Ice Break of R

An Introduction to the R Programming Language

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November 25, 2011

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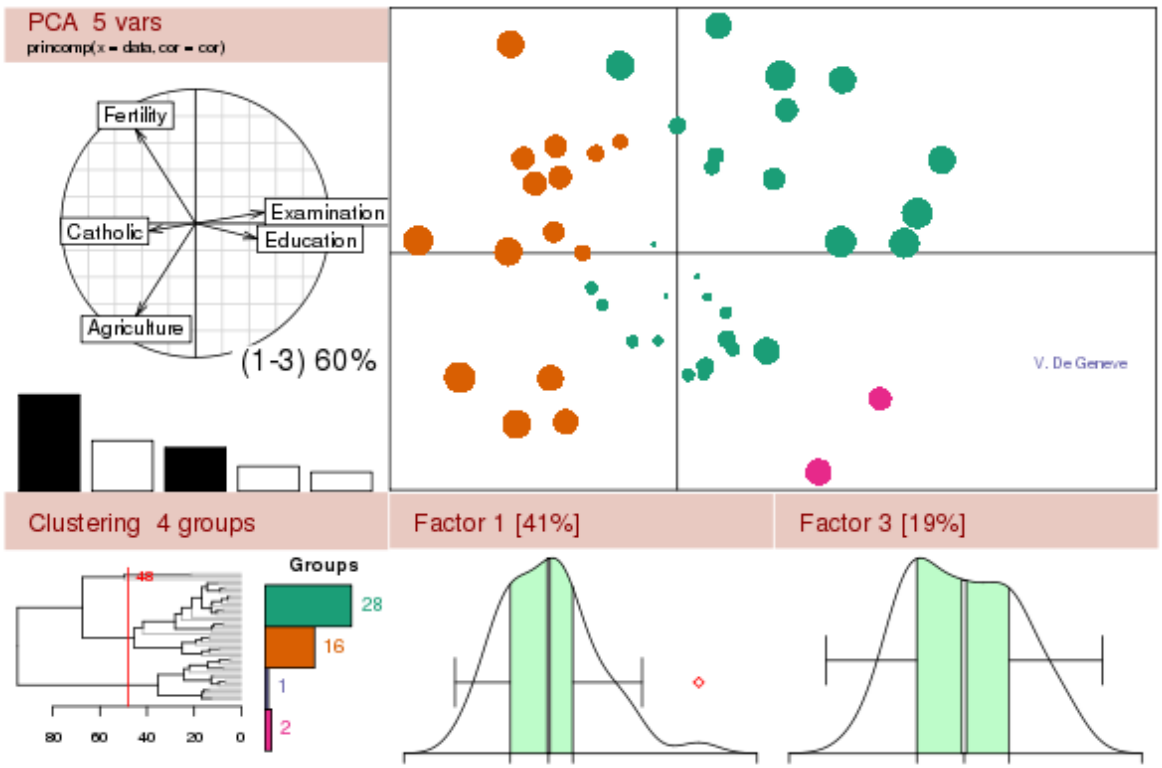
What is R?

R is an open source software for statistical computing. The commands that driving R is also called R programming language.



The homepage of R

A Brief History

- R is a dialect of S language, a statistical programming language developed by Dr. John Chambers at A&T lab in the 1970s.
- S+ in an software that implementing S, and many additional features. Before the launch of R, S+ has been widely used in statistics and modeling.
- The first version of R was developed by Robert Gentleman and Ross Ihaka, at the University of Auckland around 1997, for teaching S+.

The Characteristics of R

- **Open Source**
  The source code of R program and the extensions could be examined line by line.
- **Integrating with other Programming Language**
  R is an interpreting language, can be rather slow, but could integrate with high efficient languages such as C, C++ or Fortran
- **OS independence**
  UNIX, Linux, Windows, MacOS, FreeBSD...
- **Command line Driven**
  You have to write Commands...

Why R?

- The most extensive modeling resources in scientific research
- The fine publishing quality graphs
- Easy to develop your own model
- R is free, GNU

The Disadvantages

- **R is slow**
  R is an interpreting language and is not very fast.
  Could be 1/40 of C.
- **Limitation of Memory**
  All the objects are in memory.
- **R is hard to learn**
  One has to memorize the commands/functions, and understand the logics of programming.
  The fluency in R requires great time and energy.

CRAN The Comprehensive R Archive Network

china				
cran.csdb.cn @	http	21 hours	1 hour	ok
mirror.bjtu.edu.cn @	http	8 hours	5 hours	no time
mirrors.ustc.edu.cn @	http	7 hours	2 hours	ok
mirrors.xmu.edu.cn @	http	18 hours	1 hour	ok
mirrors.geoexpat.com @	http	104.8 days	104.3 days	no time
ftp.ctex.org @	http	15 hours	renewed	ok

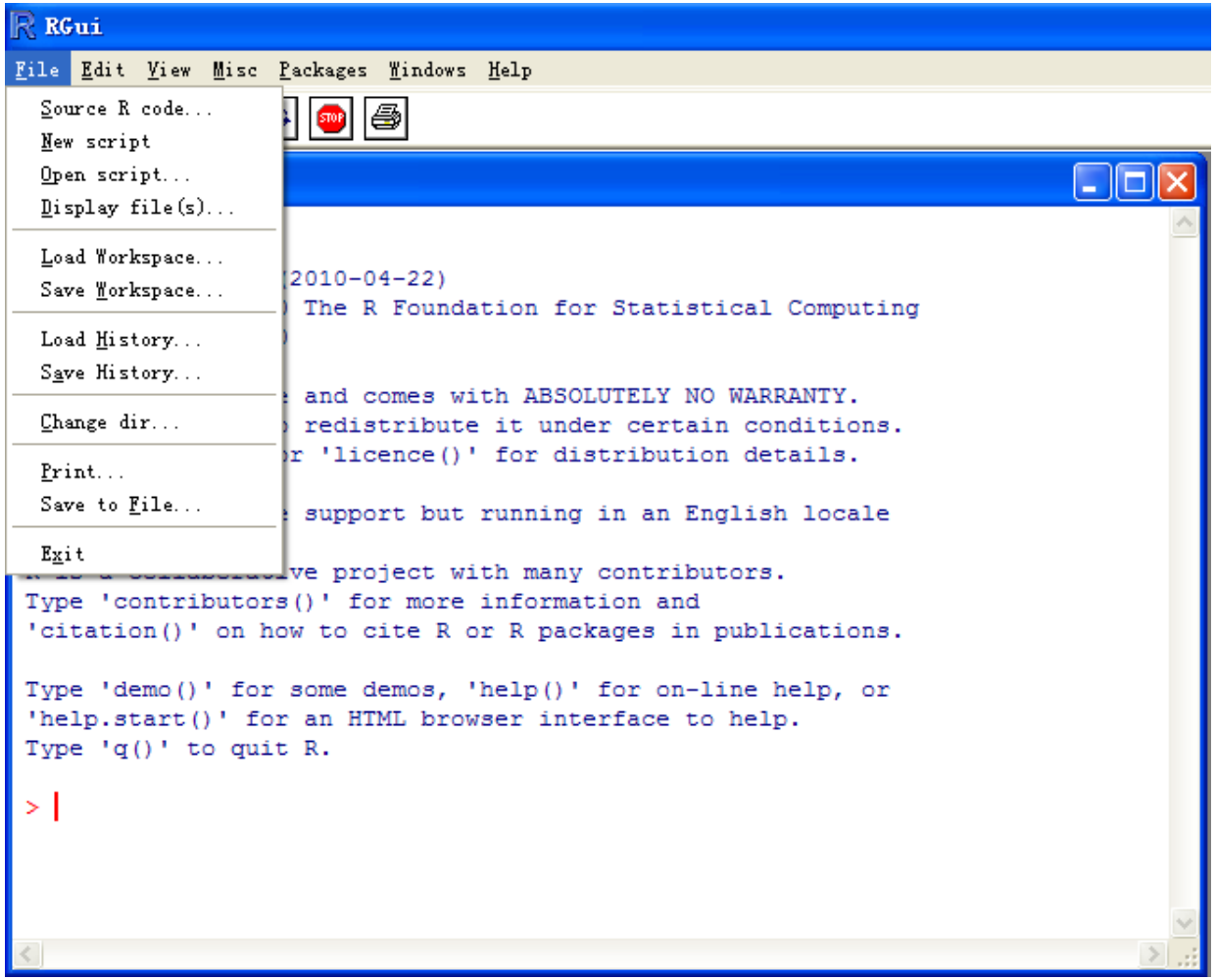
88 Sites in 36 Regions

The software and packages are deposited on CRAN mirrors

First Step

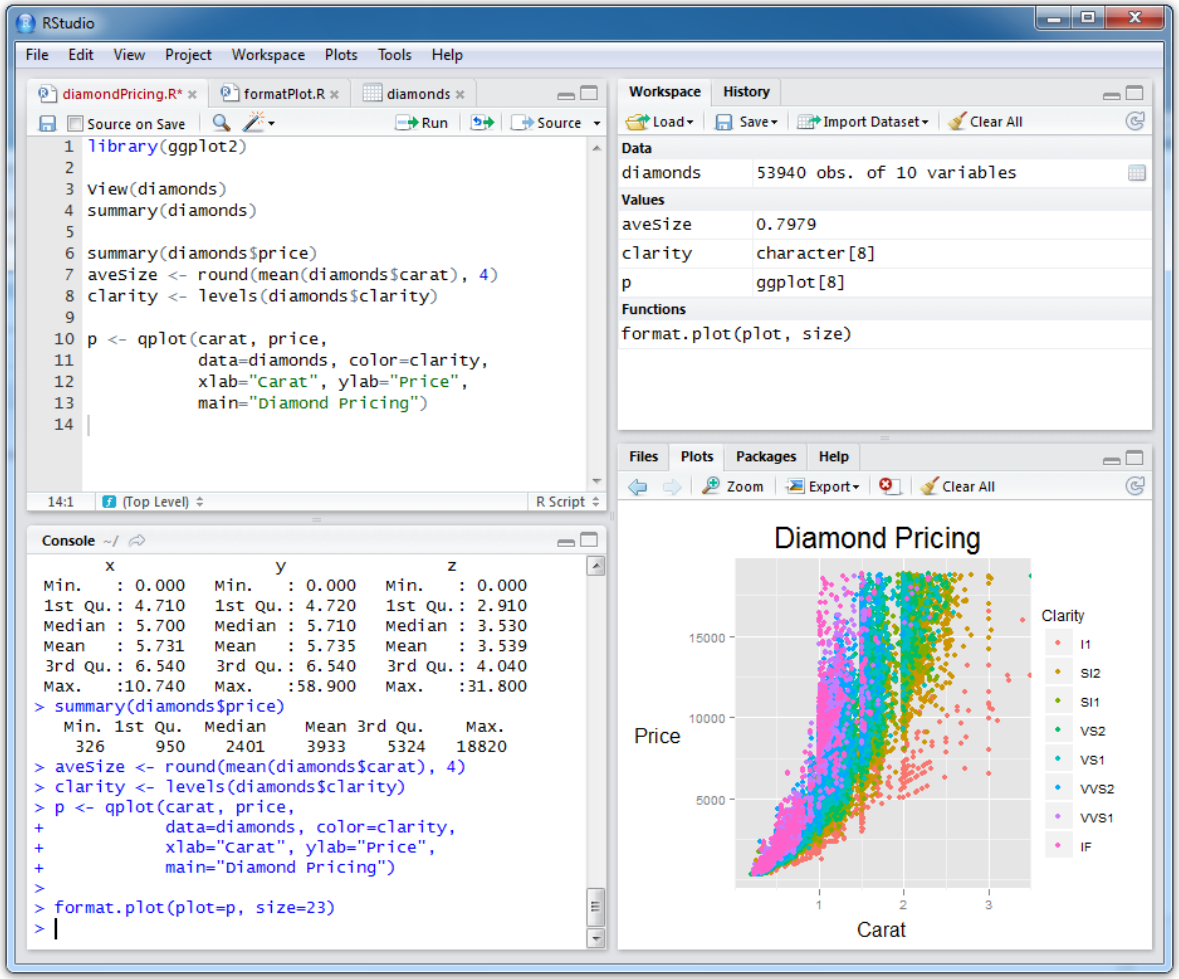
R could be download at
http://www.r-project.org/
at any CRAN mirror around the world.
There are 87 Sites in 36 Regions, which are called "CRAN", and currently hosting R and the 3400 packages.

R Graphical User Interface



The R core Team provides a simple GUI for R.

Other GUIs



Rstudio, available on Linux, Windows, MacOS

R Package

A Package is a collection of R functions with comprehensive documents.
A Package includes: R functions, Data Example, Help Files, Namespace and Description.
The default installation is kept as minimum.
The function of R could be extent by loading R packages.

- Phylogenetics
- Multivariate
- Bayesian statistics

The Packages I

ade4	Analysis of Ecological Data using Euclidean methods
ape	Analysis of Ecology and Evolution
boot	Bootstrap
cluster	Cluster Analysis
ecodist	Ecological Distance
e1071	Misc Functions of the Dept. Stat. TU Wien
MASS	Venables and Ripley's MASS
lattice	Lattice Graphics

The Packages II

maptools	Tools for reading and handling spatial objects
mvpart	Multivariate partitioning
nlme	Linear and Nonlinear Mixed Effects Models
ouch	Ornstein-Uhlenbeck models
raster	Geographic analysis and modeling with raster data
sp	classes and methods for spatial data
spatstat	Spatial Point Pattern analysis, model-fitting
vegan	Community Ecology Package

CRAN Task View

CRAN Task Views

Bayesian	Bayesian Inference
ChemPhys	Chemometrics and Computational Physics
ClinicalTrials	Design, Monitoring, and Analysis of Clinical Trials
Cluster	Cluster Analysis & Finite Mixture Models
Distributions	Probability Distributions
Econometrics	Computational Econometrics
Environmetrics	Analysis of Ecological and Environmental Data
ExperimentalDesign	Design of Experiments (DoE) & Analysis of Experimenta
Finance	Empirical Finance
Genetics	Statistical Genetics
Graphics	Graphic Displays & Dynamic Graphics & Graphic Device Visualization
gR	gRaphical Models in R
HighPerformanceComputing	High-Performance and Parallel Computing with R
MachineLearning	Machine Learning & Statistical Learning
MedicalImaging	Medical Image Analysis
Multivariate	Multivariate Statistics
NaturalLanguageProcessing	Natural Language Processing
Optimization	Optimization and Mathematical Programming

The packages are reviewed periodically by profounding experts, the results are appeared online as CRAN TaskViews.

Homepage of Package Vegan

vegan: Community Ecology Package

Ordination methods, diversity analysis and other functions for community and vegetation ecologists.

Version:	1.17-2
Suggests:	MASS, mgcv, lattice, cluster, scatterplot3d, rgl, tcltk
Published:	2010-03-08
Author:	Jari Oksanen, F. Guillaume Blanchet, Roeland Kindt, Pierre Legendre, R. B. O'Hara, Gavin L. Simpson, Peter Solymos, M. Henry H. Stevens, Helene Wagner
Maintainer:	Jari Oksanen <jari.oksanen at oulu.fi>
License:	GPL-2
URL:	http://vegan.r-forge.r-project.org/
In views:	Environmetrics, Multivariate, Phylogenetics, Psychometrics, Spatial
CRAN checks:	vegan results

Downloads:

Package source:	vegan_1.17-2.tar.gz
MacOS X binary:	vegan_1.17-2.tgz
Windows binary:	vegan_1.17-2.zip
Reference manual:	vegan.pdf

Description and the checking results of packages could be found at CRAN Mirror.

Install Packages

To install a package, just type

R code

```
install.packages("vegan")
```

Or,
Packages > install packages from local files

Use a Package

Packages must be loaded into memory before the functions could be called.

R code

```
library("vegan")
```

There are comprehensive documentations for R functions, to look at the help files, just type, for example:

R code

```
?vegan
help("vegan")
help.search("t.test")
```

or RGui>Help>Html help

Html of Help

lm {stats} R Documentation

Fitting Linear Models

Description

lm is used to fit linear models. It can be used to carry out regression, single stratum analysis of variance and analysis of covariance (although aov may provide a more convenient interface for these).

Usage

```
lm(formula, data, subset, weights, na.action,
   method = "qr", model = TRUE, x = FALSE, y = FALSE, qr = TRUE,
   singular.ok = TRUE, contrasts = NULL, offset, ...)
```

Arguments

formula	an object of class "formula" (or one that can be coerced to that class): a symbolic description of the model to be fitted. The details of model specification are given under 'Details'.
data	an optional data frame, list or environment (or object coercible by as.data.frame to a data frame) containing the variables in the model. If not found in data, the variables are taken from environment(formula), typically the environment from which lm is called.
subset	an optional vector specifying a subset of observations to be used in the fitting process.

Help page

Contents of Help Files

lm{stats}	function and the package name
Fitting Linear Models	Title of the function
Description	The description
Usage	Parameters of the function
Arguments	Parameters in detail
Details	How the algorithms implemented
Author(s)	Author of the function
References	Literature Cited
Examples	Example of the function

R as a calculator

You can directly input R commands:

R code

```
2 + 2
a <- 2
```

Assignment

`<-, =, or even ->`

R code

```
b <- 2
c <- a+b
c
```

```
# Comments
```

Objects in R

- Type of elements

`Numeric`	100, 0, -4.335
`Character`	"China"
`Logical`	TRUE, FALSE
`Factor`	Different levels
`Complex`	2 + 3i

- Type of Objects

`Vector`	c(1,2,3); c("a","a","b","b","c")
`Matrix`	x <− 1:12 ; dim(x) <− c(3,4)
`Dataframe`	Combined vectors of different types
`List`	Container of Different objects
`Array`	Matrix with different dimensions

Operators

Math

+, −, *, /, ∧

Comparisons

>, <, <=, >=, ==, !=

Logical

!, &, &&, |, ||

Creating Vectors

Character

```
character<-c("China", "Korea", "Japan", "UK", "USA",
"France", "India", "Russia")
```

Numerical

```
numeric<-c(1, 3, 6, 7, 3, 8, 6, 4)
```

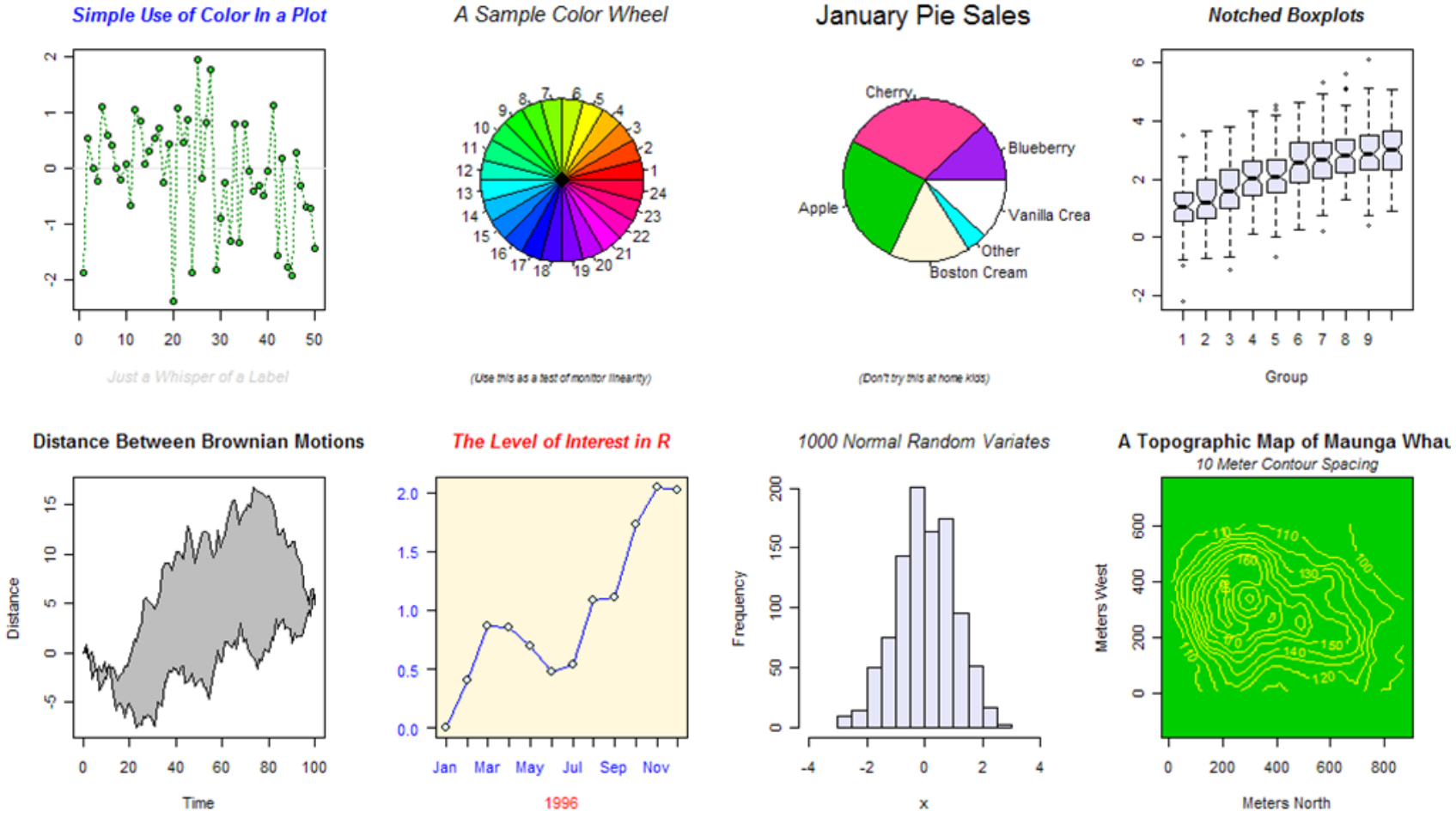
Logical

```
logical<-c(T, F, T, F, T, F, F, T)
```

Function to Creat Vectors

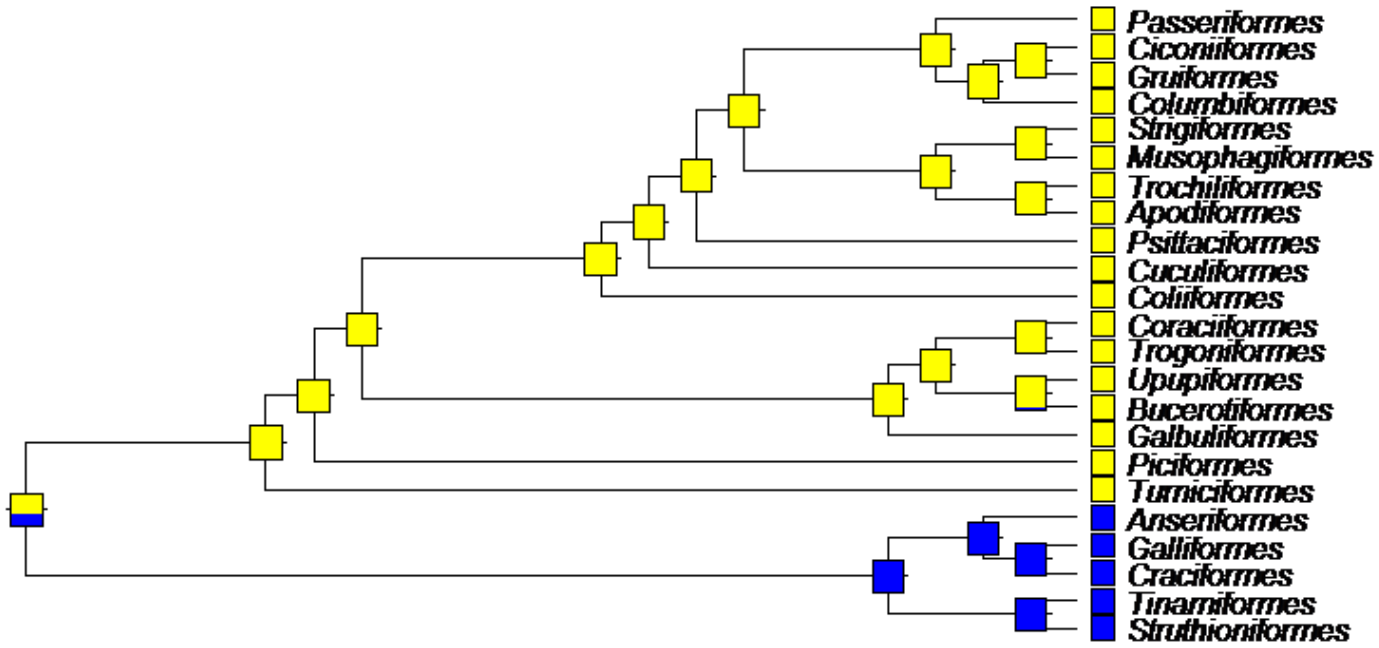
```
c(2,5,6,9)
rep(2,times=4)
seq(from=3, to=21, by=3 )
1:15
```

Graphics generated by R



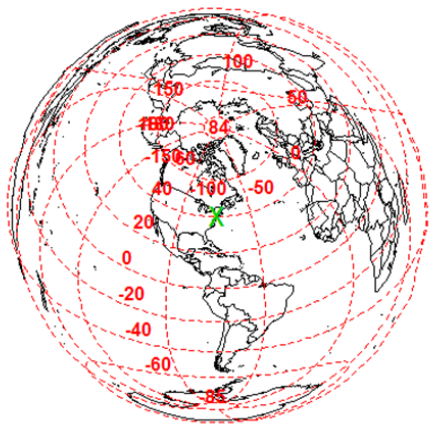
The R basic graphs

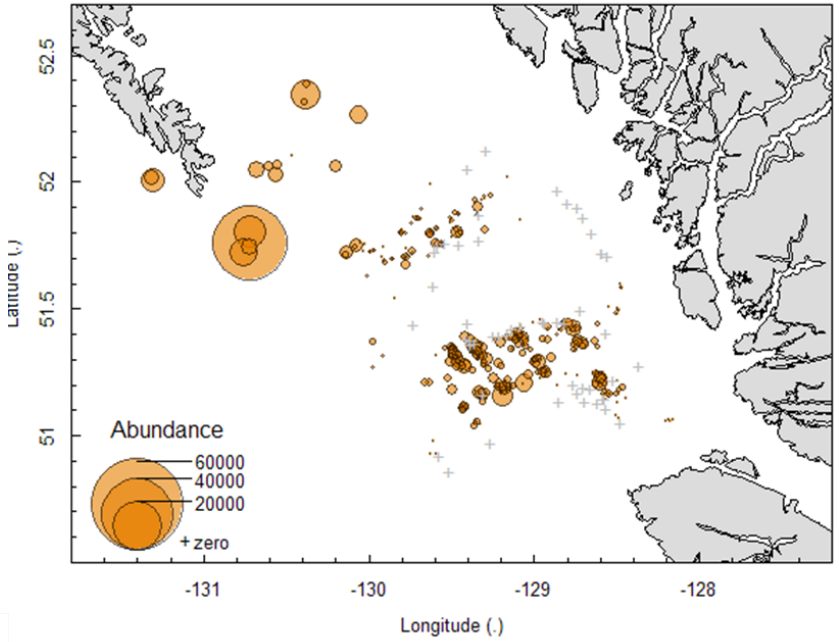
Graphics generated by R



Ancestral Reconstruction using R

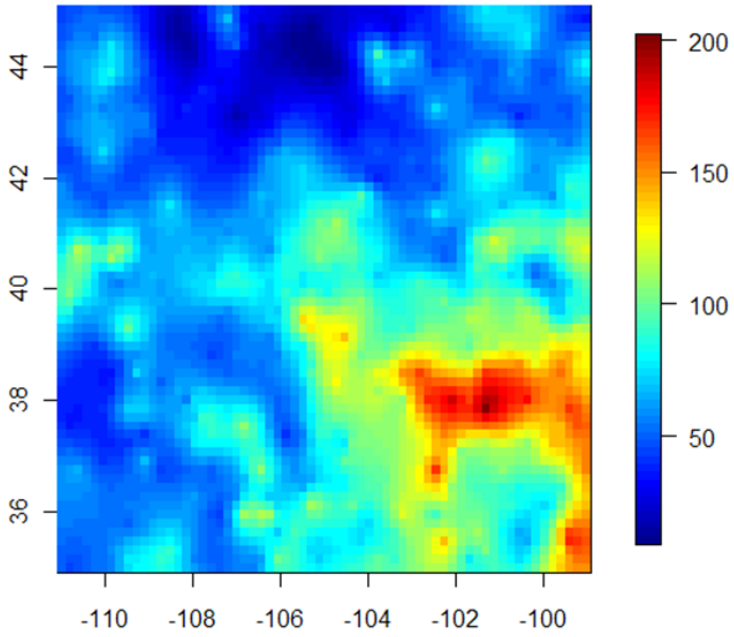
Graphics generated by R

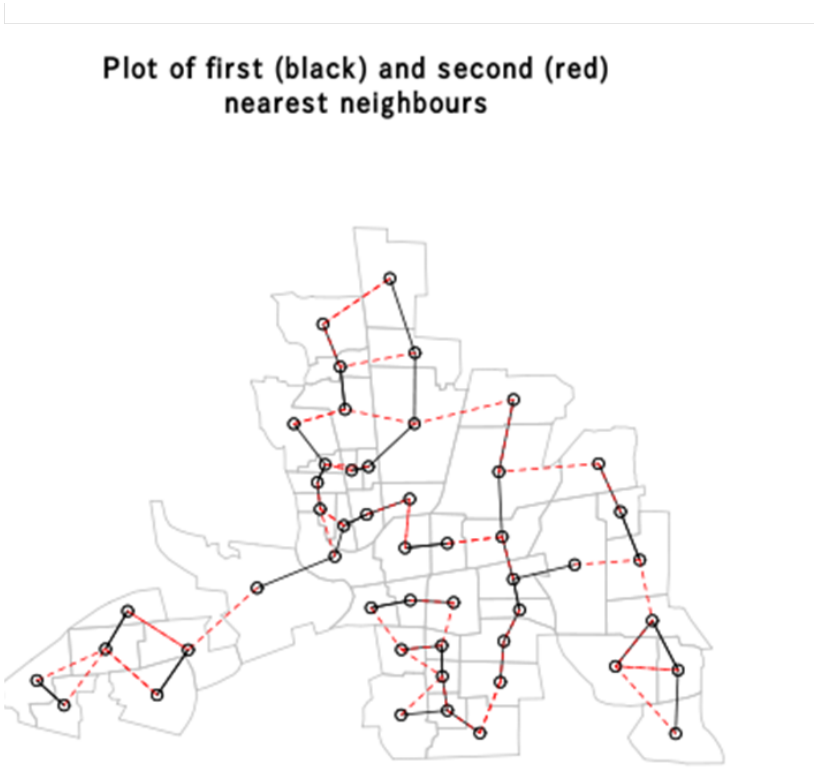




Handling: SHP files, Converstion between Projections, Raster data, extract values, Krigging, Spatial Autoregressive Models

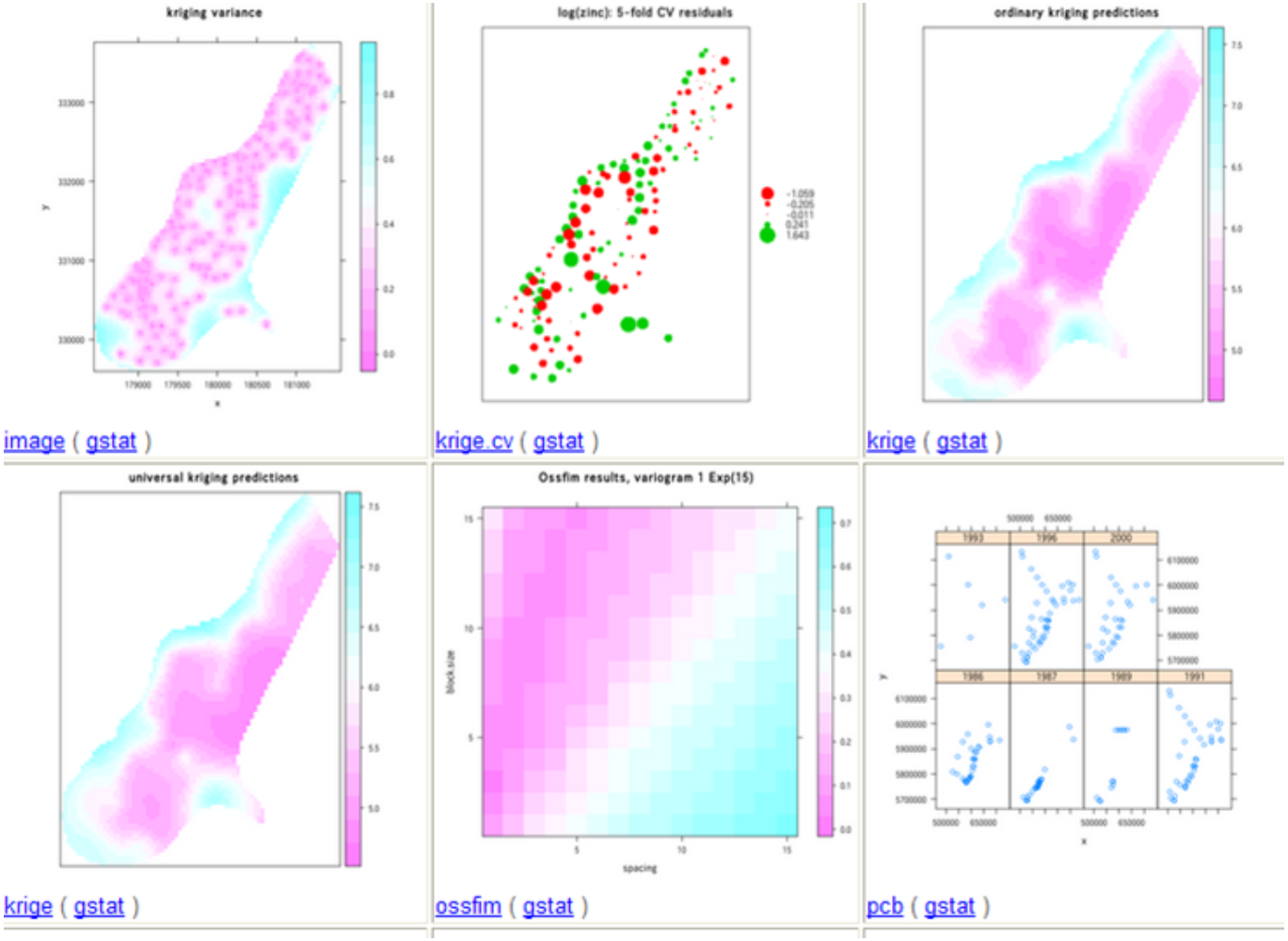
Graphics generated by R





Krigging and spatial analysis

Graphics generated by R



Results of spatial analysis

Higher Plotting Functions

plot()	Scatter plot
hist()	Histograms
boxplot()	Boxplot
stripchart()	stripchart
barplot()	barplot
piechart()	Pies
legend()	Add legends

Lower Plotting Functions

lines()	add line to plot
curve()	add curve
abline()	add straight line
points()	add points
segments()	Add segments
axis()	add axis
box()	Add box to the plot
title()	Add title
text()	Add text to plot

Creating a scatter plot I

Original Data

```
x <- runif(50,0,2)
y <- runif(50,0,2)
```

Step 1

```
plot(x, y, type="n", xlab="", ylab="", axes=F)
```

Step 2

```
points(x,y)
```

Creating a scatter plot II

Step 3

```
axis(1);
axis(at=seq(0.2,1.8,0.2), side=2)
```

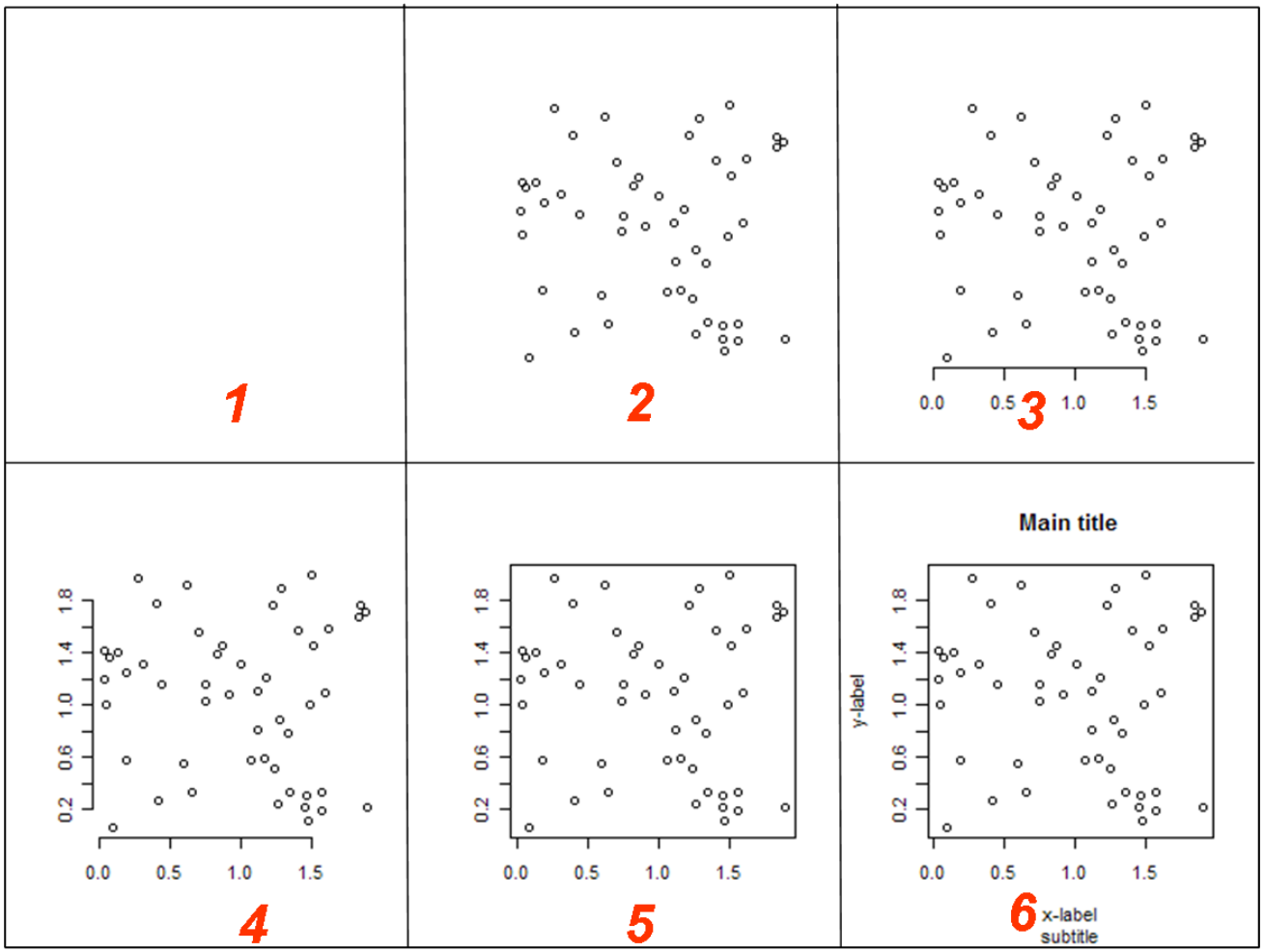
Step 4

```
box()
```

Step 5

```
title(main="Main title", sub="subtitle", xlab="x-label",
ylab="y-label")
```

Creating a scatter plot III



A plot step by step

Scripting

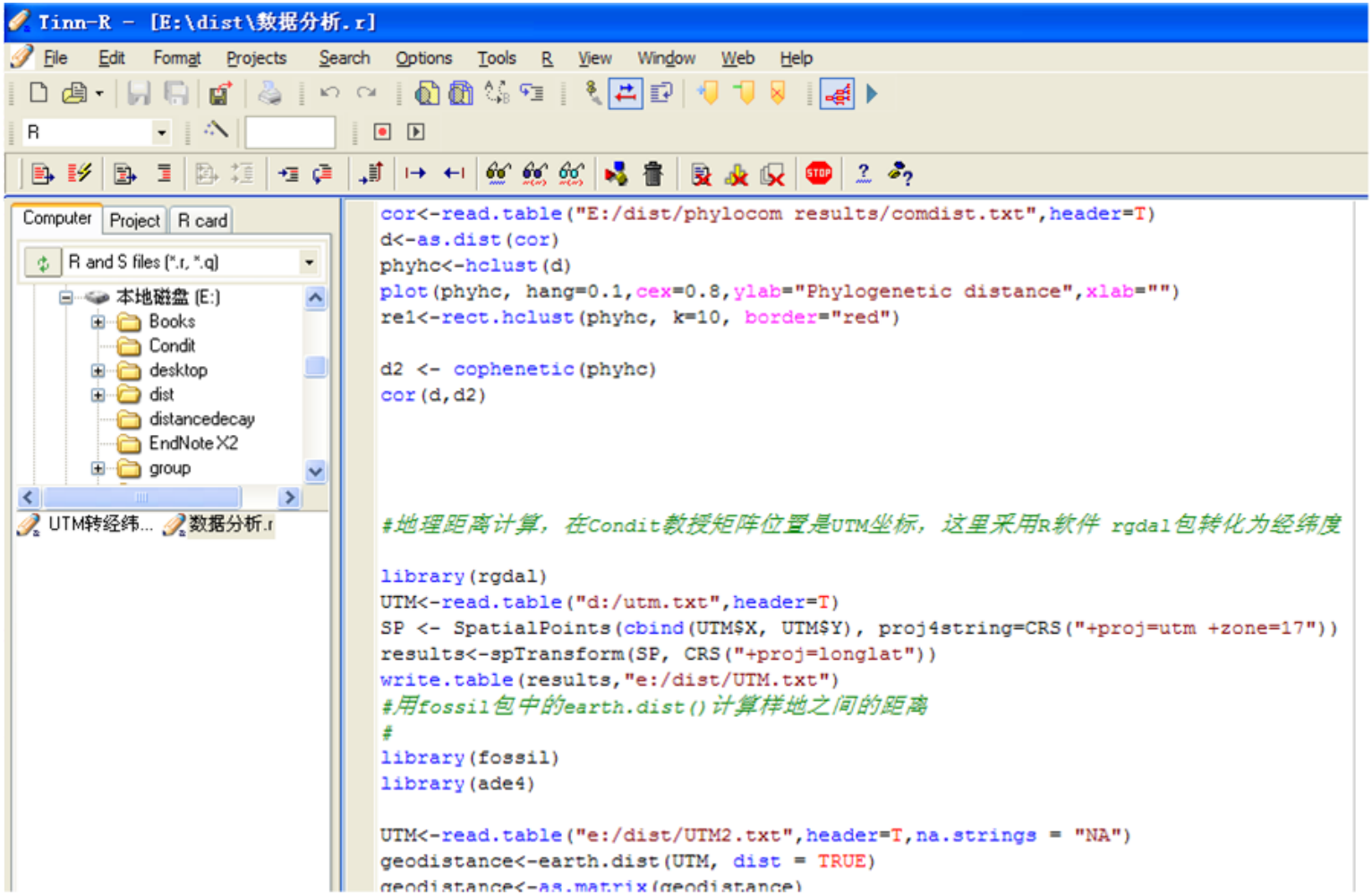
Save the R code in a plaint text editor, with an extension .r
The code could be implemented later.

Code Highlighting

```
data2mat <-
function(data = data)
{
  if (!any(colnames(data) == "abundance"))
  stop("A column named \"abundance\" must be speciefied.")
  if (!any(is.integer(data$abundance)))
  stop("Number of individuals must be integer!")
  col <- which(colnames(data) == "abundance")
  data1 <- data[,-col]
  abundance <- as.numeric(data[,col])
  result1 <- data.frame(rep(NA, sum(abundance)))
  colnames(result1) <- "plots"
  for (i in 1:(ncol(data)-1))
  {
    result1[, i] <-  rep(as.character(data[, i]), abundance)
  }
  result <- table(result1)
  return(result)
}
```

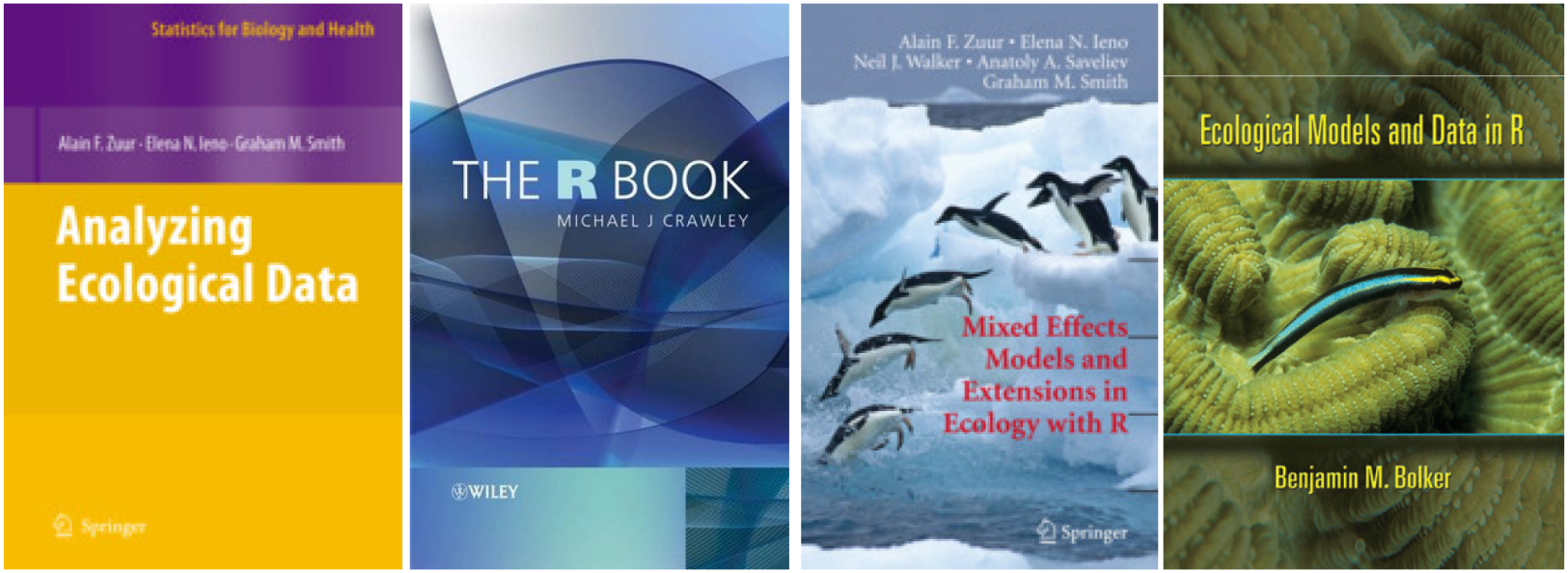
Highlighting of key words

Text Editors: TinnR



Code Highlighting by TinnR

Further Reading



Selected Publications

Many Thanks!
Questions?