

GIS in R

Lecture 1

Marie Auger-Méthé
Ocean Tracking Network
Dalhousie University

Topics of today

- GIS in R at glance
- Coordinate reference systems
- Vector data – Points data
- Where to get information

What is GIS?

- Geographical Information System (GIS):
 - Store and analyse spatial data
 - Set of tools to handle data referenced to Earth,
e.g. tools to:
 - Store
 - Retrieve
 - Transform
 - Visualise

GIS in R

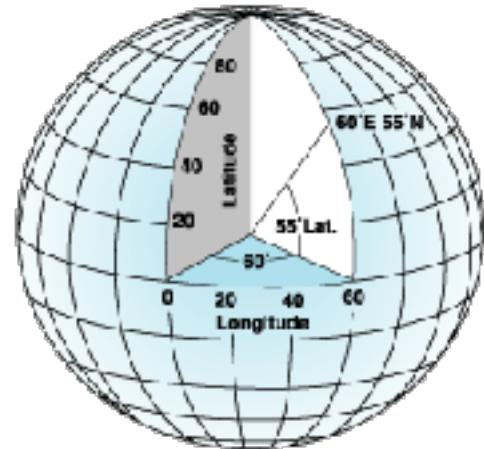
- R can be used to:
 - Analyse spatial data, including:
 - retrieve, transform, and statistical analyses
 - Visualise spatial data
- R doesn't have a storage capacity per say
 - No equivalent of Arc Catalogue or GIS database
 - But can somewhat handle this with proper R practices, including using R Studio projects

What is spatial data?

- Spatial data is referenced with respect to their location on Earth
- Answer question: ***Where is it?***
- For this you need:
 - Coordinate Reference System (CRS)

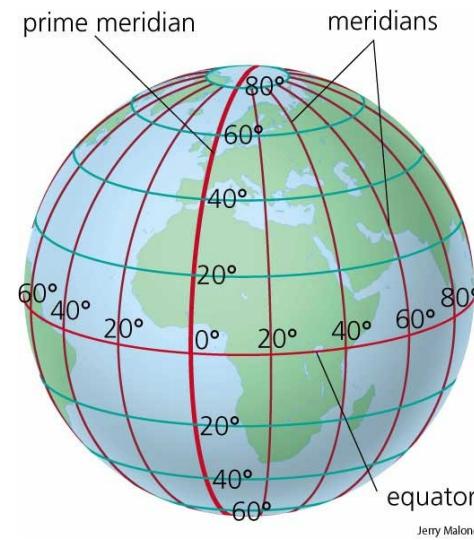
Geographic coordinate system

Angular unit
of measure



WGS84: Longitude & Latitude

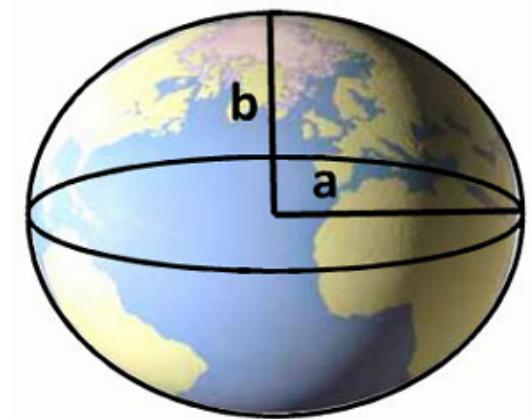
Prime meridian



Greenwich

Datum

$$a > b$$

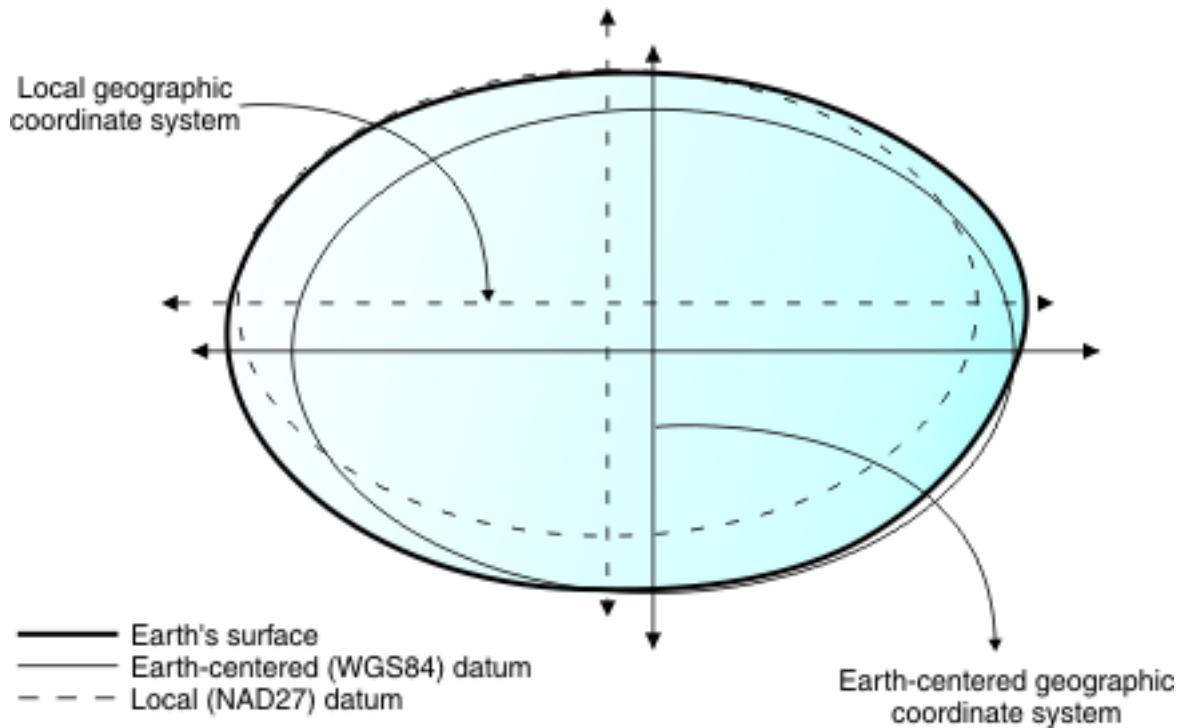


$a = 6378137 \text{ m}$
 $b = 6356752.3142 \text{ m}$
Origin: Earth's center of mass

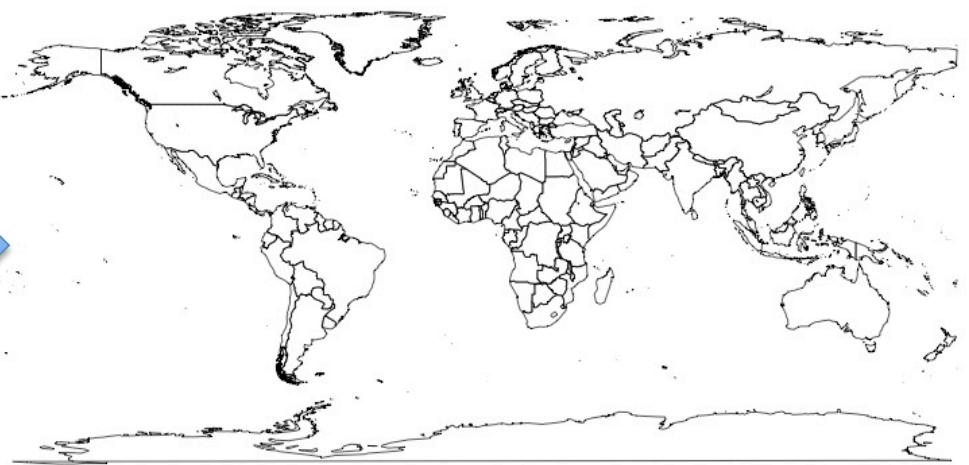
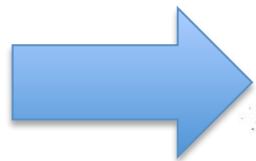
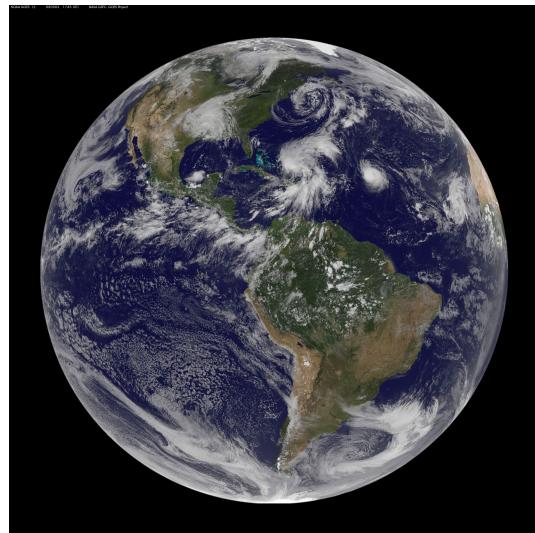
Geographic coordinate system

- Define a point on the earth's surface
- World Geodetic System 1984 (WGS84)
 - models the earth as a ellipsoid
(not a perfect sphere)
- Latitude 90° to -90° North South
 - Poles are fixed
- Longitude 0° to 360° (-180° to 180°) East-West
 - Choice of prime meridian, usually Greenwich

Geographic coordinate system: Global vs. local



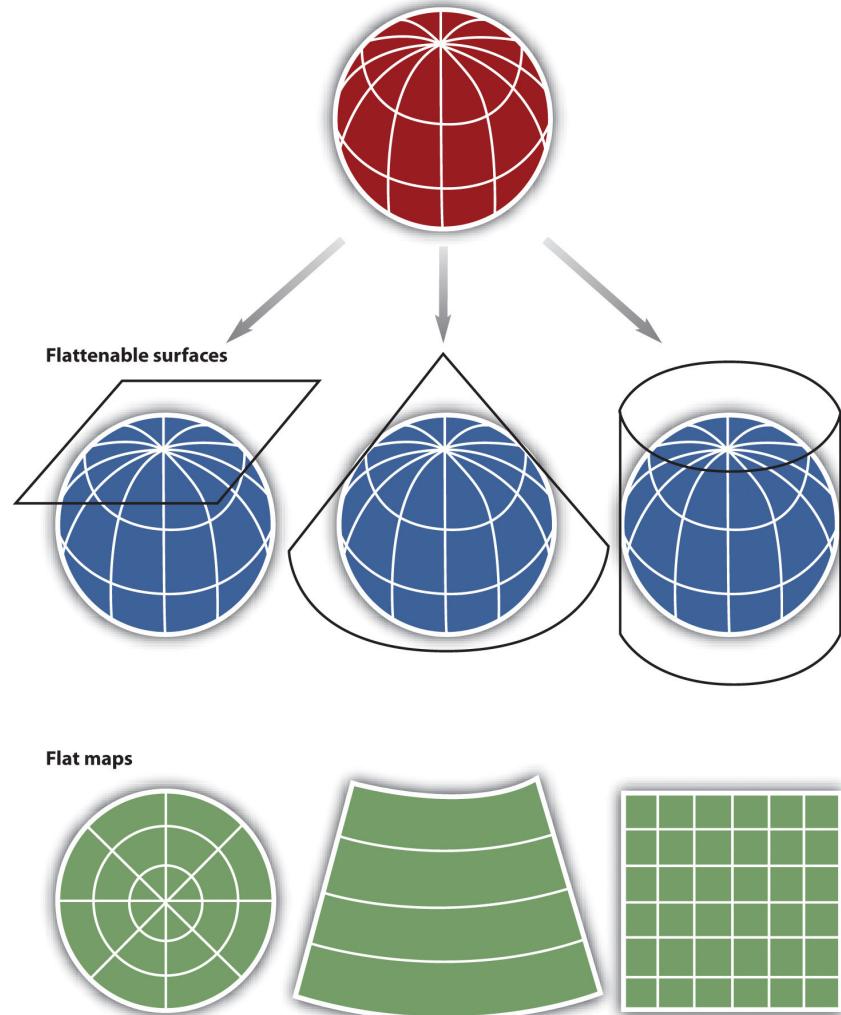
A spherical Earth on a flat map: Projected coordinate reference system



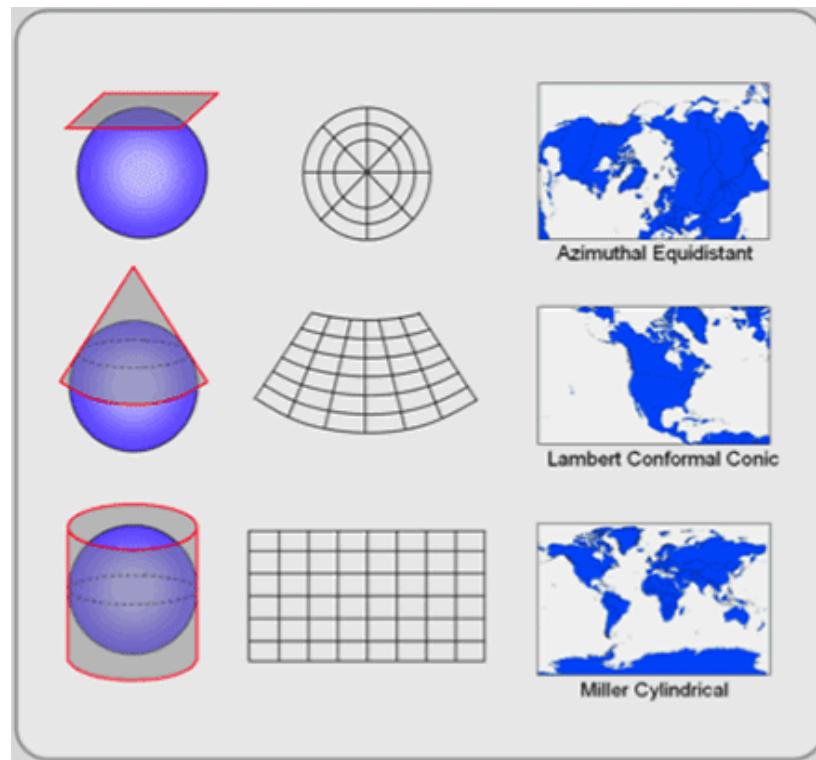
Projected coordinate system

- Defined on flat, 2D surface
- Always based on a geographic coordinate system
- Locations identified by x and y coordinates on a grid, with origin at the center of the grid.
- Always distort some measures
- Trade-off between area, direction, shape and distance.

Projected coordinate reference system

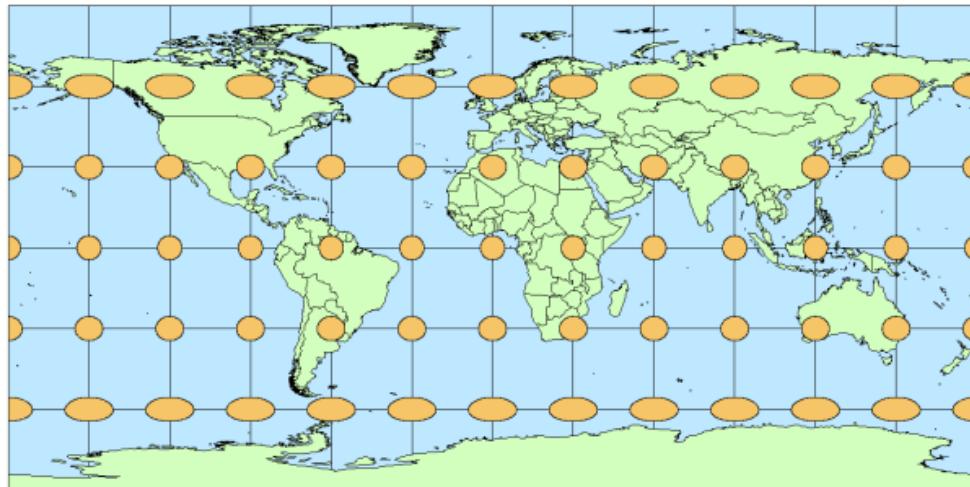


Projected coordinate reference system



Projected coordinate system: Tissot indicatrix

Cylindrical



Cylindrical

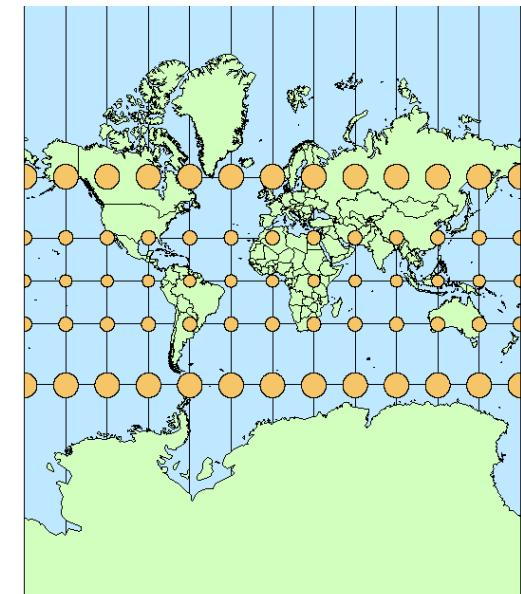
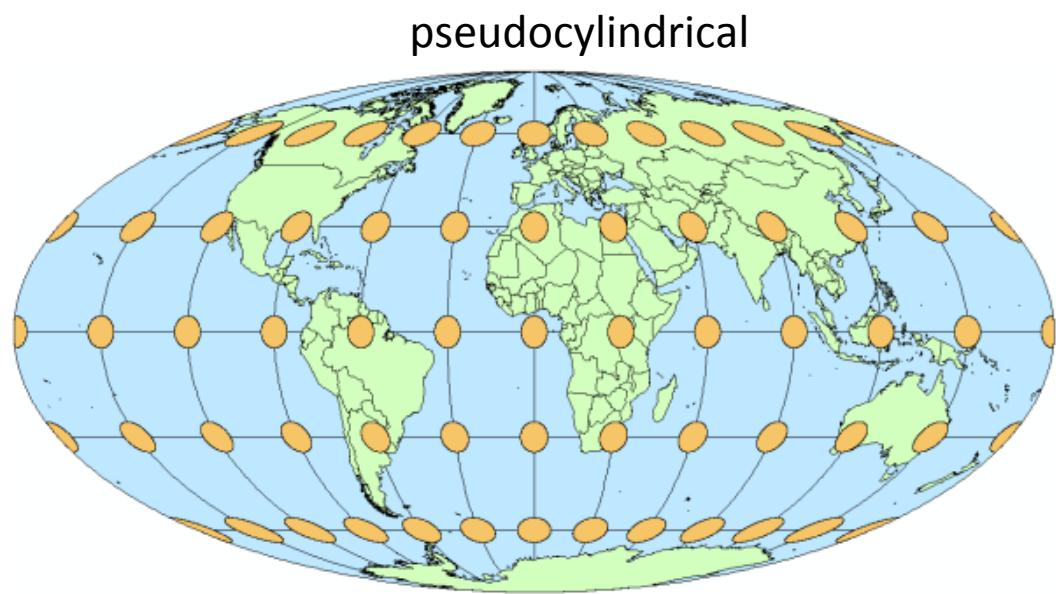


Plate carrée

Mercator

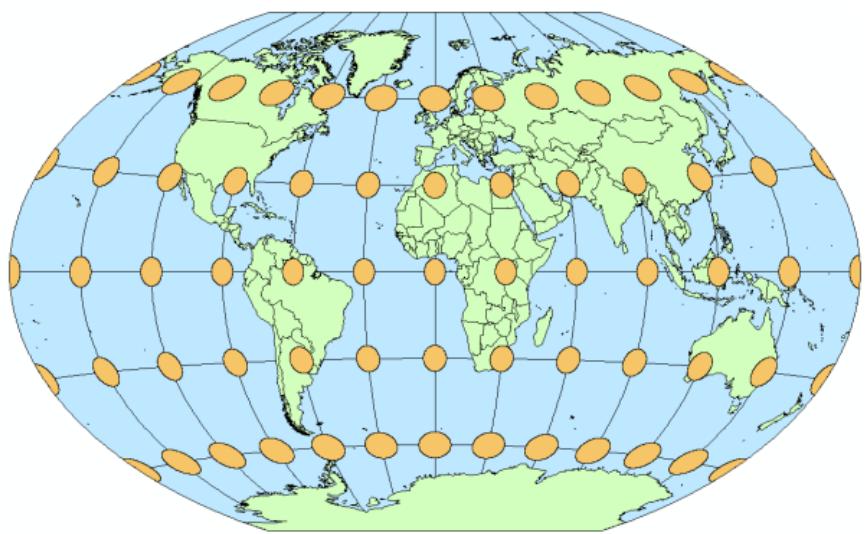
Equal shape (conformal)

Projected coordinate system: Tissot indicatrix



Mollweide

Equal area



Winkel

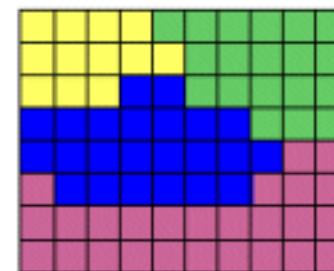
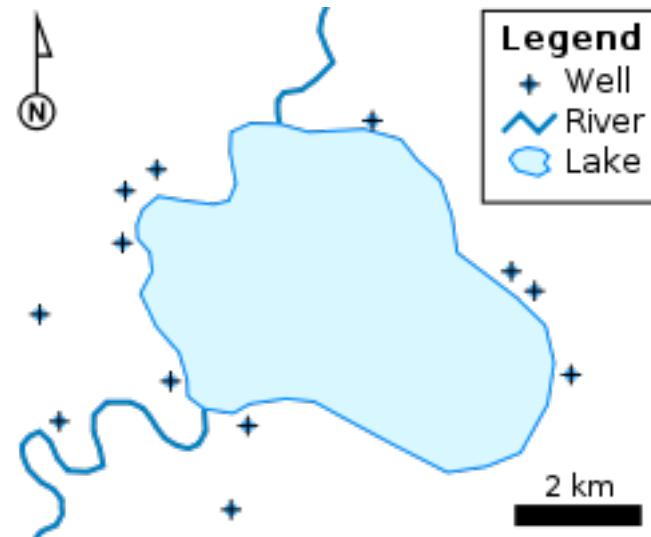
Compromise:
- Area
- Direction
- Distance

Projected coordinate reference system

- European Petroleum Survey Group (EPSG, now Oil & Gas Producers) have a list
- spatialreference.org
- Available through rgdal package
- PROJ.4

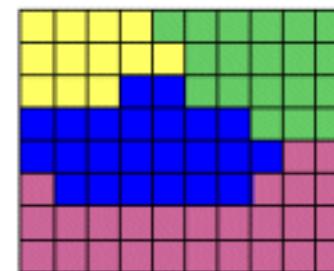
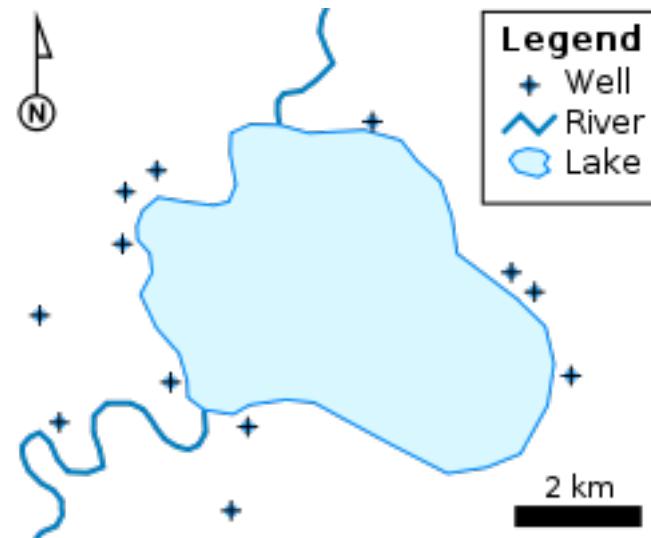
Data type

- Vector data
 - Points
 - Lines
 - Polygon
- Raster data



Data type

- Vector data
 - Points
 - Lines
 - Polygon
- Raster data



Points

- Point
 - 0D geometric object
 - Single location in a coordinate space
 - Described by a pair of numbers, e.g.,
 - (x, y)
 - (longitude, latitude)
 - (Easting, Northing)

Object class in R

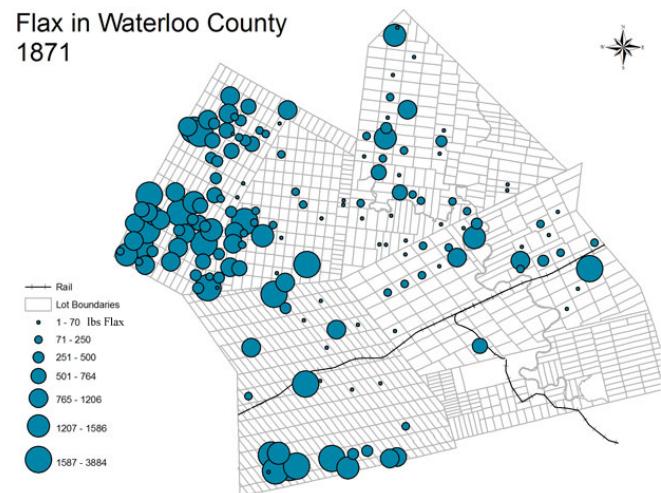
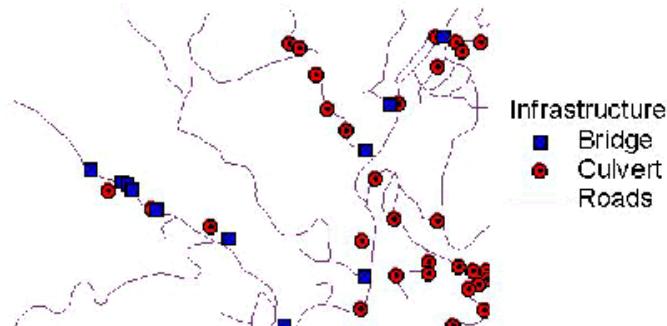
- Class of R objects will determine the methods (generic functions) used to handle it
- Class will usually affect `print()`, `plot()`, `summary()`, etc
- S4 class have formal definitions that specify the name and type of the contained slots (i.e. components)

Spatial object in R - SpatialPoints

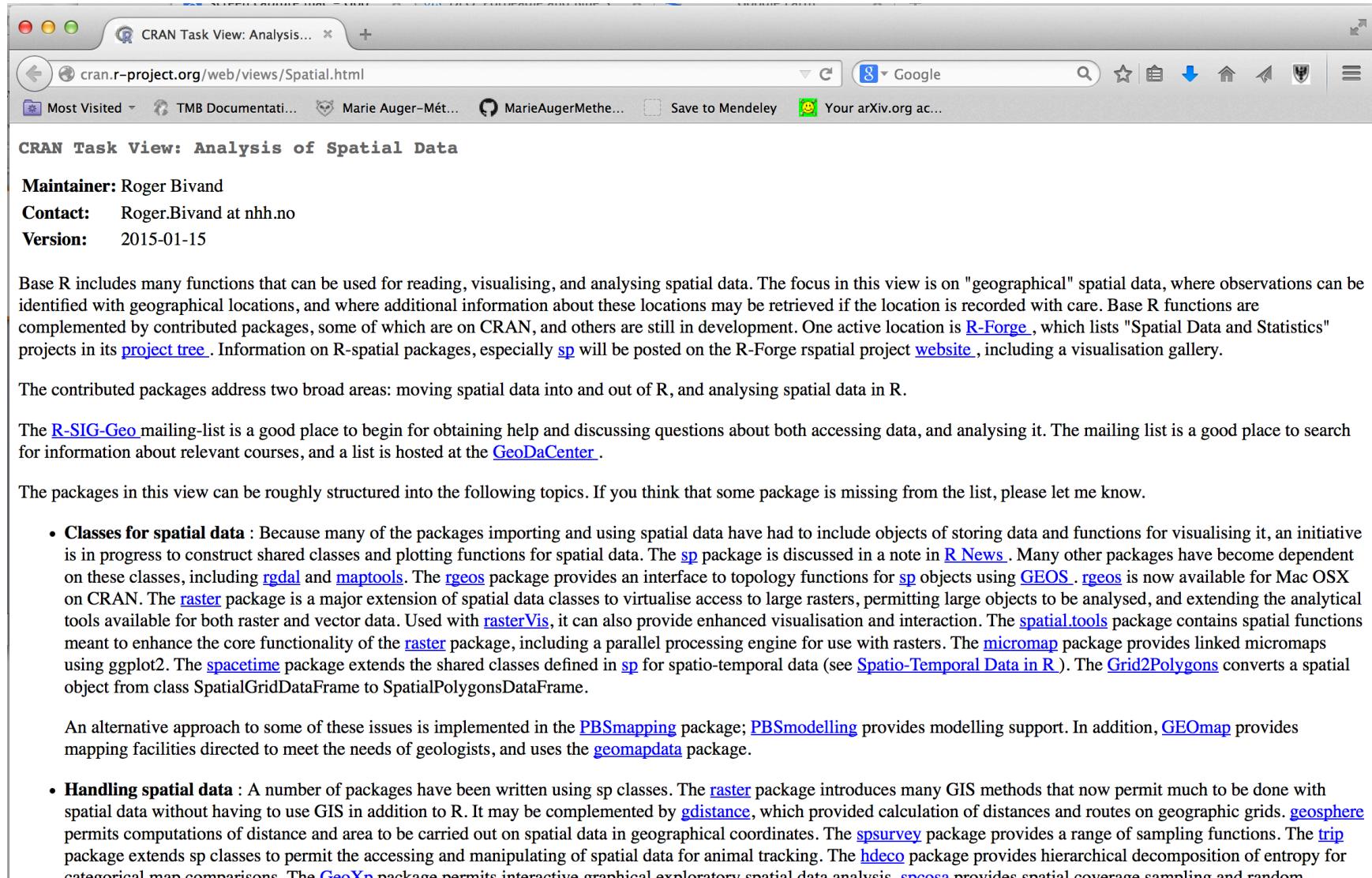
- Slots:
 - coords: Coordinates of the points
 - (x,y locations)
 - bbox: bounding box
 - extent of the object: xmin-xmax, ymin-ymax
 - proj4string: coordinate reference system

Attributes

- Answer question: ***what is where?***
- SpatialPointsDataFrame:
 - data (slot) data frame with attributes
- Attributes generally differ from across points.



Where to get info: CRAN spatial task view



The screenshot shows a web browser window with the title "CRAN Task View: Analysis of Spatial Data". The URL in the address bar is "cran.r-project.org/web/views/Spatial.html". The page content includes contact information for the maintainer (Roger Bivand), version (2015-01-15), and a description of the R spatial data analysis capabilities. It also mentions the R-SIG-Geo mailing list and provides links to related resources like PBSmapping, PBSmodelling, and GEOMap.

Maintainer: Roger Bivand
Contact: Roger.Bivand at nhh.no
Version: 2015-01-15

Base R includes many functions that can be used for reading, visualising, and analysing spatial data. The focus in this view is on "geographical" spatial data, where observations can be identified with geographical locations, and where additional information about these locations may be retrieved if the location is recorded with care. Base R functions are complemented by contributed packages, some of which are on CRAN, and others are still in development. One active location is [R-Forge](#), which lists "Spatial Data and Statistics" projects in its [project tree](#). Information on R-spatial packages, especially [sp](#) will be posted on the R-Forge r spatial project [website](#), including a visualisation gallery.

The contributed packages address two broad areas: moving spatial data into and out of R, and analysing spatial data in R.

The [R-SIG-Geo](#) mailing-list is a good place to begin for obtaining help and discussing questions about both accessing data, and analysing it. The mailing list is a good place to search for information about relevant courses, and a list is hosted at the [GeoDaCenter](#).

The packages in this view can be roughly structured into the following topics. If you think that some package is missing from the list, please let me know.

- **Classes for spatial data** : Because many of the packages importing and using spatial data have had to include objects of storing data and functions for visualising it, an initiative is in progress to construct shared classes and plotting functions for spatial data. The [sp](#) package is discussed in a note in [R_News](#). Many other packages have become dependent on these classes, including [rgdal](#) and [maptools](#). The [rgeos](#) package provides an interface to topology functions for [sp](#) objects using [GEOS](#). [rgeos](#) is now available for Mac OSX on CRAN. The [raster](#) package is a major extension of spatial data classes to virtualise access to large rasters, permitting large objects to be analysed, and extending the analytical tools available for both raster and vector data. Used with [rasterVis](#), it can also provide enhanced visualisation and interaction. The [spatial.tools](#) package contains spatial functions meant to enhance the core functionality of the [raster](#) package, including a parallel processing engine for use with rasters. The [micromap](#) package provides linked micromaps using ggplot2. The [spacetime](#) package extends the shared classes defined in [sp](#) for spatio-temporal data (see [Spatio-Temporal Data in R](#)). The [Grid2Polygons](#) converts a spatial object from class SpatialGridDataFrame to SpatialPolygonsDataFrame.

An alternative approach to some of these issues is implemented in the [PBSmapping](#) package; [PBSmodelling](#) provides modelling support. In addition, [GEOMap](#) provides mapping facilities directed to meet the needs of geologists, and uses the [geomapdata](#) package.

- **Handling spatial data** : A number of packages have been written using sp classes. The [raster](#) package introduces many GIS methods that now permit much to be done with spatial data without having to use GIS in addition to R. It may be complemented by [gdistance](#), which provided calculation of distances and routes on geographic grids. [geosphere](#) permits computations of distance and area to be carried out on spatial data in geographical coordinates. The [psurvey](#) package provides a range of sampling functions. The [trip](#) package extends sp classes to permit the accessing and manipulating of spatial data for animal tracking. The [hdeco](#) package provides hierarchical decomposition of entropy for categorical map comparisons. The [GeoXn](#) package permits interactive graphical exploratory spatial data analysis. [snosa](#) provides spatial coverage sampling and random

Where to get info: R-Sig-Geo mailing list

The screenshot shows a web browser window with multiple tabs open. The active tab is titled "R-sig-Geo Info Page". The page content is as follows:

R-sig-Geo -- R Special Interest Group on using Geographical data and Mapping

About R-sig-Geo

A mailing list for discussing the development and use of R functions and packages for handling and analysis of spatial, and particularly geographical, data. The list also covers mapping and cartographic issues, and interfaces between R and geographical information systems.

To see the collection of prior postings to the list, visit the [R-sig-Geo Archives](#).

Using R-sig-Geo

This list is for subscribed members only. Once you have subscribed, you can post a message to all the list members, by sending email to r-sig-geo@r-project.org. Please read the general R list [instructions](#) and the [posting guide](#) before sending anything to this mailing list!

You can subscribe to the list, or change your existing subscription including your subscribed email address, in the sections below.

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Your name (optional):

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Pick a password:

Where to get info: R-Sig-Geo mailing list

The image shows two screenshots of a web browser window. The top screenshot displays the 'R-sig-Geo Info Page' with a blue header bar containing the text 'R-sig-Geo -- R Special Interest Group on using Geographical data and Mapping'. Below this, a yellow box on the left contains the heading 'About R-sig-Geo' and a text block describing the mailing list's purpose. A yellow box on the right contains the text 'English (USA)'. The bottom screenshot shows the 'r-sig-geo.2731867.n2.nabble.com' page, which is an archive for the mailing list. It features a header with 'R-sig-geo' and links for 'Login' and 'Register'. Below the header is a search bar and a navigation bar with links for 'New Topic', 'People', and 'Options'. A pagination bar shows pages 1 through 231. The main content area is a table titled 'Topics (8061)' with columns for 'Topics', 'Replies', 'Last Post', and 'Views'. The first three rows of the table are visible.

Topics (8061)	Replies	Last Post	Views
Raster package - Focal sum in circles by Vanessa Machault	0	7:17am by Vanessa Machault	1
regression kriging with singular variogram by Bede-Fazekas Ákos	1	3:20am by edzer	0
Intersection - Input geom 0 is invalid by Milan Cictv	2	10:25am by Milan Cictv	2

Where to get info: R-Sig-Geo mailing list

Screenshot of a web browser showing the R-sig-Geo Info Page:

The browser tabs include: CRAN Task View: Analysis..., R-Forge: Software Map, R-sig-Geo Info Page, search r-sig-geo - Google..., and R-sig-geo | Mailing List A... .

The address bar shows: https://stat.ethz.ch/mailman/listinfo/r-sig-geo

The page title is: R-sig-Geo -- R Special Interest Group on using Geographical data and Mapping

A yellow header bar contains "About R-sig-Geo" and "English (USA)".

The main content area describes the mailing list as a forum for discussing the development and use of R functions and packages for handling and analysis of spatial, and particularly geographical, data. The list also covers mapping and cartographic issues, and interfaces between R and geographical information systems.

Screenshot of the R-sig-geo mailing list archive on nabble.com:

The browser tabs and address bar are identical to the previous screenshot.

The page title is: R-sig-geo

The main content area states: This forum is an archive for the mailing list **r-sig-geo@r-project.org** ([more options](#)). Messages posted here will be sent to this mailing list.

A large red arrow points from the "Messages posted here will be sent to this mailing list." text towards the search bar.

The navigation bar includes: New Topic, People, Options, Login, Register, and a search bar.

The topic list table has columns: Topics (8061), Replies, Last Post, and Views.

Topics (8061)	Replies	Last Post	Views
Raster package - Focal sum in circles by Vanessa Machault	0	7:17am by Vanessa Machault	1
regression kriging with singular variogram by Bede-Fazekas Ákos	1	3:20am by edzer	0
Intersection - Input geom: 0 is invalid by Milan Cictv	2	10:25am by Milan Cictv	2

Where to get info: stackoverflow

The screenshot shows a web browser window with multiple tabs open. The active tab is 'Stack Overflow' at stackoverflow.com. The page displays the 'Top Questions' section, featuring a list of programming-related questions. The first question is about 'DPLYR "Error in n(): function should not be called directly"'. Other visible questions include 'Python: search and replace - string delineation issue', 'How insert csv into mysql with rails in join table?', 'Linkage Errors while building Wrapping class using Boost.Python', and 'which '.PID' file as 'uwsgi reload' parameter in non-django python project?'. To the right of the main content, there is a sidebar titled 'Hot Meta Posts' listing several community-related topics. At the bottom right, there is an advertisement for Microsoft Azure.

CRAN Task View: Analysis... R-Forge: Software Map R-sig-Geo Info Page Stack Overflow

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5 votes 1 answer 1k views DPLYR "Error in n(): function should not be called directly" r function plyr dplyr conflicting-libraries modified 32 secs ago Michael Bellhouse 90

0 votes 0 answers 1 view Python: search and replace - string delineation issue python string python-2.7 search asked 33 secs ago Duncan 649

0 votes 0 answers 2 views How insert csv into mysql with rails in join table? mysql ruby-on-rails ruby csv ruby-on-rails-4 asked 40 secs ago user3089327 37

0 votes 0 answers 3 views Linkage Errors while building Wrapping class using Boost.Python c++ visual-studio-2012 boost boost-python asked 41 secs ago scap3y 782

0 votes 0 answers 3 views which '.PID' file as 'uwsgi reload' parameter in non-django python project? python-2.7 uwsgi modified 45 secs ago Yan Yang 20

Hot Meta Posts

19 'Unregistered' is offset on the user page

7 Do we need community promotion ads?

14 "Congratulations!" audit notification does not appear if audit is the 20th re...

3 Remove bottom margin on images

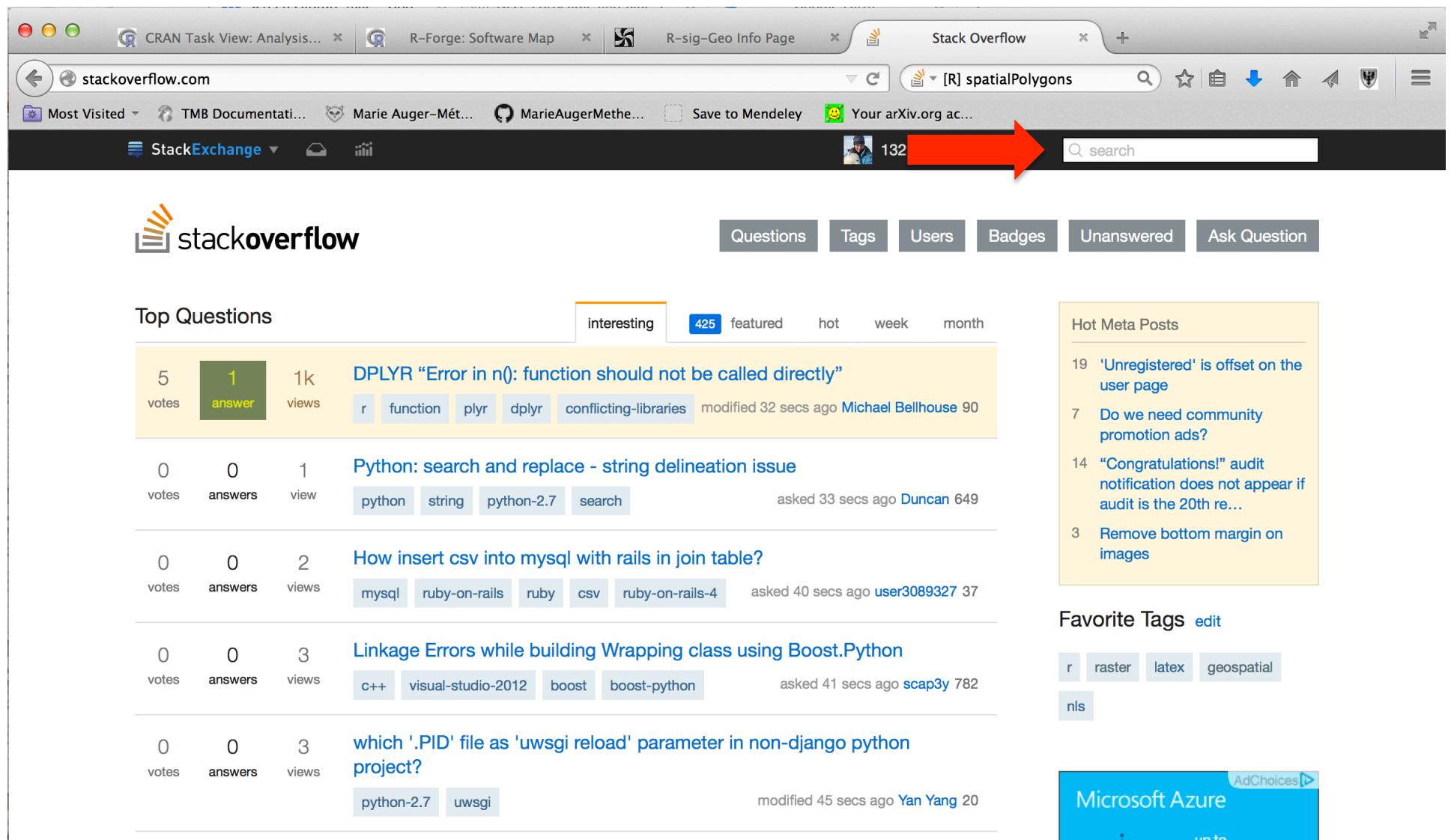
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Where to get info: stackoverflow



The screenshot shows a web browser window with several tabs open. The active tab is 'Stack Overflow'. The browser's address bar shows 'stackoverflow.com' and the search term '[R] spatialPolygons'. The user profile icon in the top right corner is highlighted with a large red arrow.

Top Questions

votes	answers	views	question title	tags	asked	by	views
5	1	1k	DPLYR "Error in n(): function should not be called directly"	r function plyr dplyr conflicting-libraries	modified 32 secs ago	Michael Bellhouse	90
0	0	1	Python: search and replace - string delineation issue	python string python-2.7 search	asked 33 secs ago	Duncan	649
0	0	2	How insert csv into mysql with rails in join table?	mysql ruby-on-rails ruby csv ruby-on-rails-4	asked 40 secs ago	user3089327	37
0	0	3	Linkage Errors while building Wrapping class using Boost.Python	c++ visual-studio-2012 boost boost-python	asked 41 secs ago	scap3y	782
0	0	3	which '.PID' file as 'uwsgi reload' parameter in non-django python project?	python-2.7 uwsgi	modified 45 secs ago	Yan Yang	20

Hot Meta Posts

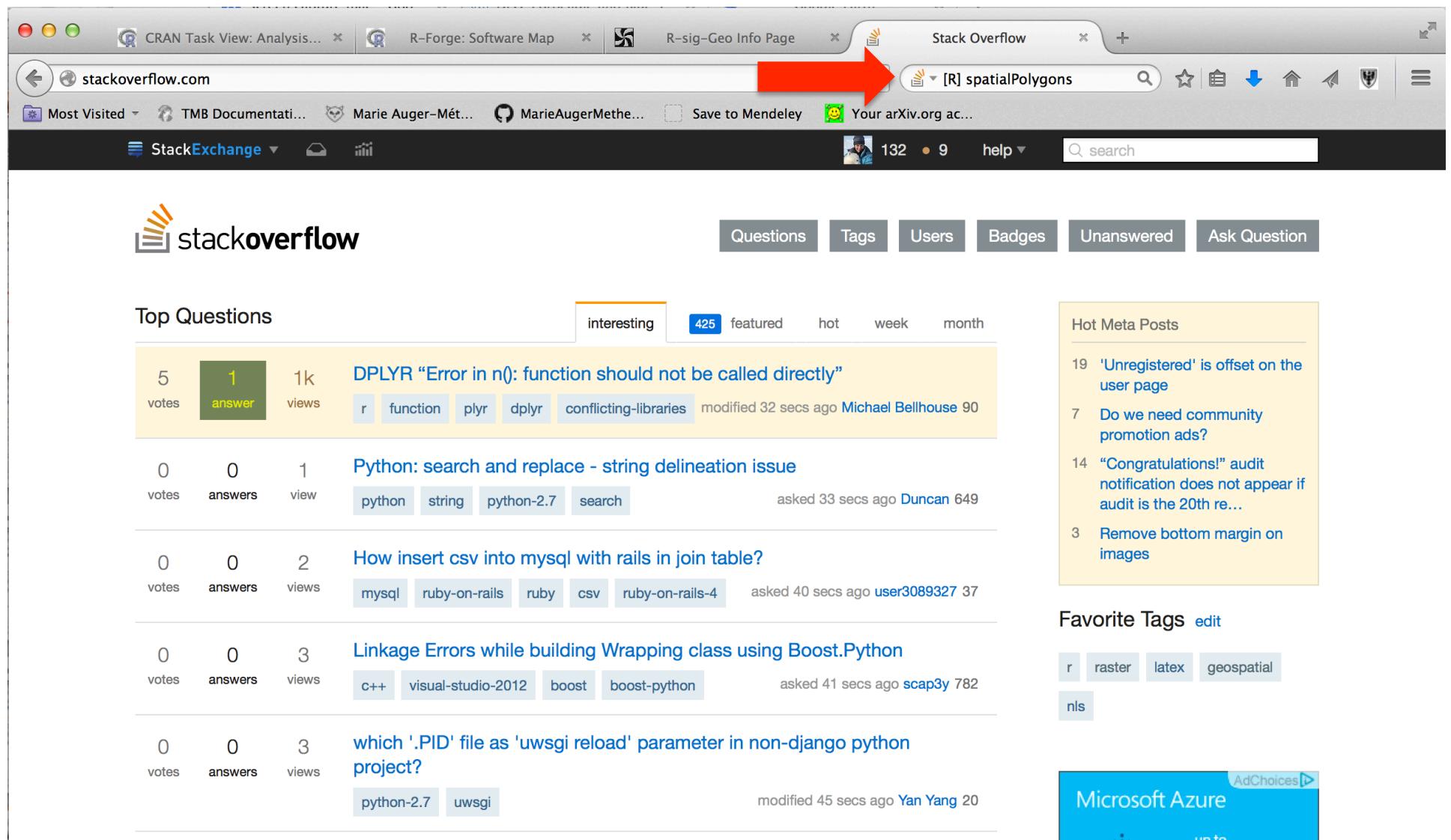
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- geospatial
- nls

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Where to get info: stackoverflow



The screenshot shows a web browser window with several tabs open. The active tab is 'Stack Overflow'. The search bar in the top right of the browser has the text '[R] spatialPolygons' entered. A large red arrow points from the left towards this search bar.

Top Questions

votes	answers	views	question title	tags	asked	by	views
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0	0	3	Linkage Errors while building Wrapping class using Boost.Python	c++ visual-studio-2012 boost boost-python	asked 41 secs ago	scap3y	782
0	0	3	which '.PID' file as 'uwsgi reload' parameter in non-django python project?	python-2.7 uwsgi	modified 45 secs ago	Yan Yang	20

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Question

Question

Best
answer

Best
answer

How can I create raster plots with the same colour scale in R?

I'm creating some maps from raster files using the "raster" package in R. I'd like to create comparison rasters, showing several maps side by side. It's important for this that the color scales are the same for all maps made, regardless of the values in each map. For example, if map 1 has values from 0-1, and map 2 has values from 0-100, one with a value of 5 should have the same colour on both maps.

For example:

- map 1 has values from 0 to 1
- map 2 has values from 0 to 0.5
- the colour goes from red (lowest) to green (highest)

I can't find a way to make this work. I can't see any way to set the range of pixel values to use with the plotting function, `setMinMax()` doesn't help as 'plot' always calculates the extent. Even trying to set the values by hand (`g[3]@data@max < 10`) doesn't work. These are ignored when plotting.

Finally, making a stack of the maps (which might be expected to plot everything on the same colour scale) doesn't work either - each map still has its own colour scale.

Any thoughts on how to do this?

EDIT:

The solution I ended up using is:

```
plot(d, col=rev(rainbow(99, start=0,end=1)), breaks=seq(min(d@values), d@maxValue))
```

share edit flag asked Nov 30 '10 at 18:40 [mrooseph](#) 3 ● 9 ● 16 ● 27

the solution you ended up using is actually the best answer. Please put it as an answer and accept! I almost missed it - I don't look for answers in a question. – TMB Aug 26 '13 at 8:09

`sprint` creates a `RasterStack`, with a global legend for all the layers. The `raster` package defines a method for `plot`, so you can't need to convert your `RasterStack` to an `SpatRaster` object to use it.

– Oscar Perpiñán Aug 30 '13 at 0:24

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3 Answers

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Since the `image.raster` function specifies that the `image` base arguments can be passed to `grid` suggests that image-based plots probably work, wouldn't you just specify the same `cols` and `breaks` arguments to all calls to `image.raster`? You do need to get the breaks and the col arguments "in sync". The number of colors needs to be one less than the number of breaks. The example below is based on the first version of the data and the second version shows how a range of values can be excluded from an image:

```
x <- 10^2*1:(new(volcano))
y <- 10^2*(new(volcano))
image(x, y, col=rev(rainbow(99, start=0, end=1)), breaks=seq(0, 250, by = 1), axes = FALSE, t axisLabels = at = seq(200, 400, by = 100))
axis(1, at = seq(200, 400, by = 100))
axis(2, at = seq(200, 400, by = 100))
box()
title(main = "Mauna Whau Volcano", font.main = 4)

x <- 10^2*1:(new(volcano))
y <- 10^2*(new(volcano))
image(x, y, col=rev(rainbow(99, start=0, end=1)), breaks=seq(100, 200, by = 5)-1, axes = FALSE,
t axisLabels = at = seq(200, 400, by = 100))
axis(1, at = seq(200, 400, by = 100))
axis(2, at = seq(200, 400, by = 100))
box()
title(main = "Mauna Whau Volcano Restricted to elevations above 100", font.main = 4)
```

A specific example would aid this.

share edit flag answered Nov 30 '10 at 18:21 [BordenDust](#) 196 ● 3 ● 70 ● 171

That's perfect, thanks so much! I ended up doing `plot(d, col=rev(rainbow(99, start=0,end=1)), breaks=seq(0, 250, by = 1), axes = FALSE, t axisLabels = at = seq(200, 400, by = 100))` (sorry, can't seem to format in the comments) – [Roman Luttko](#) Nov 30 '10 at 18:40

add a comment

More work to do here in "raster" here is a hack:

```
library(raster)
r1 <- raster(volcano, res=rw@res)
r2 <- raster(volcano[[1]])
r3 <- raster(volcano[[2]])
r4 <- raster(volcano[[3]])
r5 <- raster(volcano[[4]])
rk <- stack(r1, r2, r3, r4, r5)
s <- stack(rk, r6)
```

`blk <- c(0.25, 0.5, 0.75, 1)`

r-sig-geo raster package display

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Colin Robertson Jun 29, 2011, 12:50pm [raster package display](#) Reply Threaded

Dear List,

I am creating a `raster` as the output of a function, and for testing purposes the output of this function should be a `raster` with all 1's.

When I check with summary, this is the case:

```
class(out)[2]
[1] "raster"
attr("package")
[1] "raster"
```

summary(out)[2]
Cells: 300
Mean: 1
Min: 1
1st Qu.: 1
Median: 1
Mean: 1
3rd Qu.: 1
Max: 1
NA's: 304

Yet when I `plot` using `plot(out[2])`, I get a display of values ranging from 0.6 - 1.4.

All summaries on the `raster` indicates all cells have value of 1, but the display shows differently.

Any ideas on what is happening here much appreciated,

Thanks +
Colin

2-expGeo mailing list
[\[hidden email\]](#)
<https://expat.eliza.ch/mailman/listinfo/r-sig-geo>

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Barry Rowlingson Jun 29, 2011, 11:13pm Re: raster package display

On Wed, Jun 29, 2011 at 4:50 PM, Colin Robertson <[\[hidden email\]](#)> wrote:

> Dear List,

> I am creating a `raster` as the output of a function, and for testing purposes the output of this function should be a `raster` with all 1's.

> When I check with summary, this is the case:

```
> class(out)[2]
[1] "raster"
> [1] "raster"
```

> I suspect... and a quick look at the code will confirm it - that it just decides to expand the key a bit because your values are all 1.

The image `plot` function in the fields package does the `same` thing for a matrix of all the `same` values.

In a word, it's not lying, because its showing you all the cells which have a value of 1. I think it's just not showing you that there are no cells with any other colour. I guess a `scale` with 1 at the top, middle, and bottom would look odd.

If you add a `lim` parameter you can get something that may be a bit more meaningful:

```
plot(raster(marne[1,10,10]))
plot(raster(marne[1,10,10], lim=c(0,1)))
plot(raster(marne[1,10,10], lim=c(0,99,1,01)))
```

The colour ramp then shows you there's nothing at 1.010, since there's nothing green on the plot...

Barry

2-expGeo mailing list
[\[hidden email\]](#)
<https://expat.eliza.ch/mailman/listinfo/r-sig-geo>

Colin Robertson Jun 29, 2011, 1:12pm Re: raster package display

Thanks Barry, that was it.

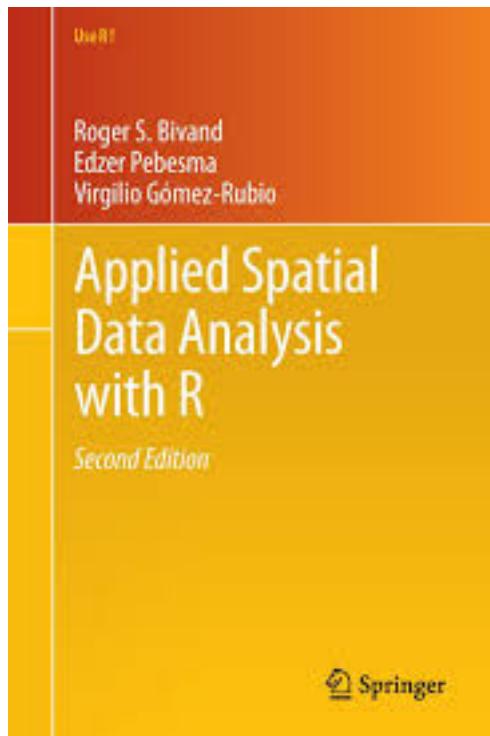
Colin

On Wed, Jun 29, 2011 at 12:13 PM, Barry Rowlingson <[\[hidden email\]](#)> wrote:

> On Wed, Jun 29, 2011 at 4:50 PM, Colin Robertson <[\[hidden email\]](#)> wrote:

>> > I am creating a `raster` as the output of a function, and for testing purposes the output of this function should be a `raster` with all 1's.

Where to get info: Bivand et al. (2013) Book



Online version available through
Dalhousie's library

Mainly for vector data
(not much on rasters)