5085c/6015c Introduction to Lanscape Ecology & GIS

Spring 2019

Contents

Syllabus

Contact information

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Introduction of the TAs

- Andres Hernandez-Camacho M.Sc. https://github.com/andher1802
- Esteban Correa-Agudelo M.Sc. https://github.com/maurosc3ner

- Format of the Lab sessions:
  - This is not a class on statistics !!!!
  - Only a brief introduction about the use of the tool for a better understanding of the landscape ecology applications.
  - Notebooks with theory, practices, code samples, etc.
  - Videos with detailed explanation about the topics.
  - Lab assignment weekly starting on week 2.
- Lab sessions tutorials and materials can be found on https://maurosc3ner.github.io/ .

Content

The goal of this section is to exemplify the role of R in analysis of spatial data in landscape ecology applications. At the beginning, we will review the fundamentals of the use of R within the RStudio interface, basic data structures and operations. Then, we will explore the capabilities of plotting information with R, and finally the use of the library leaflet integrated with RStudio for visualizing spatial data. This brief introduction will help us in understanding the second part of the course, when we will analyze landscape ecology problems and using advance scripts to compute and simulate interesting scenarios of landscape disturbances.

Schedule

References

1. Landscape ecology in theory and practice: Pattern and process, second edition (Turner and Gardner, 2015)

Table 1: Lab schedule for the course (changes can take place due to unexpected events)

x
Week 1 - No assignment
Introduction to R programming language – Getting familiar with R Studio interface, types of data structures, basic operat
Week 2 - Lab assignment 2
Introduction to R programming language - Loops, functions and graphics in R.
Week 3 – Lab assignment 3
Introduction to R programming language – Basic statistical operations in R. Proportion test and two sample test, linear re
Week 4 – Lab assignment 4
Use of R as GIS part I. Use of leaflet for mapping spatial data, use of base maps, basic geolocation in R, set map properti
Week 5 – Lab assignment 5
Use of R as GIS part II. Use of leaflet for mapping spatial data, use of base maps, basic geolocation in R, set map propert
Week 6 – Lab assignmentc 6
Introduction to landscape metrics. Chapter 4 in Gergel, S. E., & Turner, M. G. (2002). Learning landscape ecology: A pra
Week 7 – Lab assignment 7
Variograms and semivariograms. Chapter 5 in Gergel, S. E., & Turner, M. G. (2002). Learning landscape ecology: A prac
Week 8 – Lab assignment 8
Characterizing categorical landscape patterns. Chapter 6 in Gergel, S. E., & Turner, M. G. (2002). Learning landscape ec
Week 11 – Lab assignment 9
Introduction to Markov Models. Chapter 8 in Gergel, S. E., & Turner, M. G. (2002). Learning landscape ecology: A pract
Week 12 – Lab assignment 10
Disturbances and network applications in landscape ecology. Chapter 11 & 12 in Gergel, S. E., & Turner, M. G. (2002). L

2. Learning Landscape Ecology: A Practical Guide to Concepts and Techniques (Gergel and Turner, 2001)
3. Geocomputation with R (Robin Lovelace and Muenchow, 2019)

Chapter 1

Introduction to Landscape Ecology

1.1 Requirements

Chapter 1 - Introduction to Landscape Ecology. (Gergel and Turner, 2001)

1.2 Learning objetives

- Install R and R Studio in your computer
- Understand the basic datatypes and data structures in R
- Declare basic datatypes and data structures
- Do basic element-wise and vector-wise operations

1.3 Lab Theory

1.3.1 What is R?

- R is a multiplatform programming language (*"It means that we ask the computer to do jobs."*)
- R works in Windows, MacOs, Linux.
- R is **free**.
- Easy to learn and very powerful.
- R can do many jobs:
  - Used as a calculator.
  - R can be used to create figures such as scatter plots, bar plots, pie plots, etc.
  - R can be used to summarize data (numerically and graphically).
  - R can be used to do a lot of specific analyses.

1.3.2 What is R Studio?

- RStudio is an integrated development environment (IDE) for R.
- It includes a console, syntax-highlighting editor that supports direct code execution.
- Tools for plotting, history, debugging and workspace management.
- Open source.

1.3.3 Installation of R and R Studio

- In this course, we run R on Windows for demonstration purposes.
- The installation of R on Windows is easy:
  - Download R (for Windows) at https://cran.r-project.org.
  - Run the downloaded .exe file.
  - Current version is 3.5.2 (upgraded multiple times every year).
- Installation of RStudio is also straightforward
  - Download can be found https://www.rstudio.com/products/rstudio/download/#download
  - Current version 1.1.463 (for windows).

1.4 Lab: Getting familiar with R

Installation

Introduction

1.5 Lab: Code practice

This section is intended to complement the concepts explained in videos. You will find all the commands used but also the expected results. Please type these codes in your RStudio Editor and start to execute (CTRL+ENTER) line by line.

1.5.1 Task 1: Basic variables:

```
numberStudents <- 41          # Declaration of an integer value
myFirtsName <- "Abraham"      # Declaration of a character value
myWeight <- 160.5             # Declaration of a numeric value
isUCStudent <- TRUE           # Declaration of a logical value
height <- c(152, 171.5, 165)  # Declaration of a numeric vector
mat <- matrix(
              c(14, 16, 18, 15, 22, 11),
              nrow = 3,
              ncol = 2,
              byrow = TRUE
              )
# Declaration of a n-dimensional matrix
rubikCube <- array(c('green','yellow','red','blue', 'white','orange'),dim = c(3,3,6))
#Declaration of a data frame
friends <- data.frame( names = c("Thomas","Andrew","Lindsay"), gender = c("Male", "Male","Female"), heig

# See the content of your variables
print(numberStudents)         # Check the content of numberStudents
```

```
## [1] 41
```

```r
print(myFirtsName)            # Check the content of myFirstName
```

```
## [1] "Abraham"
```

```r
print(myWeight)               # Check the content of myWeight
```

```
## [1] 160.5
```

```r
isUCStudent                   # Additional way to see the content within
```

```
## [1] TRUE
```

```r
dim(mat)                      # Check the dimensions of the matrix
```

```
## [1] 3 2
```

```r
print(mat)                    # Check the content of the mat matrix
```

```
##      [,1] [,2]
## [1,]   14   16
## [2,]   18   15
## [3,]   22   11
```

```r
dim(rubikCube)                # Check the dimensions of the matrix
```

```
## [1] 3 3 6
```

```r
print(rubikCube)              # Check your rubik content
```

```
## , , 1
##
##      [,1]     [,2]     [,3]
## [1,] "green"  "blue"   "green"
## [2,] "yellow" "white"  "yellow"
## [3,] "red"    "orange" "red"
##
## , , 2
##
##      [,1]     [,2]     [,3]
## [1,] "blue"   "green"  "blue"
## [2,] "white"  "yellow" "white"
## [3,] "orange" "red"    "orange"
##
## , , 3
##
##      [,1]     [,2]     [,3]
## [1,] "green"  "blue"   "green"
## [2,] "yellow" "white"  "yellow"
```

```
## [3,] "red"    "orange" "red"
##
## , , 4
##
##      [,1]     [,2]     [,3]
## [1,] "blue"   "green"  "blue"
## [2,] "white"  "yellow" "white"
## [3,] "orange" "red"    "orange"
##
## , , 5
##
##      [,1]     [,2]     [,3]
## [1,] "green"  "blue"   "green"
## [2,] "yellow" "white"  "yellow"
## [3,] "red"    "orange" "red"
##
## , , 6
##
##      [,1]     [,2]     [,3]
## [1,] "blue"   "green"  "blue"
## [2,] "white"  "yellow" "white"
## [3,] "orange" "red"    "orange"
```

```
print(friends)                # Check list content
```

```
##     names gender height weight Age
## 1  Thomas   Male  152.0     81  42
## 2  Andrew   Male  171.5     93  38
## 3 Lindsay Female  165.0     78  26
```

1.5.2 Task 2: Operations

```
a <- 1.5                      # Declaration of a numeric value
b <- 4.0                      # Declaration of another numeric value

a + b                         # Summation
```

```
## [1] 5.5
```

```
b - a                         # Substraction
```

```
## [1] 2.5
```

```
b * a                         # Multiplication
```

```
## [1] 6
```

```
b / a                         # Division
```

```
## [1] 2.666667
```

```r
b ** 2                        # Exponent
```

```
## [1] 16
```

```r
b %% 2                        # Modulus operation
```

```
## [1] 0
```

```r
# Declaration of a vector of numeric values
vector_values <- c(1, 4, 9, 12, 15, 23, 17, 13, 9)

mean(vector_values)           # Computing the average of the set of values.
```

```
## [1] 11.44444
```

```r
sum(vector_values)            # summation of the set of values.
```

```
## [1] 103
```

```r
length(vector_values)         # Computing the average of the set of values.
```

```
## [1] 9
```

```r
vector_values + 3             # Add or substract a number to each value on the set of values.
```

```
## [1]  4  7 12 15 18 26 20 16 12
```

```r
vector_values * 5             # Multiply a number to each value on the set of values.
```

```
## [1]   5  20  45  60  75 115  85  65  45
```

```r
vector_values %% 2            # Apply a modulo operation over the set of values.
```

```
## [1] 1 0 1 0 1 1 1 1 1
```

```r
vector_values[1]              # Indexing vectors in R (find the ith element).
```

```
## [1] 1
```

```r
vector_values[5]              # Suppose that we want to find the fifth element.
```

```
## [1] 15
```

```
vector_values[-2]             # Get the vector without the second element.
```

```
## [1]  1  9 12 15 23 17 13  9
```

```
vector_values[1:3]            # Get the first three elements of the vector.
```

```
## [1] 1 4 9
```

```
vector_values[c(1,3,5)]       # Get the elements 1st, 3rd and 5th of the vector.
```

```
## [1]  1  9 15
```

```
vector_values == 9            # Check if the vector values are equals to 9
```

```
## [1] FALSE FALSE  TRUE FALSE FALSE FALSE FALSE FALSE  TRUE
```

```
which(vector_values == 9)     # where are this value
```

```
## [1] 3 9
```

```
sum(vector_values == 9)       # How many 9's are in the vector
```

```
## [1] 2
```

1.5.3 Task 3. Creating vectors

```
new_vector <- 1:10            # Create a vector from 1 to 10
new_vector
```

```
##  [1]  1  2  3  4  5  6  7  8  9 10
```

```
new_vector <- rep(5, 10)      # Create a vector of 10 5's (ten times five)
new_vector
```

```
##  [1] 5 5 5 5 5 5 5 5 5 5
```

```
new_vector <- seq(1, 10, 2)   # Create a vector from 1 to less equals to 10 but with step of 2
new_vector
```

```
## [1] 1 3 5 7 9
```

```
new_vector <- seq(2, 10, 2)   # Same as before but with even numbers
new_vector
```

```
## [1]  2  4  6  8 10
```

1.5.4 Task 4. Operations between two or more vectors

```
vector1 <- seq(2,10,2)
vector1
```

```
## [1]  2  4  6  8 10
```

```
vector2 <- seq(11,20,2)       # Declare two vectors
vector2
```

```
## [1] 11 13 15 17 19
```

```
vector_result <- c(vector1, vector2) # Create a vector with the combination of vector1 and vector2
vector_result
```

```
##  [1]  2  4  6  8 10 11 13 15 17 19
```

```
vector1 + vector2             # Addition of two vectors
```

```
## [1] 13 17 21 25 29
```

```
vector1 - vector2             # Substraction of two vectors
```

```
## [1] -9 -9 -9 -9 -9
```

```
vector1 * vector2             # Multiplication of two vectors
```

```
## [1]  22  52  90 136 190
```

```
vector1 / vector2             # division of two vectors
```

```
## [1] 0.1818182 0.3076923 0.4000000 0.4705882 0.5263158
```

```
max(vector_result)            # vector max
```

```
## [1] 19
```

```
min(vector_result)            # vector min
```

```
## [1] 2
```

```
pmax(vector1, vector2)        # element-wise max
```

```
## [1] 11 13 15 17 19
```

```r
pmin(vector1, vector2)          # element-wise min
```

```
## [1]  2  4  6  8 10
```

```r
head(vector_result)             # first 5 elements
```

```
## [1]  2  4  6  8 10 11
```

Chapter 2

Causes of Landscape Pattern

Here is a review of existing methods.

Bibliography

Gergel, S. and Turner, M. (2001). *Learning Landscape Ecology: A Practical Guide to Concepts and Techniques*, volume 83.

Robin Lovelace, Robin, J. N. and Muenchow, J. (2019). *Geocomputation with R*, volume 1.

Turner, M. and Gardner, R. (2015). *Landscape ecology in theory and practice: Pattern and process, second edition.*