Introduction to open source Spatial Analysis Tools and R

International Summer Academy on Spatial Ecotoxicology and Ecotoxicological Risk Assessment
Using an Open Commmunity Approach

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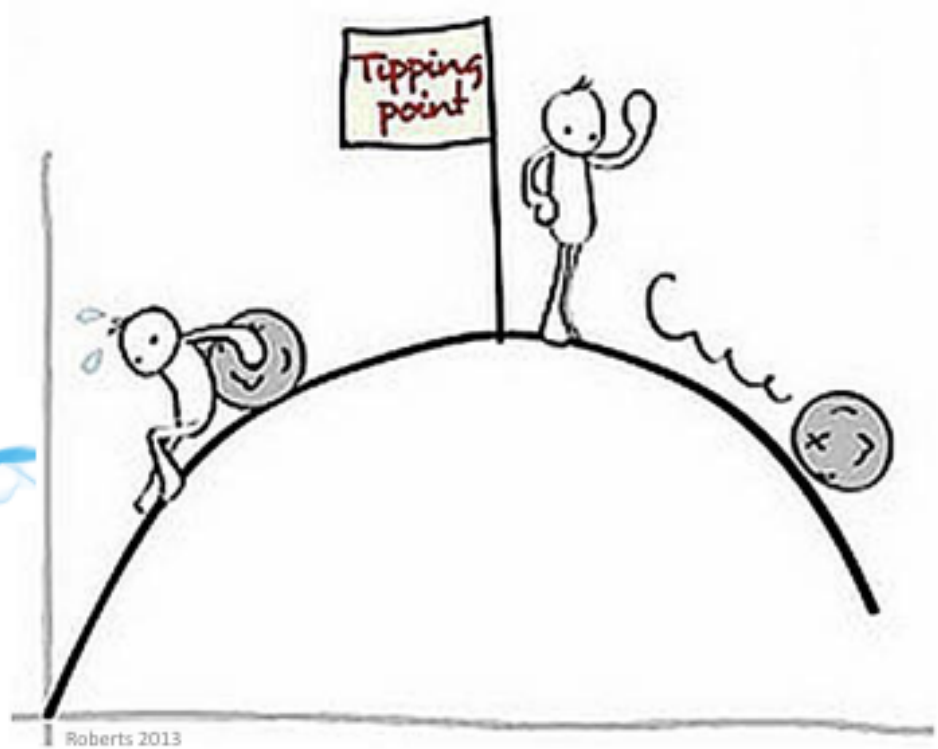
Stockholm University

Who am I?

PostDoc, Stockholm Resilience Centre | Lecturer, Universität Koblenz-Landau

The word cloud is based on the highlights from my publications (see publication section for details). Identification of the highlights and creation of the word cloud was performed using the R package wordcloud.



http://avitbhowmik.ml/ @avitbhowmik

Why Open Source?

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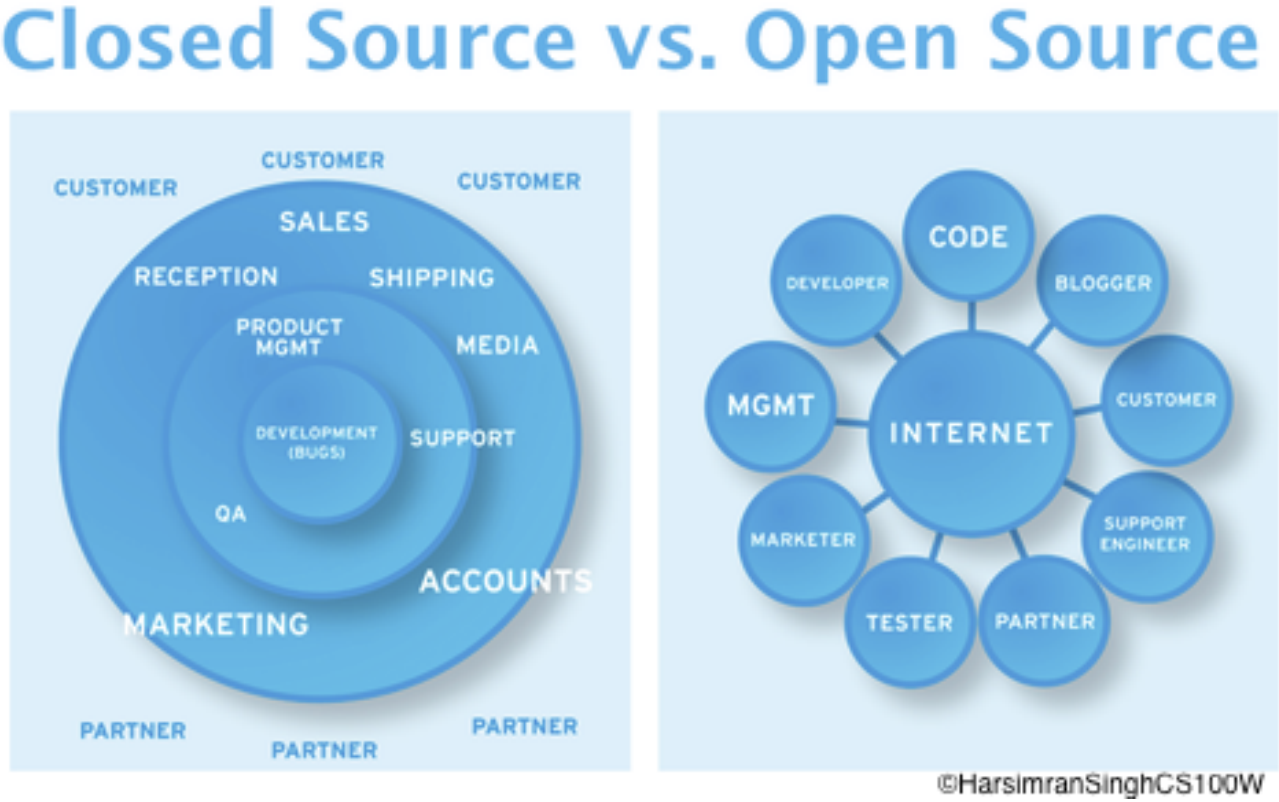


Why Open Source?

Advantages

- No costs (!!!)
  European Commision 2012: c.a. 450 billion euro savings p.a.
  https://joinup.ec.europa.eu/news/contribution-open-source-europes-economy-450-billion-year
- Coherent standard with proprietary software
- Freedom to adjust and distribute program
- Transparency and Reproducibility
  Rocchini and Neteler (2012) TREE, Barnes (2010) Nature
- Platform-independent

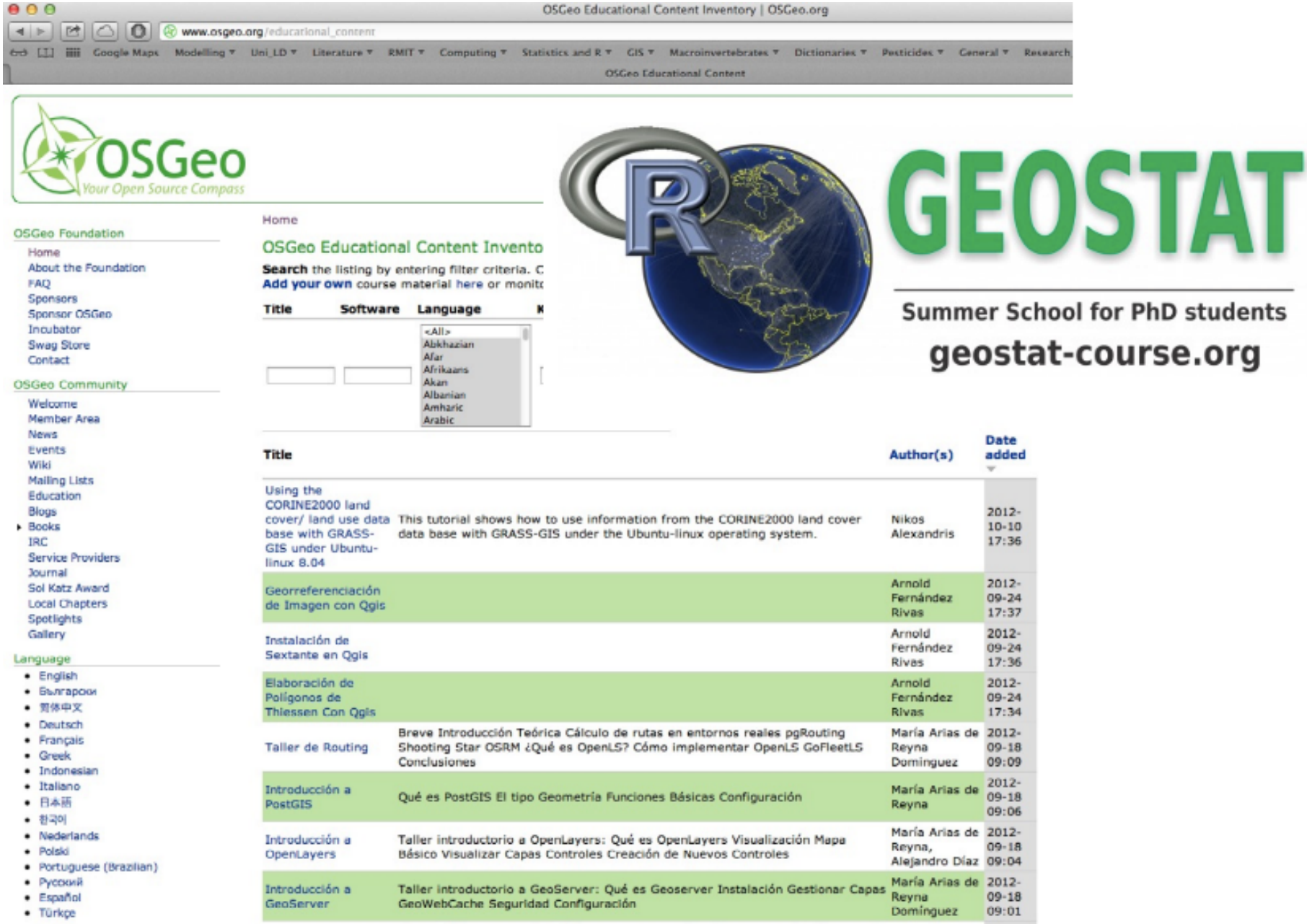
Why Open Source?

(Dis)advantages

- Comes without guarantee regarding bugs and features (but mailing lists and internet community)
- Sometimes smaller user communities (especially in companies and administration)
- In most cases less user-friendly/steeper learning curve

Big communities of “Free Open Source Software (FOSS)”

Learn about "Free Open Source Software (FOSS)"



Learn about "Free Open Source Software (FOSS)"

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International Journal of Geographical Information Science
Vol. 23, No. 10, October 2009, 1345–1370

Taylor & Francis
Taylor & Francis Group

Review Article

An overview on current free and open source desktop GIS developments

STEFAN STEINIGER*† and ERWAN BOCHER‡
†Department of Geography, University of Calgary, Calgary, AB, Canada
‡Ecole Central de Nantes, IRSTV, Nantes Cedex, France

(*Received 23 April 2008; final version received 19 October 2008*)

Over the past few years the world of free and open source geospatial software has experienced some major changes. For instance, the website FreeGIS.org currently lists 330 GIS-related projects. Besides the advent of new software projects and the growth of established projects, a n
Foundation has been established to of
an overview on existing free and open s
understanding of the open source
explanation of associated terms and in
license types: the General Public Lice
License (LGPL). After laying out the
different desktop GIS software projects
main tables summarise information
currently available software versions. F
open source software, with an emphasi

Keywords: free software; open source;

FOSS4G BOSTON 2017

ELSEVIER

Research Policy
Volume 32, Issue 7, July 2003, Pages 1243–1258
Open Source Software Development

Why Open Source software can succeed ☆

Andrea Bonaccorsi, Cristina Rossi

Ecological Informatics 4 (2009) 183–195

ELSEVIER

Contents lists available at ScienceDirect

Ecological Informatics

journal homepage: www.elsevier.com/locate/ecolinf

Free and open source geographic information tools for landscape ecology

Stefan Steiniger *, Geoffrey J. Hay

Department of Geography, University of Calgary, Calgary, Alberta, Canada T2N1N4

Open source (coherent) spatial analyses tools

GIS Sector	Examples proprietary Software	Examples Free Open Source Software
Desktop GIS	ArcGIS, GeoMedia, MapInfo, Idrisi	GRASS GIS, ILWIS, QGIS, SAGA GIS, R
Spatial Statistics	ArcGIS Extensions, Idrisi, ERDAS Imagine	OpenGeoDa, GeoMS, R & packages
Spatial Databases	Oracle Spatial, ArcGIS SDE	PostGIS, SpatiaLite, R & packages
Remote Sensing & Image Processing	ERDAS Imagine, ENVI, Ecognition, IDL	OTB, ILWIS, Opticks, GRASS GIS, R

R and moRe

R and moRe

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- Syntax : C++ family
- Object-oriented using classes
- Originally available in command line interface, popular editor: RStudio
- Also available in graphical user interface (GUI), e.g. "Duducer" and "R Commander". But forget about them!

R and moRe

Why R?

You cannot do it with anything else!

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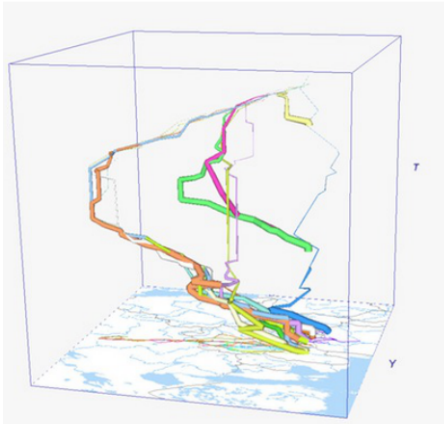
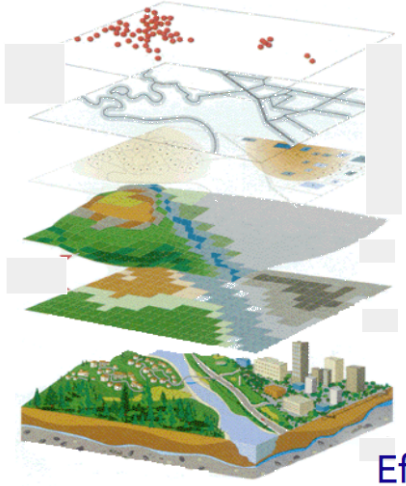


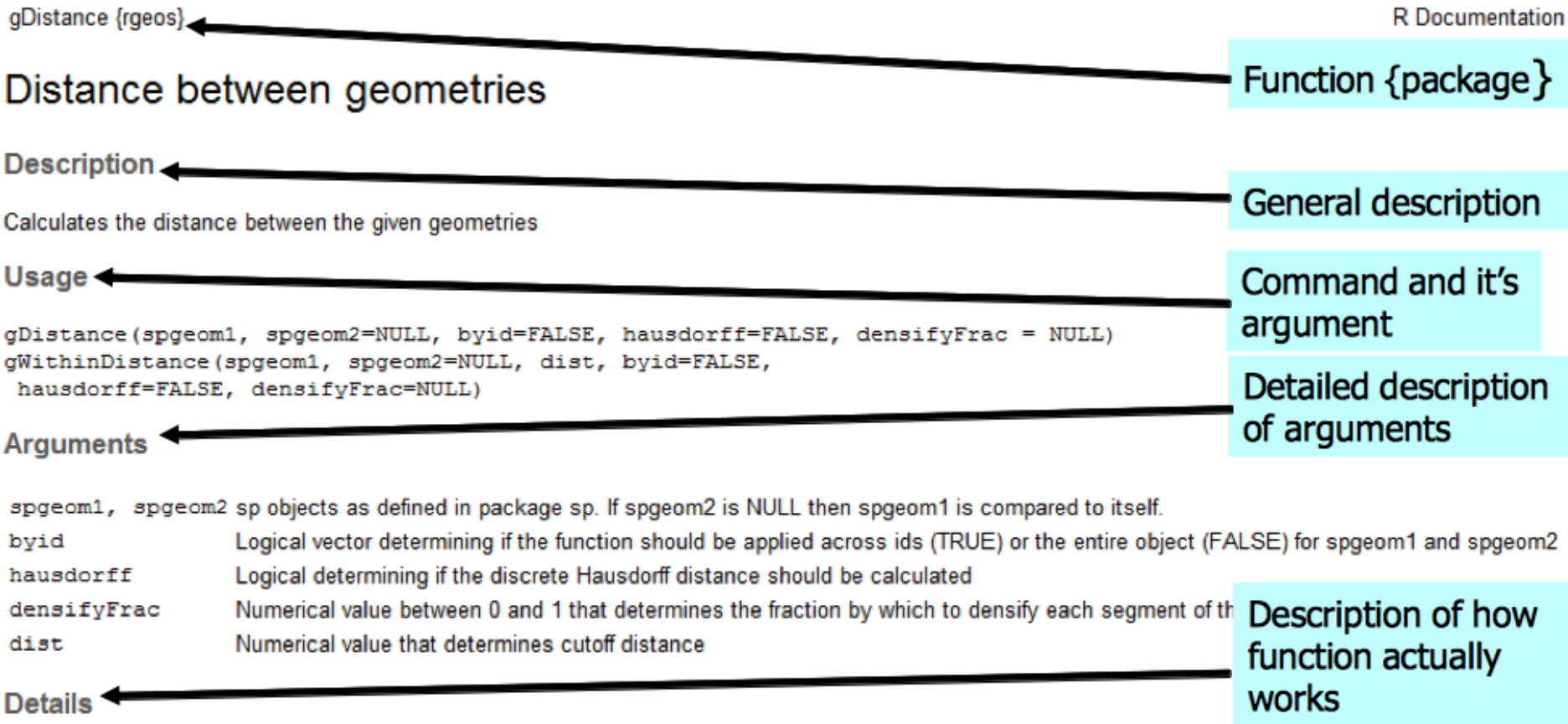
Analyses of Space-time data

Co-interfacing with other software



Efficient big raster data analysis

R and moRe: Functions



R and moRe: Functions

Value

What function returns

gDistance by default returns the cartesian minimum distance between the two geometries in the units of the current projection. If `hausdorff` is TRUE then the Hausdorff distance is returned for the two geometries.

gWithinDistance returns TRUE if returned distance is less than or equal to the specified `dist`.

Author(s)

Roger Bivand & Colin Rundel

References

Hausdorff Differences: http://en.wikipedia.org/wiki/Hausdorff_distance http://lin-ear-th-inking.blogspot.com/2009/01/computing-geometric-similarity.html

See Also

Related functions

`gWithinDistance`

Examples

Examples, can be run from R by `gDistance()`

```
pt1 = readWKT("POINT(0.5 0.5)")
pt2 = readWKT("POINT(2 2)")

p1 = readWKT("POLYGON((0 0,1 0,1 1,0 1,0 0))")
p2 = readWKT("POLYGON((2 0,3 1,4 0,2 0))")

gDistance(pt1,pt2)
gDistance(p1,pt1)
```

R and moRe: Objects

Vector

- An array (collection) of numbers, strings or factors
- e.g. 1 2 3 4 5 or “a” “b” “c” “d” “e”

R and moRe: Objects

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Factor

- An array (collection) of level (grouping variables), can be numbers or strings
- e.g. a b c d e

R and moRe: Objects

Matrix

- A table where rows and columns contain vectors
- Vector types of columns and rows should be the same, e.g. either numeric or string, these can not be combined

	col 1	col 2
row 1	“a”	“c”
row 2	“b”	“d”

R and moRe: Objects

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	col 1	col 2
row 1	"a"	"c"
row 2	"b"	"d"

Data Frame

- A table where columns contain vectors
- Vector types of columns can be different, e.g. numeric and string, and can be combined

	vector 1	vector 2
row 1	"a"	1
row 2	"b"	2

R and moRe: Objects

List

- A collection of elements, vectors or other objects

List[["Vector"]] "a" "b" "c" "d" "e"
List[["Matrix"]]

	col 1	col 2
row 1	"a"	"c"
row 2	"b"	"d"

List[["Data Frame"]]

	vector 1	vector 2
row 1	"a"	1
row 2	"b"	2

R and moRe

Spatial Packages

```
library(spacetime)
library(sp)
library(rgdal)
library(maptools)
library(mapdata)
library(raster)
library(rgeos)
library(spgrass)
library(tseries)
```

R and moRe

Integration with other spatial tools

- GRASS GIS ('spgrass6' package)
- SAGA GIS ('RSAGA' package)
- QGIS ('manageR' package)
- PostGIS (different solutions)
- ArcGIS ('RpyGeo' package) and many more...

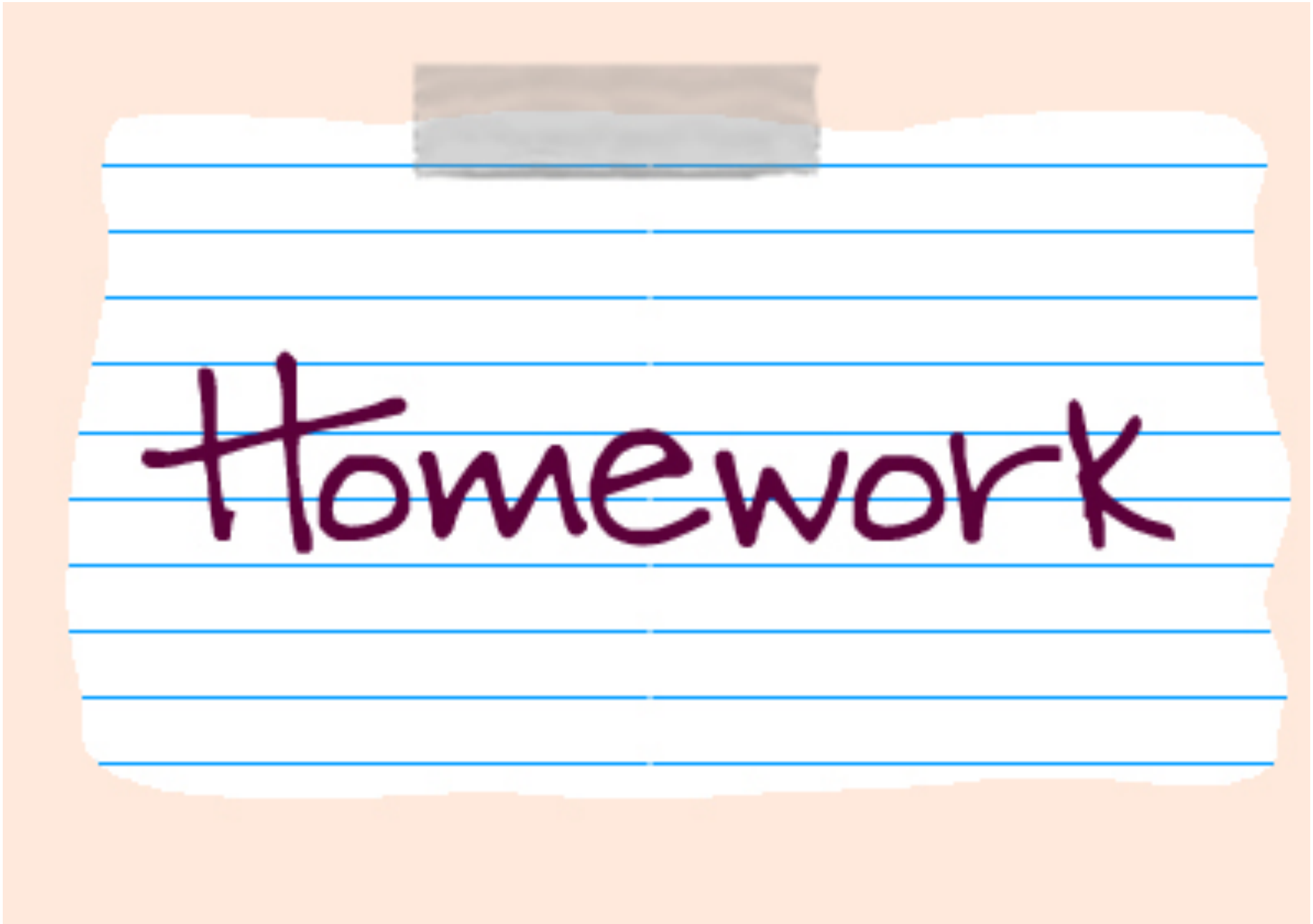
R and moRe

Spatial objects: class()

```
SpatialPointsDataFrame
SpatialLinesDataFrame
SpatialPolygonsDataFrame
SpatialGridDataFrame
stfdf
sp
raster
Extent
Date
xts, ts
```

Let's do it together!

Brain warming!


Homework

R Tutorials

Swirl

http://swirlstats.com/students.html

Online Course

http://tryr.codeschool.com/levels/1/challenges/1

R Project Page

https://www.r-project.org/

Software Map

Tag cloud | Project Tree | Project List

Project tree

Topic > **Spatial Data & Statistics**

- Classes for Spatial Data *(9 projects)*
- Disease Mapping and Areal Data Analysis *(3 projects)*
- Ecological Analysis *(43 projects)*
- Geostatistics *(9 projects)*
- Point Pattern Analysis *(7 projects)*
- Reading and Writing Spatial Data *(13 projects)*

RSpatial

CRAN Task View: Analysis of Spatial Data

Maintainer: Roger Bivand
Contact: Roger.Bivand at nhh.no
Version: 2015-08-09

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 rspatial 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.

There are a number of contributed tutorials and introductions; a recent one is Introduction to visualising spatial data in R by Robin Lovelace and James Cheshire.

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 . 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.

https://cran.r-project.org/web/views/Spatial.html

R Cookbook

Cookbook for R

Welcome to the Cookbook for R. The goal of the cookbook is to provide solutions to common tasks and problems in analyzing data.

Most of the code in these pages can be copied and pasted into the R command window if you want to see them in action.

1. Basics
2. Numbers
3. Strings
4. Formulas
5. Data input and output
6. Manipulating data
7. Statistical analysis
8. Graphs
9. Scripts and functions
10. Tools for experiments

My book about data visualization in R is available! The book covers many of the same topics as the Graphs and Data Manipulation sections of this website, but it goes into more depth and covers a broader range of techniques. You can preview it at Google Books.

Purchase it from Amazon, or direct from O'Reilly.

This site is created by Winston Chang. It is not related to Paul Teetor's excellent R Cookbook (Amazonlink).

http://www.cookbook-r.com/

The slides, scripts, materials and data are available from:
https://github.com/AvitBhowmik/SA17

See you on Tomorrow!