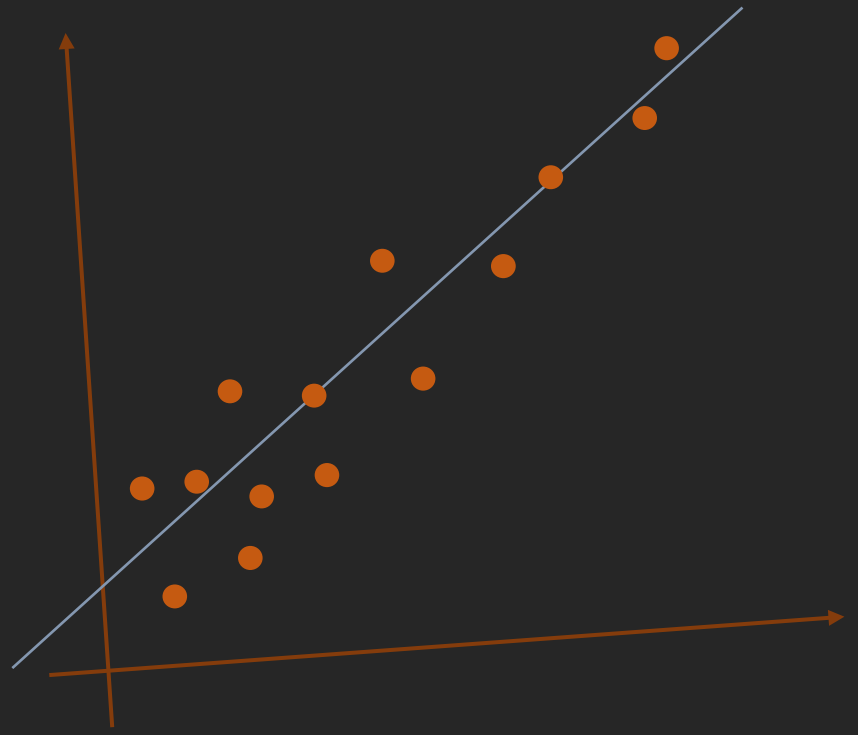
Applied Regression Analysis

STAT 4043/ STAT 5543



Introduction to R

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Overview

- What are R and RStudio?
- Basic navigation on RStudio interface.

- Matrices and vectors – definition.
- Accessing specific elements of a vector/matrix.

Introduction to R

- R is a statistical language and environment for data analysis and display. (https://cran.r-project.org/)
- R is open-source and involves many developers.
- Install R and Rstudio. (https://www.rstudio.com/products/rstudio/download/)

Introduction to R

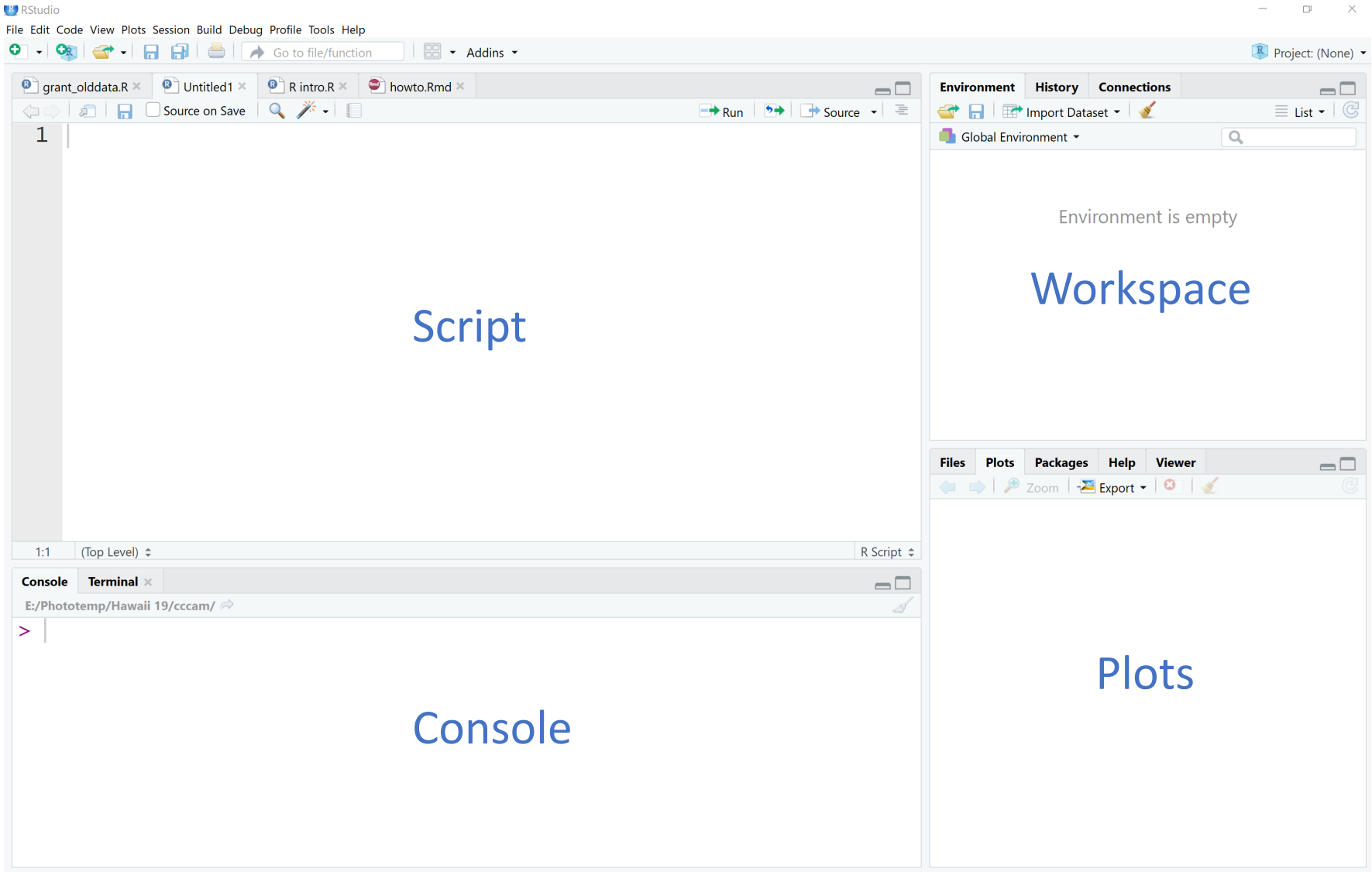
Optional reading

- Some quick reads:
  - https://www.statmethods.net/r-tutorial/index.html
    - Only the first page.
  - http://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf
    - Only Chapter 2.

Why R?

- R is free.
- Do we need any other reason?
- R is very flexible. Since it's open source, it's not limited in functionality by an owner. People can develop additional functionalities and share (packages).
- Excellent online support.
- Excellent new features and much improved speed in recent times.

Basic navigation on RStudio



Variables and their values (constants)

- Think about variables like boxes with names. You can put something in the boxes. Those are the values.
- Example:

Different types of variables

- Numeric: Numbers.
  - Example: x <- 5
- Character: Text strings.
  - Example: x <- “Friday”
- Logical: TRUE or FALSE.
  - Example: x <- TRUE

Assign the value 5 to the variable x.

<- is the assignment operator. You can also use =

Operators: Usually goes between two variables

Operator	Description
+	addition
-	subtraction
*	multiplication
/	division
^ or **	exponentiation

Arithmetic Operators

Operator	Description
>	greater than
>=	greater than or equal to
==	exactly equal to
!=	not equal to

Logical Operators

Functions

- Functions are like machines that takes some input (we call them arguments/parameters) and returns some output (we call them value).
- Functions can be user-defined or pre-existing in R.
- Once a function is defined, it is used as below:
  - NameOfFunction(arguments)

parentheses

- User-defined functions are not necessary for this course.

Other topics to be covered over the example codes

- Missing values (NA)
- Warnings and errors
- Overflow/underflow
- Importance of different types of brackets
- Examples of functions
- R packages

Introduction to linear algebra

Vectors, matrices and basic operations

Vectors

- A vector (as opposed to a scalar) is a one dimensional array of elements.
- We usually write the elements within parentheses and separated by commas.
- Numeric vector of length 7: (2, 5, 6, 2, 9, 1, 4)
- Character vector of length 5: (“s”, “f”, “o”, “o”, “d”)
  - Why are we using quotation marks?
- Character vector of length 4: (“Hello”, “Good”, “Morning”, “!”)
- A vector can be a row vector or a column vector

Matrix

- A matrix is a rectangular array of elements arranged in rows and columns.
- Example of a numeric matrix: $\begin{pmatrix} 3 & 45 \\ 2 & 72 \\ 5 & 29 \end{pmatrix}_{3\times2}$ → Dimensions, we don't always write these
- A vector can be thought of as a special case of a matrix.
  - $(2, 5, 6, 2, 9)_{1\times5}$ Row Vector
  - $\begin{pmatrix} 2 \\ 5 \\ 6 \\ 2 \\ 9 \end{pmatrix}_{5\times1}$ Column Vector (in Linear Algebra, usually 'a vector' means 'a column vector')

Matrices can also be numeric, character, etc. But in linear algebra, we will only use numeric vectors and matrices.

Standard notations

- A matrix (or a vector) is usually written in bold face, and the dimensions are written as subscripts. e.g. $\boldsymbol{A}$
- The element in the ith row and jth column is called (i, j)th element and is usually denoted by something like a_{ij}
- In abbreviated form, we often write a matrix with r rows and c columns like

$$A = (a_{ij}), i = 1,2, \dots, r; j = 1,2, \dots, c.$$

Equality of matrices and addition/subtraction

- Two matrices are equal if and only if they have the same dimensions and all the corresponding elements are equal.
- Addition/Subtraction only allowed when two matrices have equal dimensions. Simply add/subtract the corresponding elements.
- Example: $\begin{pmatrix} 3 & 45 \\ 2 & 72 \\ 5 & 29 \end{pmatrix} + \begin{pmatrix} 5 & -5 \\ 4 & 0 \\ -2 & 1 \end{pmatrix} = \begin{pmatrix} 8 & 40 \\ 6 & 72 \\ 3 & 30 \end{pmatrix}$

Multiplication by a scalar

- Simply multiply each element by the scalar.
- Example: $2\begin{pmatrix} 3 & 5 \\ 2 & 7 \\ 5 & 2 \end{pmatrix} = \begin{pmatrix} 6 & 10 \\ 4 & 14 \\ 10 & 4 \end{pmatrix}$

Transpose of a matrix

- Transpose of a matrix $\boldsymbol{A}$ is another matrix, denoted by $\boldsymbol{A'}$, obtained by changing the rows into columns.
- Example: $\mathbf{A} = \begin{pmatrix} 3 & 45 \\ 2 & 72 \\ 5 & 29 \end{pmatrix}_{3\times 2}$
- $\boldsymbol{A}' = \begin{pmatrix} 3 & 2 & 5 \\ 45 & 72 & 29 \end{pmatrix}_{2\times 3}$
- What will be the transpose of a row vector?

Some common matrix types

- Square matrix.
  - Example:

$$\begin{pmatrix} 1 & 4 & 0 \\ 3 & 2 & 9 \\ 1 & 5 & 2 \end{pmatrix}$$

- Symmetric matrix.
  - Example:

$$\begin{pmatrix} 1 & 4 & 0 \\ 4 & 2 & 9 \\ 0 & 9 & 5 \end{pmatrix}$$

- Diagonal matrix.
  - Example:

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 2 & 0 \\ 0 & 0 & 5 \end{pmatrix}$$

- Identity matrix.
  - Example:

$$\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$