Package ‘arcpullr’

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Description Functions to efficiently query 'ArcGIS REST' APIs <https://developers.arcgis.com/rest/>.
Both spatial and SQL queries can be used to retrieve data.
Simple Feature (sf) objects are utilized to perform spatial queries.
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Description

A package for pulling spatial data from an ArcGIS REST API

Details

The role of the arcpullr package is simple...to pull spatial data from an ArcGIS REST API. These APIs are housed by various different agencies, organizations, entities, etc., but allow a consistent format for storing and retrieving spatial data.

get_spatial_layer

This function makes up the core of the package. It allows users to pull spatial data given a URL of an ArcGIS REST API. There are many additional query parameters that can (and probably should) be added; however, we’ve simplified many of these out for you with the functions below.
get_layer_by_spatial family of functions

These functions allow you to pull layers using a spatial query. The abstract syntax is wrapped into the functions, so all you have to do is pass these functions an sf object of the spatial area, line, or point you want to query by. These functions include get_layer_by_poly, get_layer_by_point, get_layer_by_line, get_layer_by_multipoint, and get_layer_by_envelope. It should be fairly obvious what type of spatial layer each function takes with the exception of get_layer_by_envelope except that it isn’t particularly useful for a single point.

Helper functions

There are a few utility functions to help you along the way. The first is plot_layer, which is a useful way to plot the spatial layer you’ve tried to pull just to make sure it works. If you want fancier maps you’d be better served with ggplot2 or tmaps, though.

Other helpers include the sf_objects functions, which allow you to easily create sf points, lines, and polygons with a few coordinates.

Lastly, there is a sql_where function to help aid in building more complex SQL WHERE clauses used to query by the where argument in the retrieval functions above.

format_coords

Convert coordinates from an 'sf' object to formatted well-known text

Description

Use this function to convert the coordinates of a sf polygon object to a string of well known text. The output can be passed to an ArcGIS REST API to perform a spatial query.

Usage

format_polygon_coords(sf_obj)
format_line_coords(sf_obj)
format_multipoint_coords(sf_obj)
format_point_coords(sf_obj)
format_envelope_coords(sf_obj)
format_coords(sf_obj, geom_type)

Arguments

sf_obj An sf object
geom_type Either "points", "paths", or "rings". Choose wisely
Details

Spatial queries from an ArcGIS REST API require specific text inputs formatted in a way called well-known text (WKT). ArcGIS REST APIs have their own syntax for how the text is taken. These functions will format sf objects in the correct way to be able to make spatial queries from a ArcGIS REST API.

Value

String of well known text

Examples

mke_polygon_coords <- format_polygon_coords(mke_county)

get_geometry_type

Description

This function will return the geometry type of feature service layers housed on an ArcGIS REST API server. If a URL is provided that points to a map or image layer the function will return an error.

Usage

get_geometry_type(url)

Arguments

url A character string of a feature services URL

Value

A character string of the layers geometry type

Examples

## Not run:
get_geometry_type(reykjanes_lava_flow_url)

## End(Not run)
get_image_layer

Retrieve an image service layer from an ArcGIS REST API

Description

This function retrieves image service layers from an ArcGIS REST services API and returns them as a RasterStack object.

Usage

```r
get_image_layer(
  url,
  sf_object = NULL,
  bbox = NULL,
  token = "",
  clip_raster = TRUE,
  format = "png",
  transparent = TRUE,
  ...
)
```

Arguments

- `url`: A character string of the url for the layer to pull
- `sf_object`: An sf object used for the bounding box
- `bbox`: Character string of the bounding box
- `token`: A character string of the token (if needed)
- `clip_raster`: Logical. Should the raster be clipped to contain only the pixels that reside in the sf_object? By default, ArcGIS returns some overlapping edge pixels. Setting clip_raster to TRUE (default) will remove these using mask from the raster package.
- `format`: The raster format desired. Default is "png"
- `transparent`: Logical. Retrieve a raster with a transparent background (TRUE, default) or not (FALSE)
- `...`: Additional arguments to pass to the ArcGIS REST API

Details

This is one of the core functions of the package. It retrieves image service layers from an ArcGIS REST API designated by the URL. These layers require a bounding box to query the map layer, which is either taken from the sf_object argument or optionally can be passed via the bbox argument. Either sf_object or bbox are optional, but one of them must be present.

All of the querying parameters are sent via a POST request to the URL, so if there are issues with passing additional parameters via ... first determine how they fit into the POST request and make adjustments as needed. This syntax can be tricky if you’re not used to it.
get_layers_by_spatial

Value

A "RasterStack" object

Examples

## Not run:
wi_leaf_off_layer <- get_image_layer(wi_leaf_off_url, wis_poly)
plot_layer(wi_leaf_off_layer, outline_poly = wis_poly)

## End(Not run)

get_layers_by_spatial  Retrieve ArcGIS REST API spatial layer by spatial query

Description

These functions are wrappers around get_spatial_layer that are specialized for querying by a spatial layer. They will make a POST request to the query URL which returns data (if available) based on the appropriate spatial feature (geometry) and relationship (sp_rel).

Usage

get_layer_by_poly(url, geometry, sp_rel = "esriSpatialRelContains", ...)
get_layer_by_line(url, geometry, sp_rel = "esriSpatialRelIntersects", ...)
get_layer_by_point(url, geometry, sp_rel = "esriSpatialRelIntersects", ...)
get_layer_by_multipoint(
  url,
  geometry,
  sp_rel = "esriSpatialRelIntersects",
  ...)
)
get_layer_by_envelope(url, geometry, sp_rel = "esriSpatialRelIntersects", ...)

get_layer_by_spatial(
  url,
  geometry,
  geom_type,
  sp_ref = NULL,
  sp_rel = "esriSpatialRelIntersects",
  ...)
)
*get_layer_html*

**Arguments**

- **url**: A character string of the url for the layer to pull
- **geometry**: An sf object used for the spatial query
- **sp_rel**: Character. The type of relationship to query by.
- **...**: Additional arguments to pass to `get.spatial.layer`
- **geom_type**: A character of the geometry type to be used. This param is automatically specified in all `get.layer_by_*` functions except `get.spatial.layer`
- **sp_ref**: The spatial reference value

**Value**

An object of class "sf" of the appropriate layer

**Examples**

```r
base_wdnr_url <- "https://dnrmaps.wi.gov/arcgis/rest/services/
hydro_path <- "WT_SWDV/WT_Inland_Water_Resources_WTM_Ext_v2/MapServer/2"
hydro_url <- paste0(base_wdnr_url, hydro_path)
mke_waters <- get_layer_by_poly(url = hydro_url, mke_county)
```

---

**Description**

Used internally to pull HTML for a layer’s web page so that the call doesn’t have to be made twice in `get.geometry.type` if the url provided there is for a raster layer.

**Usage**

```r
get_layer_html(url)
```

**Arguments**

- **url**: Character. The URL of the web page

**Value**

A character string of the HTML body
get_layer_legend  

Returns a legend for a raster layer

Description

Raster layers are accompanied with legends to identify what the colors mean. This function retrieves those legend values and returns them as a data.frame with the associated RGB color values. This will likely be most useful for plotting and analysis of map layers.

Usage

get_layer_legend(url)

Arguments

url  
A URL to a Map or Image Service layer

Value

A data.frame with two columns (color, values) and the number of rows equal to the number of values in a layer

Examples

## Not run:
get_layer_legend(wi_landcover_url)
## End(Not run)

get_map_layer  

Retrieve a map service layer from an ArcGIS REST API

Description

This function retrieves map service layers from an ArcGIS REST services API and returns them as a RasterLayer object

Usage

get_map_layer(
  url,
  sf_object = NULL,
  bbox = NULL,
  token = "",
  clip_raster = TRUE,
  format = "png",
)
get_map_layer

```r
transparent = TRUE,
add_legend = TRUE,
...
)
```

Arguments

- **url**: A character string of the url for the layer to pull
- **sf_object**: An sf object used for the bounding box
- **bbox**: Character string of the bounding box
- **token**: A character string of the token (if needed)
- **clip_raster**: Logical. Should the raster be clipped to contain only the pixels that reside in the sf_object? By default, ArcGIS returns some overlapping edge pixels. Setting clip_raster to TRUE (default) will remove these using mask from the raster package
- **format**: The raster format desired. Default is "png"
- **transparent**: Logical. Retrieve a raster with a transparent background (TRUE, default) or not (FALSE)
- **add_legend**: Logical. Pull legend and match to color values (TRUE, default) or not (FALSE)
- **...**: Additional arguments to pass to the ArcGIS REST API

Details

This is one of the core functions of the package. It retrieves map service layers from an ArcGIS REST API designated by the URL. These layers require a bounding box to query the map layer, which is either taken from the sf_object argument or optionally can be passed via the bbox argument. Either sf_object or bbox are optional, but one of them must be present.

All of the querying parameters are sent via a POST request to the URL, so if there are issues with passing additional parameters via ... first determine how they fit into the POST request and make adjustments as needed. This syntax can be tricky if you’re not used to it.

Value

A "RasterLayer" object

Examples

```r
## Not run:
wi_landcover<- get_map_layer(wi_landcover_url, wis_poly)
plot_layer(wi_landcover, outline_poly = wis_poly)
## End(Not run)
```
get_raster_layer  Pull a raster layer from a map service or image service layer of an ArcGIS REST API

Description

This is an internal function to pull raster layers from either a map service or an image service of an ArcGIS REST API. This function is the engine that drives get_map_layer and get_image_layer.

Usage

get_raster_layer(
  url,
  sf_object = NULL,
  bbox = NULL,
  token = "",
  clip_raster = TRUE,
  format = "png",
  transparent = TRUE,
  export_type = "map",
  add_legend = FALSE,
  ...
)

Arguments

url  A character string of the url for the layer to pull
sf_object  An sf object used for the bounding box
bbox  Character string of the bounding box
token  A character string of the token (if needed)
clip_raster  Logical. Should the raster be clipped to contain only the pixels that reside in the sf_object? By default, ArcGIS returns some overlapping edge pixels. Setting clip_raster to TRUE (default) will remove these using mask from the raster package
format  The raster format desired. Default is "png"
transparent  Logical. Retrieve a raster with a transparent background (TRUE, default) or not (FALSE)
export_type  Character. Either "map" or "image" for the respective service layer desired
add_legend  Logical. Pull legend and match to color values (TRUE, default) or not (FALSE)
...  Additional arguments to pass to the ArcGIS REST API

Value

An object of type RasterLayer if export_type = "map" or an object of type RasterStack if export_type = "image"
get_service_type

Get Service Type of a REST endpoint

Description
Get Service Type of a REST endpoint

Usage
get_service_type(url, ...)

Arguments
url A character string of a valid layer URL
... Only used internally

Value
A character string defining the layer type

Examples
## Not run:
get_service_type(reykjanes_lava_flow_url)

## End(Not run)

get_sf_crs
Return CRS value of an sf object

Description
Return CRS value of an sf object

Usage
get_sf_crs(sf_obj)

Arguments
sf_obj An object of class sf

Value
A numeric value referring to the coordinate reference system

Examples
get_sf_crs(iceland_poly)
get_spatial_layer

Retrieve a feature service layer from an ArcGIS REST API

Description

This function retrieves spatial layers present in Feature Service layers of an ArcGIS REST services API and returns them as an sf object.

Usage

get_spatial_layer(
  url,
  out_fields = c("*"),
  where = "1=1",
  token = "",
  sf_type = NULL,
  ...
)

Arguments

url
  A character string of the url for the layer to pull
out_fields
  A character string of the fields to pull for each layer
where
  A character string of the where condition. Default is 1=1
token
  A character string of the token (if needed)
sf_type
  A character string specifying the layer geometry to convert to sf ("esriGeometryPolygon", "esriGeometryPoint", "esriGeometryPolyline"), if NULL (default) the server will take its best guess
...
  Additional arguments to pass to the ArcGIS REST POST request

Details

This is one of the core functions of this package. It retrieves spatial layers from feature services of an ArcGIS REST API designated by the URL. Additional querying features can be passed such as a SQL WHERE statement (where argument) or spatial queries as well as any other types of queries that the ArcGIS REST API accepts (using ...). However, for easier spatial querying see get_layers_by_spatial.

All of the querying parameters are sent via a POST request to the URL, so if there are issues with passing additional parameters via ... first determine how they fit into the POST request and make adjustments as needed. This syntax can be tricky if you’re not used to it.

Value

An object of class "sf" of the appropriate layer
Examples

## Not run:
```r
# lava flows on Reykjanes (pr. 'rake-yah-ness') peninsula in Iceland
lava_flows <- get_spatial_layer(reykjanes_lava_flow_url)
plot_layer(lava_flows, outline_poly = reykjanes_poly)
plot_layer(lava_flows, outline_poly = iceland_poly)
```

## End(Not run)

### match_raster_colors

*Match colors in RasterLayer color space to the provided legend values*

**Description**

Colors provided by the legend do not always correspond exactly with the colors in the colortable of a RasterLayer object. They are usually pretty close, though, so this function finds the closest colors, maps them to the appropriate colors in the RasterLayer object, and applies that to the legend.

**Usage**

```r
match_raster_colors(legend, x)
```

**Arguments**

- `legend`: An object of class raster_legend as returned by `get_layer_legend`
- `x`: A RasterLayer object as returned by `get_map_layer`

**Details**

Raster colors in `x` are mapped to those in `legend` by converting the RGB hexadecimal values to a 3D vector of values for red, green and blue. The closest values are then assigned using 3D Pythagorean theorem to compute the distance among all colors. The minimum distance in three dimensional space is the color in `x` that gets mapped to the appropriate color in `legend`.

**Value**

A raster_legend object with corrected colors to match those in `x`

### Examples

```r
## Not run:
wi_landcover <- get_map_layer(wi_landcover_url, wis_poly)
legend <- get_layer_legend(wi_landcover_url)
new_legend <- match_raster_colors(legend, wi_landcover_url)
```

## End(Not run)
plot_layer

Plot a spatial layer

Description

This function plots a spatial layer as returned from get_spatial_layer.

Usage

plot_layer(x, ...)

plot_layer.sf(
  x,
  outline_poly = NULL,
  outline_size = 1.2,
  outline_color = "gray30",
  plot_pkg = "ggplot",
  ...
)

Arguments

x An sf or Raster* object as returned from a get_*_layer function
...
outline_poly Optional. An sf polygon to outline sf_data for context
outline_size Numeric argument that controls width of parameter
outline_color A character vector of a valid color
plot_pkg Character. The plotting environment to use. Either "ggplot" (default) or "base"

Value

Either a ggplot object, or simply plots x if plot_pkg = "base"

Examples

## Not run:
plot_layer(iceland_poly)
plot_layer(portage_county, outline_poly = wis_poly)

## End(Not run)
Description

Plot a RasterBrick object

Usage

```r
## S4 method for signature 'RasterBrick'
plot_layer(
  x,
  outline_poly = NULL,
  outline_size = 1.2,
  outline_color = "gray30",
  plot_pkg = "ggplot",
  ...
)
```

Arguments

- `x` An sf or Raster* object as returned from a get_*_layer function
- `outline_poly` Optional. An sf polygon to outline sf_data for context
- `outline_size` Numeric argument that controls width of parameter
- `outline_color` A character vector of a valid color
- `plot_pkg` Character. The plotting environment to use. Either "ggplot" (default) or "base"
- `...` Additional arguments to plot_layer

Examples

```r
## Not run:
wi_aerial <- get_map_layer(wi_leaf_off_url, wis_poly)
plot_layer(wi_aerial, outline_poly = wis_poly)
## End(Not run)
```
plot_layer, RasterLayer-method

*Plot a RasterLayer object*

Description

Plot a RasterLayer object

Usage

```r
## S4 method for signature 'RasterLayer'
plot_layer(
  x,
  outline_poly = NULL,
  outline_size = 1.2,
  outline_color = "gray30",
  legend = TRUE,
  plot_pkg = "ggplot",
  ...
)
```

Arguments

- **x**: An sf or Raster* object as returned from a `get_*_layer` function
- **outline_poly**: Optional. An sf polygon to outline sf_data for context
- **outline_size**: Numeric argument that controls width of parameter
- **outline_color**: A character vector of a valid color
- **legend**: Logical. Only valid when plotting RasterLayers retrieved from `get_map_layer` where legend was also retrieved
- **plot_pkg**: Character. The plotting environment to use. Either "ggplot" (default) or "base"
- **...**: Additional arguments to `plot_layer`

Examples

```r
## Not run:
wi_landcover <- get_map_layer(wi_landcover_url, wis_poly)
plot_layer(wi_landcover, outline_poly = wis_poly)
## End(Not run)
```
**plot_layer,RasterStack-method**

Plot a RasterStack object

---

**Description**

Plot a RasterStack object

**Usage**

```r
## S4 method for signature 'RasterStack'
plot_layer(
  x,
  outline_poly = NULL,
  outline_size = 1.2,
  outline_color = "gray30",
  plot_pkg = "ggplot",
  ...
)
```

**Arguments**

- `x`: An sf or Raster* object as returned from a `get_*_layer` function
- `outline_poly`: Optional. An sf polygon to outline sf_data for context
- `outline_size`: Numeric argument that controls width of parameter
- `outline_color`: A character vector of a valid color
- `plot_pkg`: Character. The plotting environment to use. Either "ggplot" (default) or "base"
- `...`: Additional arguments to `plot_layer`

**Examples**

```r
## Not run:
wi_aerial <- get_map_layer(wi_leaf_off_url, wis_poly)
plot_layer(wi_aerial, outline_poly = wis_poly)
## End(Not run)
```
plot_layer, sf-method  

Plot an sf object

Description

Plot an sf object

Usage

## S4 method for signature 'sf'
plot_layer(
  x,
  outline_poly = NULL,
  outline_size = 1.2,
  outline_color = "gray30",
  plot_pkg = "ggplot",
  ...
)

Arguments

x  
An sf or Raster* object as returned from a get_*_layer function

outline_poly  
Optional. An sf polygon to outline sf_data for context

outline_size  
Numeric argument that controls width of parameter

outline_color  
A character vector of a valid color

plot_pkg  
Character. The plotting environment to use. Either "ggplot" (default) or "base"

...  
Additional arguments to plot_layer

Examples

## Not run:
plot_layer(wis_poly)

## End(Not run)

raster_colors  

Convert RasterLayer into data.frame of colors for each pixel that can be used for plotting

Description

This function is used internally by plot_layer to convert a Raster* object to a data.frame of colors for each pixel that can be used for plotting with ggplot2
raster_colors,RasterBrick-method

Usage

raster_colors(x)

Arguments

x A Raster* object

Value

A data.frame with 3 columns and length(raster_object) rows. Two of these columns are the x-y coordinates of each pixel, and one is a value for color that can be used for plotting

Examples

## Not run:
wi_landcover <- get_map_layer(wi_landcover_url, wis_poly)
wi_landcover_data <- raster_colors(wi_landcover)
head(wi_landcover_data)
## End(Not run)

---

raster_colors,RasterBrick-method

Convert RasterBrick into data.frame of colors that can be used for plotting

Description

This function is used internally by plot_layer to convert a RasterBrick object to a data.frame of colors for each pixel that can be used for plotting with ggplot2. Note that this function assumes that the first three bands in the RasterBrick objects are the RGB values and all additional bands are ignored.

Usage

## S4 method for signature 'RasterBrick'
raster_colors(x)

Arguments

x A RasterBrick object

Value

A data.frame with 3 columns and length(raster_object) rows
raster_colors,RasterLayer-method

Convert RasterLayer into data.frame of colors that can be used for plotting

Description

This function is used internally by `plot_layer` to convert a RasterLayer object to a data.frame of colors for each pixel that can be used for plotting with ggplot2.

Usage

```r
## S4 method for signature 'RasterLayer'
raster_colors(x)
```

Arguments

- `x` A RasterLayer object

Value

A data.frame with 3 columns and `length(raster_object)` rows

Examples

```r
## Not run:
wi_landcover <- get_map_layer(wi_landcover_url, wis_poly)
wi_landcover_data <- raster_colors(wi_landcover)
## End(Not run)
```
raster_colors,RasterStack-method

Convert RasterStack into data.frame of colors that can be used for plotting

Description

This function is used internally by `plot_layer` to convert a RasterStack object to a data.frame of colors for each pixel that can be used for plotting with ggplot2. Note that this function assumes that the first three bands in the RasterStack objects are the RGB values and all additional bands are ignored.

Usage

```r
## S4 method for signature 'RasterStack'
raster_colors(x)
```

Arguments

- `x`: A RasterStack object

Value

A data.frame with 3 columns and `length(raster_object)` rows

Examples

```r
## Not run:
wi_leaf_off_layer <- get_image_layer(wi_leaf_off_url, wis_poly)
wi_leaf_off_data <- raster_colors(wi_leaf_off_layer)
## End(Not run)
```

sf_example_polys

Various example sf polygons

Description

These are sf polygons that are used for examples throughout the package
Usage

iceland_poly
mke_county
portage_county
reykjanes_poly
wis_counties
wis_poly

Format

An object of class sf and data.frame:
An object of class sf (inherits from data.frame) with 1 rows and 3 columns.
An object of class sf (inherits from data.frame) with 1 rows and 3 columns.
An object of class sf (inherits from data.frame) with 1 rows and 2 columns.
An object of class sf (inherits from data.frame) with 72 rows and 3 columns.
An object of class sf (inherits from data.frame) with 1 rows and 2 columns.

Source

map_data

---

**sf_objects**

Create sf objects from coordinates

**Description**

These are simple wrapper functions for creating sf objects from points

Usage

sf_line(..., crs = 4326)
sf_point(..., crs = 4326)
sf_points(..., crs = 4326)
sf_polygon(..., crs = 4326)
**sp_rel_lookups**

### Arguments

- ...: The coordinates of the object
- crs: The coordinate reference system. Defaults to 4326

### Value

An sf object of the appropriate type

### Examples

```r
pt_a <- c(-90, 45)
pt_b <- c(-89, 44)
pt <- sf_points(pt_a)
line <- sf_line(pt_a, pt_b)
```

---

**sp_rel_lookups**  
*Spatial relationship descriptor and lookup tables*

### Description

These data.frames are used to lookup and explain which spatial relation types go with different spatial queries.

### Usage

- sp_rel_valid
- sp_rel_lookup

### Format

- **sp_rel_valid** is a data.frame with 105 rows and 3 variables as follows:
  - **feature_class**: A feature class to be queried
  - **query_feature_class**: The feature class used to do a spatial query
  - **sp_rel**: The spatial relationships that are valid for the feature class and query_feature_class combination

- **sp_rel_lookup** is a data.frame with 9 rows and 2 variables as follows:
  - **sp_rel**: The spatial relationship being described
  - **description**: A description of the sp_rel

### Details

sp_rel_lookup explains the various different types of spatial relationships available through ArcGIS REST APIs. sp_rel_valid shows which spatial relationships are valid with different geometry types being queried and used to do spatial queries.
sql_where

Format a SQL where clause from arguments

Description

This function will create a where statement that is compatible with `get_spatial_layer`). This statement can then be passed to the `where` argument in this function.

Usage

```r
sql_where(..., rel_op = "=")
```

Arguments

- `...` Named objects to be queried by
- `rel_op` Character. The relational operator in the SQL clause (i.e. "=", "IN", "NOT IN", etc.). If a single `rel_op` is provide with multiple `...` parameters then it will be recycled `length(...)` times.

Value

A character string that can be passed to the `where` argument of `get_spatial_layer`

Examples

```r
## Not run:
wics <- sql_where(WATERBODY_WBIC = c(805400, 804600), rel_op = "IN")
base_wdnr_url <- "https://dnrmaps.wi.gov/arcgis/rest/services/"
hydro_path <- "WT_SWDV/WT_Inland_Water_Resources_WTM_Ext_v2/MapServer/3"
hydro_url <- paste0(base_wdnr_url, hydro_path)
lakes <- get_spatial_layer(url = hydro_url, where = wics)
plot_layer(lakes)
## End(Not run)
```
valid_sp_rel

Check to see which spatial relation types are applicable to the feature classes being queried and the sf objects use do to a spatial query

Description

Check to see which spatial relation types are applicable to the feature classes being queried and the sf objects use do to a spatial query

Usage

valid_sp_rel(fc1, fc2, pull = TRUE)

Arguments

fc1 Character. The feature class type being queried. Available options are "point", "multipoint", "line", or "area".

fc2 Character. The geometry type of the sf object used to do a spatial query. Available options are "point", "multipoint", "line", or "area".

pull Logical. Pull the available options (TRUE) or print all columns of the sp_rel_valid data.frame for the appropriate fc1 and fc2

Value

Either a vector or filtered data.frame showing the appropriate sp_rels for the given feature classes

Examples

valid_sp_rel("line", "line")
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