao, X., Bodur, Ö. F., Zahirovic, S., and Merdith, A.: A tectonic-rules-based mantle reference frame since 1 billion years ago – implications for supercontinent cycles and plate–mantle system evolution, Solid Earth, 13, 1127–1159, https://doi.org/10.5194/se-13-1127-2022, 2022.

Scotese, C. R. (2016). PALEOMAP PaleoAtlas for GPlates and the PaleoData Plotter Program. http://www.earthbyte.org/paleomap- paleoatlas-for-gplates

Seton, M., Müller, R. D., Zahirovic, S., Gaina, C., Torsvik, T., Shephard, G., ... Chandler, M. (2012). Global continental and ocean basin reconstructions since 200Ma. Earth-Science Reviews, 113(3–4), 212–270. https://doi.org/10.1016/j.earscirev.2012.03.002

Torsvik and Cocks (2017). Earth History and Palaeogeography. Cambridge University Press, 317 pp.

Wright, N., Zahirovic, S., Müller, R. D., & Seton, M. (2013). Towards community-driven paleogeographic reconstructions: integrating open-access paleogeographic and paleobiology data with plate tectonics. Biogeosciences, 10(3), 1529–1541. https://doi.org/10.5194/bg-10-1529-2013

Examples

```
# With the web service
# simple matrices
# replace model with desired choice
reconstruct(matrix(c(95, 54), nrow=1), 140, model=NULL)

# points reconstruction
xy <-cbind(long=c(95,142), lat=c(54, -33))
reconstruct(xy, 140, model=NULL)
```

`rgplates` *R Interface for the GPlates Web Service and Desktop Application*

Description

Query functions to the GPlates <https://www.gplates.org/> Desktop Application and the GPlates Web Service <https://gws.gplates.org/> allow users to reconstruct coordinates, static plates, Simple Features and Spatial objects without leaving the R running environment. This R extension is developed under the umbrella of the DFG (Deutsche Forschungsgemeinschaft) Research Unit TERSANE2 (For 2332, TEmperature Related Stressors in ANcient Extinctions).

Details

This is still the Beta version. As is R, this is free software and comes with ABSOLUTELY NO WARRANTY. Nevertheless, notes about found bugs and suggestions are more than welcome.

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See Also

Useful links:

- https://adamtkocsis.com/rgplates/
- Report bugs at https://github.com/adamkocsis/rgplates/issues

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