R, GRASS, and Spatial Analysis

cengel - June/06

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Geospatial data

- **data attributes:**
  - geographic location coordinates (“georeferenced”)
  - 2 or 3 dimensional
  - vector and raster file formats
- **data processing:**
  - import, conversion
  - projection, re-projection, alignment of multiple datasets, resampling
- **data analysis:**
  - visualization
  - EDA
  - spatial statistics
  - (GIS operations, eg. create new layers)

Spatial Statistics

what you might want to do..

- **spatial point processing**
  - distribution of location of events (random, regular, clustered)
- **spatial autocorrelation**
  - correlation of location of events
- **smoothing, interpolation**
  - create surfaces from few known data
- **geostatistics**
  - predict spatial distributed features

R geospatial packages
(selection)

- **sp**
  - foundation classes, interface to coordinate systems, utility plotting methods, sampling methods
    - http://finzi.psych.upenn.edu/R/library/sp/html/00Index.html

sp

- **spatial classes provided by package *sp***

data type	class	attributes	extends
points	SpatialPoints	none	Spatial*
points	SpatialPointsDataFrame	AttributeList	SpatialPoints*
pixels	SpatialPixels	none	SpatialPoints*
pixels	SpatialPixelsDataFrame	AttributeList	SpatialPixels* SpatialPointsDataFrame**
full grid	SpatialGrid	none	SpatialPixels*
full grid	SpatialGridDataFrame	AttributeList	SpatialGrid*
line	Line	none	
lines	Lines	none	Line list
lines	SpatialLines	none	Spatial*, Lines list
lines	SpatialLinesDataFrame	data.frame	SpatialLines*
polygon	Polygon	none	Line*
polygons	Polygons	none	Polygon list
polygons	SpatialPolygons	none	Spatial*, Polygons list
polygons	SpatialPolygonsDataFrame	data.frame	SpatialPolygons*

* by direct extension; ** by setIs() relationship;

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sp

- **methods provided by package *sp***

method	what it does
`[`	select spatial items (points, lines, polygons, or rows/cols from a grid) and/or attributes variables
`$, $<-, [[, [[<-`	retrieve, set or add attribute table columns
`spsample`	sample points from a set of polygons, on a set of lines or from a gridded area, using the simple sampling methods given in Ripley (1981)
`spplot`	lattice (Trellis) plots of spatial variables (figure 3; see text)
`bbox`	give the bounding box
`proj4string`	get or set the projection (coordinate reference system)
`coordinates`	set or retrieve coordinates
`polygons`	set or retrieve polygons
`gridded`	verify whether an object is a grid, or convert to a gridded format
`dimensions`	get the number of spatial dimensions
`coerce`	convert from one class to another
`transform`	(re-)project spatial coordinates (uses spproj)
`overlay`	combine two different spatial objects (see text)
`recenter`	shift or re-center geographical coordinates for a Pacific view

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more R geospatial packages

(selection)

- **maptools**
  - reading and handling of shape files
    - http://pbil.univ-lyon1.fr/library/maptools/html/00Index.html
- **maps**
  - drawing of basic geographical maps
- **spgpc**
  - polygon clipping
- **spGDAL (Geospatial Data Abstraction Library)**

R spatial statistics packages

(selection)

- **spatial**
  - core methods spatial point pattern analysis
    - part of the VR bundle (shipped with base R)
- **spatstat**
  - 2D point patterns multitype/marked points and spatial covariates, functions for exploratory data analysis, model-fitting, simulation, model diagnostics, and formal inference.
    - http://www.spatstat.org
- **splancs**
  - space-time, emphasis on points-within-polygons
- **spdep**
  - spatial regression, autocorrelation
    - http://finzi.psych.upenn.edu/R/library/spdep/html/00Index.html

more R spatial statistics packages

(selection)

- **gstat**
  - univariate and multivariate geostatistics (*large datasets*)
- **geoR, geoRglm**
  - model based geostatistics
- **fields**
  - curve and function fitting with an emphasis on splines, spatial data and spatial statistics (*large datasets*)
- **spatialCovariance**

more R packages

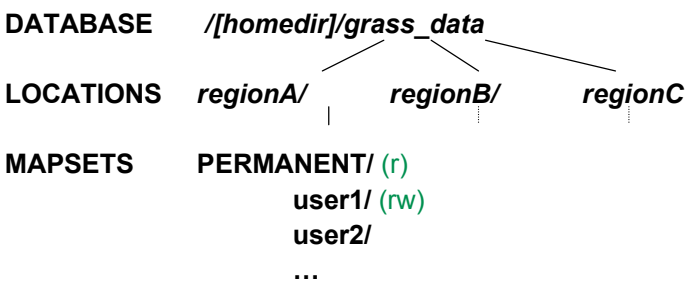
- **RArcInfo**
  - reads ArcInfo version 7 and e00 files
- **shapefiles**
  - reads and writes ESRI shapefiles
- **RColorBrewer**
  - color palettes optimized for thematic maps

References

- **Rgeo by spatial analysis Lab,U Illinois**
  - http://sal.uiuc.edu/csiss/Rgeo/
- **R-spatial on Sourceforge**
  - http://r-spatial.sourceforge.net/
- **Map packages on CRAN**
  - http://cran.r-project.org/src/contrib/Views/Spatial.html

spatial analysis with GRASS

- **GRASS 5 replaced with GRASS 6**
  - fundamental changes in handling vectors and attributes -> database
- **directory structure**



spatial analysis with GRASS

- **available methods**

d.*	display commands
db.*	database commands
g.*	general commands
g3.*	general3D commands
i.*	imagery commands
p.*	paint commands
pg.*	postGRASS commands
ps.*	postscript commands
r.*	raster commands
r3.*	raster3D commands
v.*	vector commands
m.*	miscellaneous commands
s.*	site manipulation commands

- **extensibility (write your own code)**

spatial analysis with GRASS

- **typical things being done with GRASS**
  - Erosion/hydrologic/terrain modeling,
  - visualization,
  - image processing, raster analysis,
  - landscape structure analysis (r.le)
- **often combined with R**

R/GRASS interface

- **library (GRASS)**
  - primarily data interface between R and GRASS5
- **library (spgrass6)**
  - recently released interface between R and GRASS 6
  - based on sp package
  - to provide vector and raster data interfaces

References

- **Manuals**
  - http://grass.itc.it/grass61/manuals/html61_user/full_index.html
  - http://grass.itc.it/gdp/manuals.php (searchable)
- **GRASS WIKI**
  - http://grass.gdf-hannover.de/wiki/Documents
- **g.manual -- command line**