

Introduction to R

Session 1 – Introduction

Statistical Consulting Centre

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The Department of Statistics
The University of Auckland

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DEPARTMENT OF STATISTICS

Each session comprises two parts: lecture and practice.

Session	Time	Session
1	09:00am - 10:30am	Introduction
	10:30am - 10:50am	Break
2	10:50am - 01:00pm	Data subsetting
	01:00pm - 02:00pm	Lunch break
3	02:00pm - 03:00pm	Data manipulation
	03:00pm - 03:20pm	Break
4	03:20pm - 04:30pm	Data exploration

Each session comprises two parts: lecture and practice.

Session	Time	Session
1	09:00am - 10:30am	Graphics
	10:30am - 10:50am	Break
2	10:50am - 01:00pm	Advanced Graphics (ggplot2)
	01:00pm - 02:00pm	Lunch break
3	02:00pm - 03:00pm	Simple analysis
	03:00pm - 03:20pm	Break
4	03:20pm - 04:30pm	R Markdown

R and UoA's Department of Statistics

- R was initially written by Robert Gentleman and Ross Ihaka *R & R* of the **Department of Statistics, University of Auckland**.
- Three members of the *R Development Core Team* are in UoA's Department of Statistics.



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Ross Ihaka and Robert Gentleman



Paul Murrell and Thomas Lumley

R and UoA's Department of Statistics

What does this mean?

If you want to learn R, you are talking to the right people!



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The School of Biological Sciences (SBS) has a contract with the Statistical Consulting Centre (SCC) to provide statistical support to staff and postgraduate students of SBS.

https://www.stat.auckland.ac.nz/consulting/meet-us/any1_uoa/appointment_scheduler_kevin

What is 'R'?

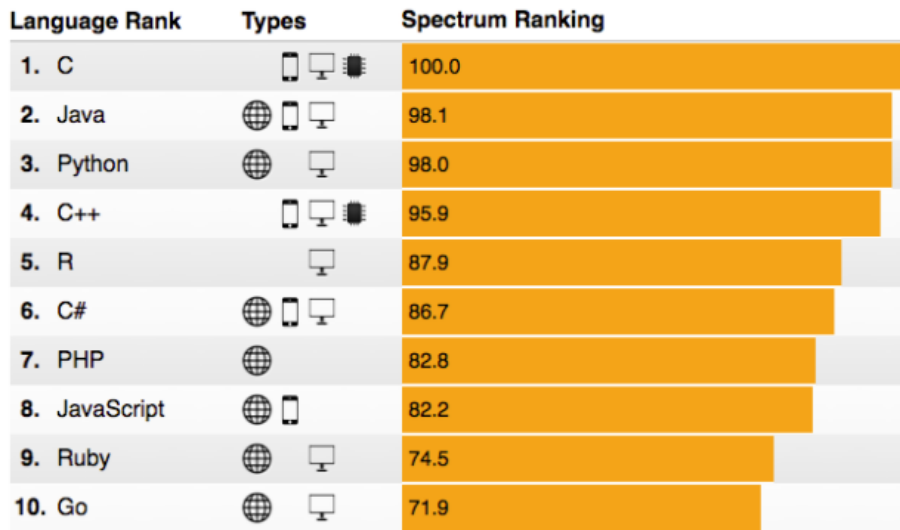
What does this mean?

R is a free software environment for statistical computing and graphics"

Key words:

- FREE!
- Statistical computing
- Graphics (much more flexible than SAS, SPSS, JMP, etc.)
- Support from communities of different fields, i.e. R packages.
<https://cran.r-project.org/web/views/>.
- Even Microsoft is in it: Microsoft R Open.
<https://mran.microsoft.com/open/>.
- <https://www.slideshare.net/RevolutionAnalytics/r-then-and-now>

What is R? (IEEE Spectrum's ranking 2016)



What is 'R'?

What does this mean?

R is a free software environment for statistical computing and graphics"

R and the biological sciences:

- Many *applications of statistical methods to biological datasets are implemented in R*
- These R *packages* are publically available on the web for immediate download and use.
- Bioconductor) <https://www.bioconductor.org/>.
- E.g. Next Generation Sequencing, Genomics.

How to download and install R

- ➊ Go to the CRAN (Comprehensive R Archive Network)
`cran.stat.auckland.ac.nz`.
- ➋ Download the relevant version for Linux/Mac/Windows.
 - We will only look at R in the Windows environment today.
- ➌ Install it on your computer (for Windows only):
 - Choose "Yes (customized startup)" in Startup options.
 - Choose "SDI (separate windows) "in Display mode.
 - Choose "HTML help" in Help .

Using the R editor

- The R GUI is not menu driven.
- Commands can be typed at the console.
 - OK for simple calculations requiring few lines of code
 - Painful for anything more!
- We *strongly* recommend using an R editor
 - Great for reproducible analyses and research.
 - Best editor for you depends on whether you are a(n)...
 - ① Beginner: Built-in R editor,
 - ② Advanced user: Rstudio, Tinn-R, Notepad++, and many others.
 - ③ R geek: Emacs

- integrated development environment, or IDE, for R programming.
- Download and install it from <http://www.rstudio.com/download>.

Reasons to use it

- Writing better R code.
- Producing reports (R markdown).
- Producing interactive reports/tools (Shiny).
- Developing R packages.

Using R as a calculator

```
1 + 2
```

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

```
1 + 3^2
```

```
## [1] 10
```

```
log(15) - sqrt(3.4)
```

```
## [1] 0.8641413
```

```
pnorm(1.96)
```

```
## [1] 0.9750021
```

Variable assignment

- `<-` is the “assign to” operator, made up of `<` and `-` without a space.
- E.g., `x <- 2` is read as “The value 2 is assigned to the object `x`”.

```
x <- 2  
y <- 3  
x^2 - 3 * y + 5
```

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

- `<-` has a direction, from right to left, `x <- 2` means assigning 2 to `x`,

Variable assignment

- `->` operates from left to right, assigning `x` to `2`.
 - `2` is a real value so you can not do that.

```
2 <- x
```

```
## Error in 2 <- x: invalid (do_set) left-hand side to assign
```

- `=` has no direction and can be confusing sometimes.
- It is good programming practice to use `<-`.
- The most important thing is to keep consistent.

Getting help

- Google!!!!
e.g. How to calculate the mean in R? The search results tell you that the function `mean()` would be helpful.
- Quick-R: <http://www.statmethods.net/>
- R-bloggers: <https://www.r-bloggers.com/>

Getting help

- `?`
e.g. `?mean` brings up the help file for this function. It will tell you (almost) everything you need to know to use `mean()`.
- `??`
e.g. `??mean` searches for everything related to `mean` in your computer.
- `RSiteSearch(" ")`
Searches everything on CRAN as well as your computer.

- Statisticians prefer (read: **want**) rectangular data files
 - Each case in its own row
 - Data collected on each variable in its own column
 - Variable names in the first row of each column
 - No blanks, e.g. fill with NA, *, 99999, anything but a blank!
- R likes (read: **needs**) this too!
- R prefers to read data files in Comma Separated Value (CSV) format.
- This does not mean R only reads files stored in csv format.

Getting data into R

Try your best to save your data in a csv or txt format.

- Most datasets are saved in an Excel spreadsheet.
- Do as much data cleaning as you can in Excel. No comments, no formatting, no colours, no fancy fonts.
- Convert it into csv by clicking on Save As. Change the Save as type from xlsx or xls into CSV (Comma Delimited).
- CSV can have one worksheet only. If you have multiple worksheets, it saves the active worksheet.

- Always set a working directory using `setwd()`, this can be a directory where you store the data and/or outputting the results.
- Use `read.csv` to read a CSV file into R.
- `dim()`: Returns the number of observations (rows) and variables (columns).
- `head()/tail()`: Returns the first/last few rows of a data set.
- `str()`: Returns the structure of the dataset, e.g., dimension, column names, type of data object, first few values of each variable.
- `names()`: Returns the names of the variables contained in a dataset.

Seven variables:

- ID: Identification Number.
- Age: in years
- Sex: 0 = Female, 1 = Male
- Race: 1 = Caucasian, 2 = African, 3 = Other
- Weight: in pounds
- Height: in inches
- Smoke: 1 = Yes, 2 = No

Reading data into R

```
setwd("your working directory")
Patient.df <- read.csv("Patient.csv")
head(Patient.df)
```

##	Patient.ID	Age	Sex	Race	Weight	Height	Smoke
## 1	3	21	Male	1	179.5	70.4	NA
## 2	4	32	Female	1	NA	63.9	NA
## 3	9	48	Female	1	149.7	61.8	2
## 4	10	35	Male	1	203.5	69.8	NA
## 5	11	48	Male	1	155.3	NA	2
## 6	19	44	Male	2	189.6	70.2	1

names(Patient.df)

```
# Names of the variables
```

```
names(Patient.df)
```

```
## [1] "Patient.ID" "Age"          "Sex"  
## [4] "Race"        "Weight"       "Height"  
## [7] "Smoke"
```

- Anything following the # symbol is treated as a comment and ignored by R.
- Writing comments is a very good habit to develop!

dim() and str()

```
dim(Patient.df)
```

```
## [1] 17030      7
```

```
str(Patient.df)
```

```
## 'data.frame':    17030 obs. of  7 variables:
## $ Patient.ID: int   3  4  9 10 11 19 34 44 45 48 ...
## $ Age       : int   21 32 48 35 48 44 42 24 67 56 ...
## $ Sex       : Factor w/ 2 levels "Female","Male": 2 1 1 2
## $ Race      : int   1  1  1  1  1  2  2  1  2  1 ...
## $ Weight    : num   180 NA 150 204 155 ...
## $ Height    : num   70.4 63.9 61.8 69.8 NA 70.2 62.6 64.4 6
## $ Smoke     : int   NA NA  2 NA  2  1  1  1 NA  2 ...
```

Note that **character** vector, Sex, is automatically converted to **factor**.

Reading data into R

```
Patient.df <- read.csv("Patient.csv",  
                      stringsAsFactors = FALSE)  
str(Patient.df)
```

```
## 'data.frame':    17030 obs. of  7 variables:  
## $ Patient.ID: int  3 4 9 10 11 19 34 44 45 48 ...  
## $ Age       : int  21 32 48 35 48 44 42 24 67 56 ...  
## $ Sex       : chr  "Male" "Female" "Female" "Male" ...  
## $ Race      : int  1 1 1 1 1 2 2 1 2 1 ...  
## $ Weight    : num  180 NA 150 204 155 ...  
## $ Height    : num  70.4 63.9 61.8 69.8 NA 70.2 62.6 64.4 ...  
## $ Smoke     : int  NA NA 2 NA 2 1 1 1 NA 2 ...
```

stringsAsFactors

stringsAsFactors argument is set to FALSE, so **character** vectors are not converted to **factors**.

Data Type

Everything in R is a vector (but some have only one element).

- ① Numeric (same as double), or integer. E.g. Patient.ID, Age, Race, Weight, Height and Smoke
- ② String (same as character). E.g. Sex
- ③ Logical: TRUE or FALSE, e.g.

```
1 == 1
```

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

```
2 <= 0
```

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

```
3 != 2
```

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

Descriptive statistics

Calculate the mean of Height:

```
mean(Height)
```

```
## Error in mean(Height): object 'Height' not found
```

You must tell R that Height is a variable (column) *within* Patient.df, i.e.

```
mean(Patient.df$Height)
```

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

You must also tell R how to deal with missing values: remove them before calculating the mean, i.e.

```
mean(Patient.df$Height, na.rm = TRUE)
```

```
## [1] 65.43787
```

table of counts

```
# One-way table of counts
```

```
table(Patient.df$Sex)
```

```
##
```

```
## Female    Male
```

```
##    9077    7953
```

table of proportions

```
# Total count  
total <- sum(table(Patient.df$Sex))  
total
```

```
## [1] 17030
```

```
# Proportions of total  
table(Patient.df$Sex)/total
```

```
##  
##      Female      Male  
## 0.5330006 0.4669994
```

One-way tables with less typing

Tired of typing `Patient.df$` over and over again? Use the `with` function.

```
Sex.table <- with(Patient.df, table(Sex))  
Sex.table
```

```
## Sex  
## Female    Male  
##    9077    7953
```

```
total <- sum(Sex.table)  
Sex.table/total
```

```
## Sex  
##      Female      Male  
## 0.5330006 0.4669994
```


One-way tables with less typing

```
# Convert to percentages
```

```
Sex.pct <- 100 * Sex.table/total
```

```
Sex.pct
```

```
## Sex
```

```
##   Female      Male
```

```
## 53.30006 46.69994
```

```
# Round to 1 decimal place
```

```
round(Sex.pct, 1)
```

```
## Sex
```

```
## Female      Male
```

```
##   53.3      46.7
```

Two-way frequency tables

```
Sex.Race.tab <- with(Patient.df, table(Sex, Race))  
Sex.Race.tab
```

```
##           Race  
## Sex           1     2     3  
##   Female 6114 2687  274  
##   Male   5498 2173  279
```

Two-way frequency tables

```
# Calculate proportion with respect to 'margin'  
# total margin = 1 (row total) or 2 (column total)  
perc.Sex.Race <- prop.table(Sex.Race.tab, margin = 2)  
perc.Sex.Race
```

```
##           Race  
## Sex           1           2           3  
## Female 0.5265243 0.5528807 0.4954792  
## Male   0.4734757 0.4471193 0.5045208
```

Two-way frequency tables

```
# Tabulate as percentages  
round(100 * perc.Sex.Race, 1)
```

```
##           Race  
## Sex         1     2     3  
## Female 52.7 55.3 49.5  
## Male   47.3 44.7 50.5
```

Summary

- Quick introduction to R
- Getting data into R
- Frequency tables