Lab 1 – Introduction to R

August 13 & 14, 2018

FANR 6750

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University of Georgia

Today's Topics

1. Why Use **R**?
2. Installing **R**
3. Basic Usage
   - Basic calculations
   - Vectors
   - Data frames
   - Importing and Exporting Data
   - Removing objects and saving workspaces
4. Getting help

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Good and Not So Good Things About **R**

Good

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- Many packages written for ecologists
- It's free
- Scripts save time
- **R** teaches you statistics

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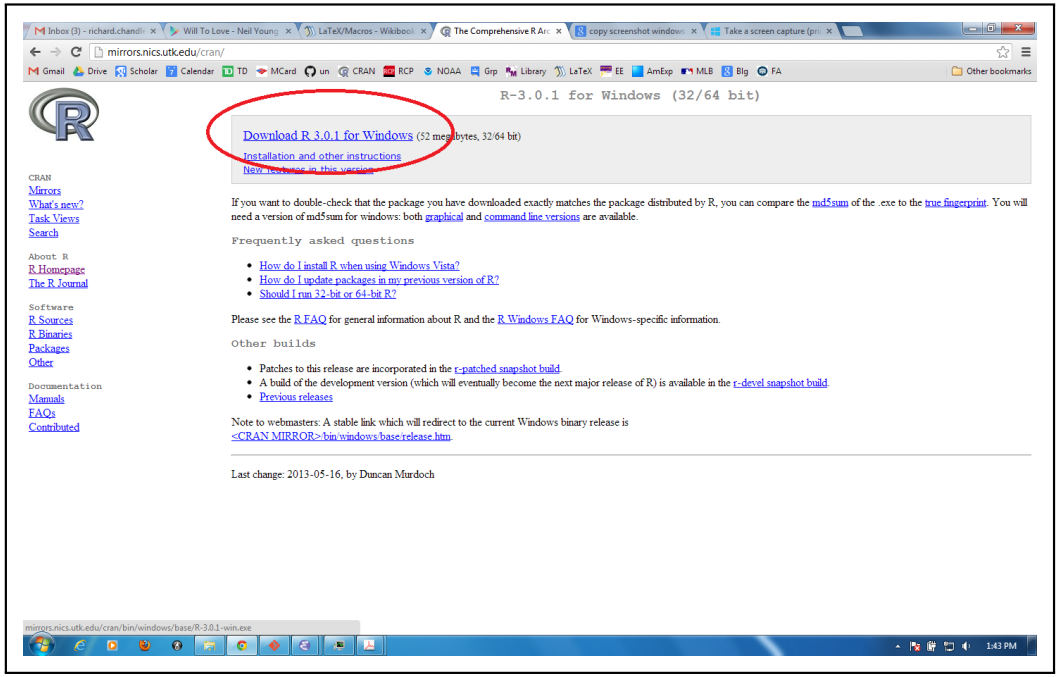
- **R** teaches you statistics

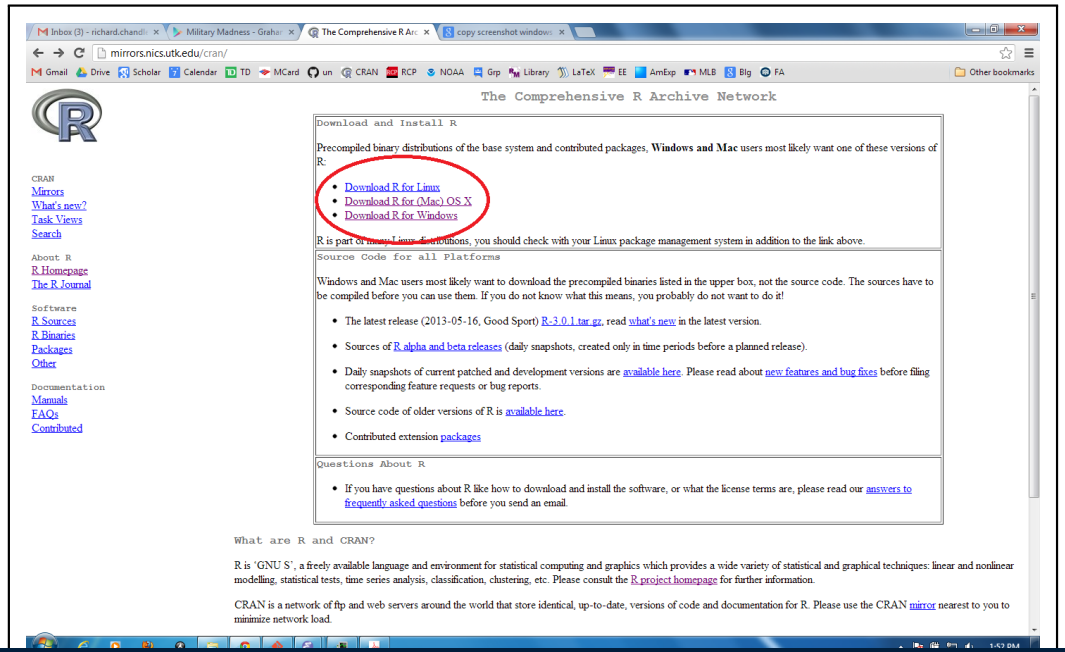
Not so good??

- Steep learning curve
- Help pages written for people familiar with **R**
- Developed by statisticians for statisticians
- Not as fast as some languages

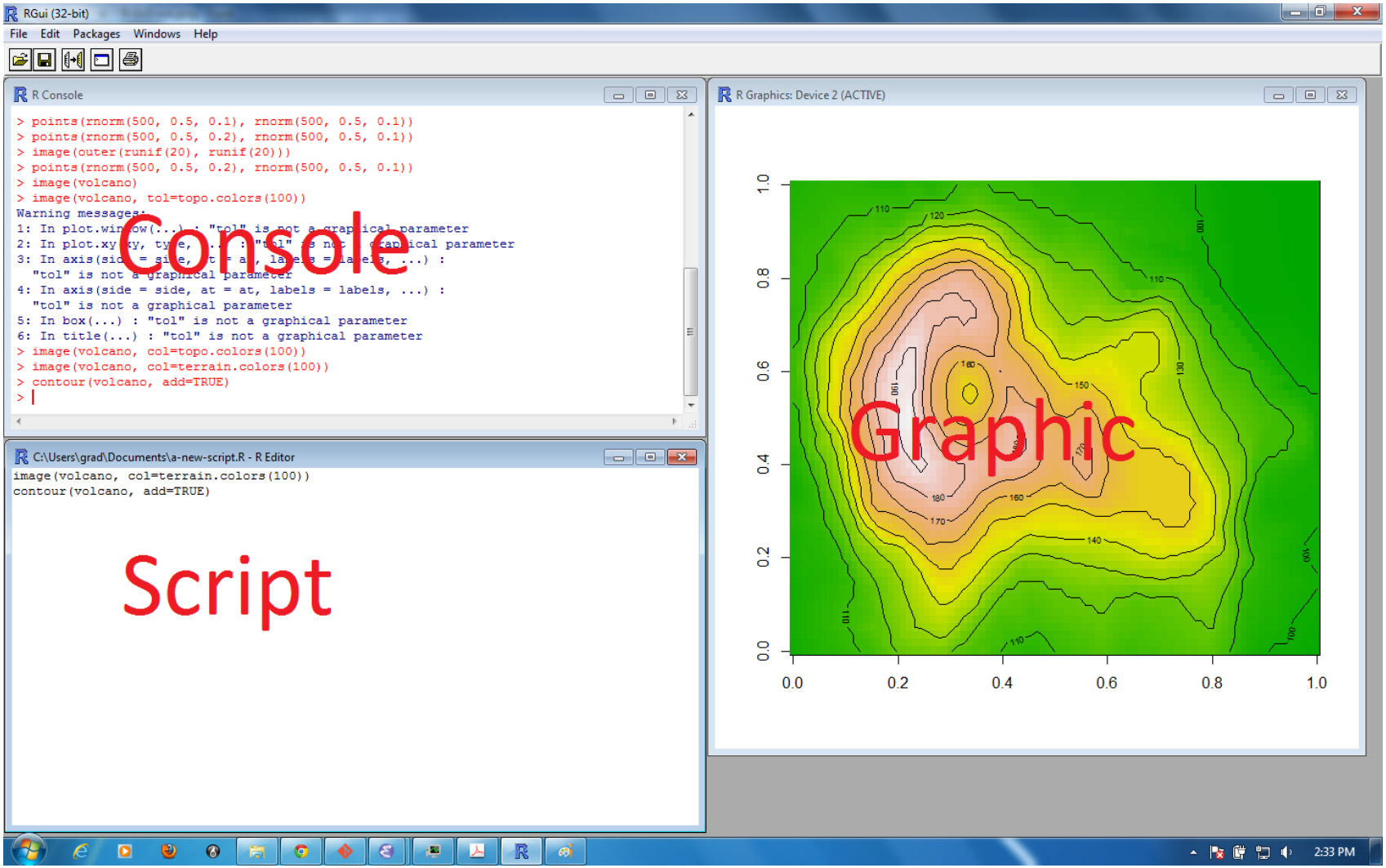
Downloading R

- Go to `www.r-project.org`
- Click on "CRAN"
- Choose a mirror near you (there is one in TN)





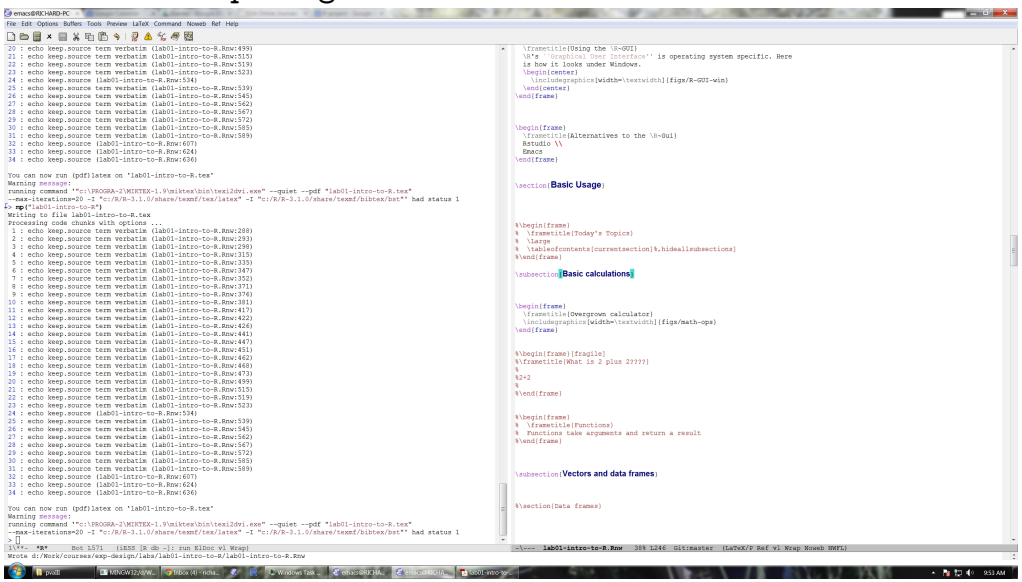
R's "Graphical User Interface" is operating system specific. Here is how it looks under Windows.



Alternatives to the R Gui

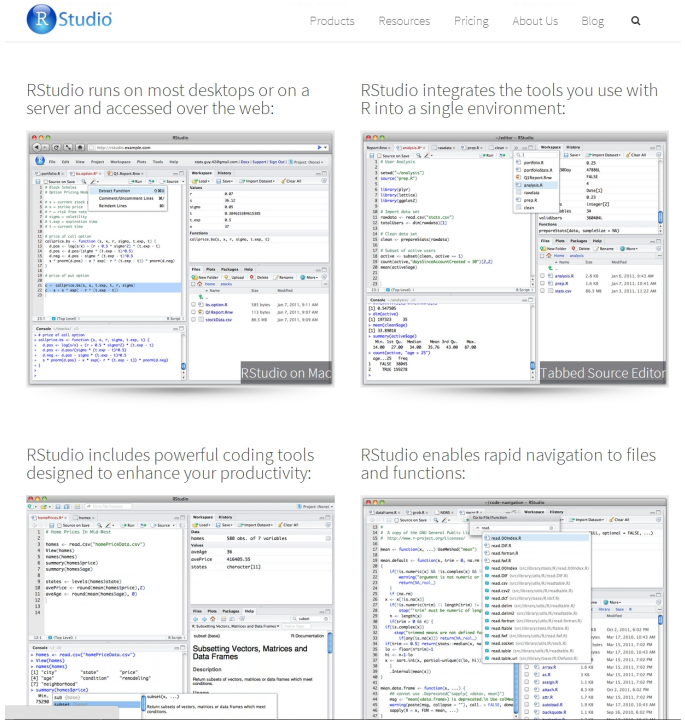
Emacs and ESS

http://vgoulet.act.ulaval.ca/en/emacs/



RStudio

http://www.rstudio.com/



You are encouraged to learn and use these programs, but we will not use them for instruction because we want to focus on **R** itself, not the interface.

How to read the code in the lab slides

Anything in a shaded box like this one is **R** code:

```
2+2

## [1] 4
```

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The line `2+2` is **R** code (input). You can copy and paste it into the console. Note that the command prompt (>) is not shown.

The line `## [1] 4` is output. Output is always indicated by two hash signs (##). Anything after a # is ignored by **R** at the command line.

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The line `## [1] 4` is output. Output is always indicated by two hash signs (##). Anything after a # is ignored by **R** at the command line.

You can copy and paste the entire code box directly into your console, but it might be easier to work with the **R** script that accompanies the PDF: `lab-intro-to-R.R`.

Overgrown calculator

Square-root of 3

```
sqrt(3)

## [1] 1.732051
```

Overgrown calculator

Square-root of 3

```
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## [1] 1.732051
```

6 squared

```
6^2

## [1] 36
```

Overgrown calculator

Square-root of 3

```
sqrt(3)
```

```
## [1] 1.732051
```

6 squared

```
6^2
```

```
## [1] 36
```

cosine of π

```
cos(pi)
```

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

Objects and assignment arrow

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Everything in **R** is an object. We can create objects using the `<-` assignment arrow.

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y <- 2
```

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You can use `=` instead of `<-` but this can cause confusion

Typing the name of an object returns its value:

```
y

## [1] 2
```

We store data in objects so that they can be easily manipulated:

```
y*2+1

## [1] 5
```

Vectors

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## [1] 5
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Usually, we want more than one number in an object. In statistics, a vector is simply a set of numbers that can be thought of as a row or column of a matrix

We store data in objects so that they can be easily manipulated:

```
y*2+1

## [1] 5
```

Usually, we want more than one number in an object. In statistics, a vector is simply a set of numbers that can be thought of as a row or column of a matrix

The easiest way to create a vector is to use the `c` function to "combine" numbers:

```
z <- c(-1, 9, 33, -4)
z

## [1] -1  9 33 -4
```

Other useful ways of creating vectors

A sequence of numbers

```
x1 <- 1:3 # Same as: x1 <- c(1, 2, 3)
          # Note: anything after "#" is a comment
x1

## [1] 1 2 3
```

Other useful ways of creating vectors

A sequence of numbers

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`seq` is more general

```
x2 <- seq(from=1, to=7, by=2)
x2

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

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x1

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```

`seq` is more general

```
x2 <- seq(from=1, to=7, by=2)
x2

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

Use `rep` to repeat elements of a vector

```
rep(x2, times=2)

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

Help with a function

These do the same thing

```
?rep
help(rep)
```

Types of vectors

Numeric vectors are used for continuous variables

```
y1 <- c(2.1, 3.5, 99.0)
class(y1)

## [1] "numeric"
```

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y1 <- c(2.1, 3.5, 99.0)
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Factors can be used to store categorical variables:

```
y2 <- factor(c("Treatment", "Control", "Treatment"))
y2

## [1] Treatment Control   Treatment
## Levels: Control Treatment
```

Vectorized arithmetic

How could we calculate the body mass index (BMI = weight/height^2) from the following data:

	Individual					
	1	2	3	4	5	6
Weight	60	72	57	90	95	72
Height	1.8	1.8	1.7	1.9	1.7	1.9

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First, create the vectors:

```
weight <- c(60, 72, 57, 90, 95, 72)
height <- c(1.8, 1.8, 1.7, 1.9, 1.7, 1.9)
```

Vectorized arithmetic

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First, create the vectors:

```
weight <- c(60, 72, 57, 90, 95, 72)
height <- c(1.8, 1.8, 1.7, 1.9, 1.7, 1.9)
```

Then, evaluate the equation in just one line:

```
BMI <- weight/height^2
BMI
```

```
## [1] 18.51852 22.22222 19.72318 24.93075 32.87197 19.94460
```

In-class assignment

Calculate the circumference and area of circles with radii: 3,5,6,11

Calculate the circumference and area of circles with radii: 3,5,6,11

(1) Create a new script called "lab1-prob1.R". You can do this by:

I. Clicking on the Console
II. Choosing `"File > New Script"` from the drop-down menu
III. Clicking on `"File > Save as..."`

(2) Create a vector containing the radii

(3) Store the computed circumferences and areas in 2 new vectors

You should be able to do this in just 3 lines in your script. Write all of your code in the script, not in console.

A common beginner's problem

If you accidentally hit "return" or fail to complete a command, you will see the cursor on a new line beginning with + instead of >.

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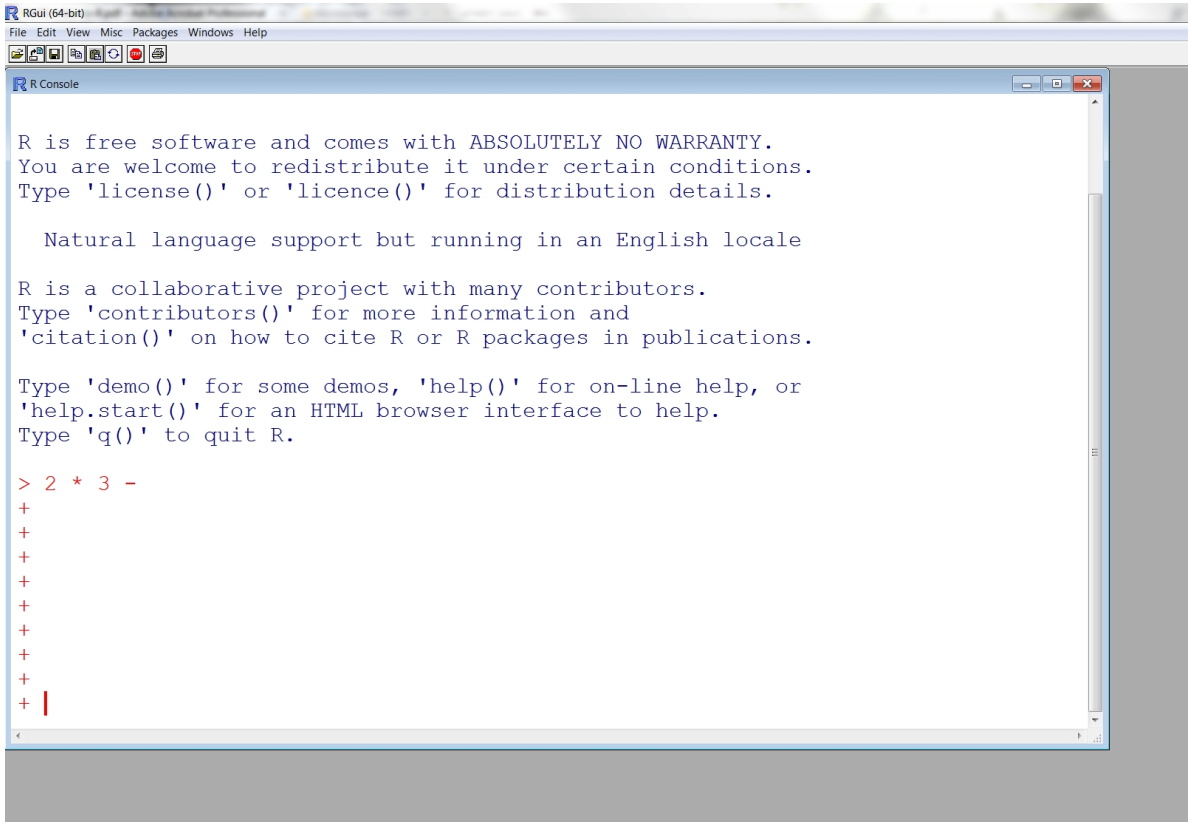

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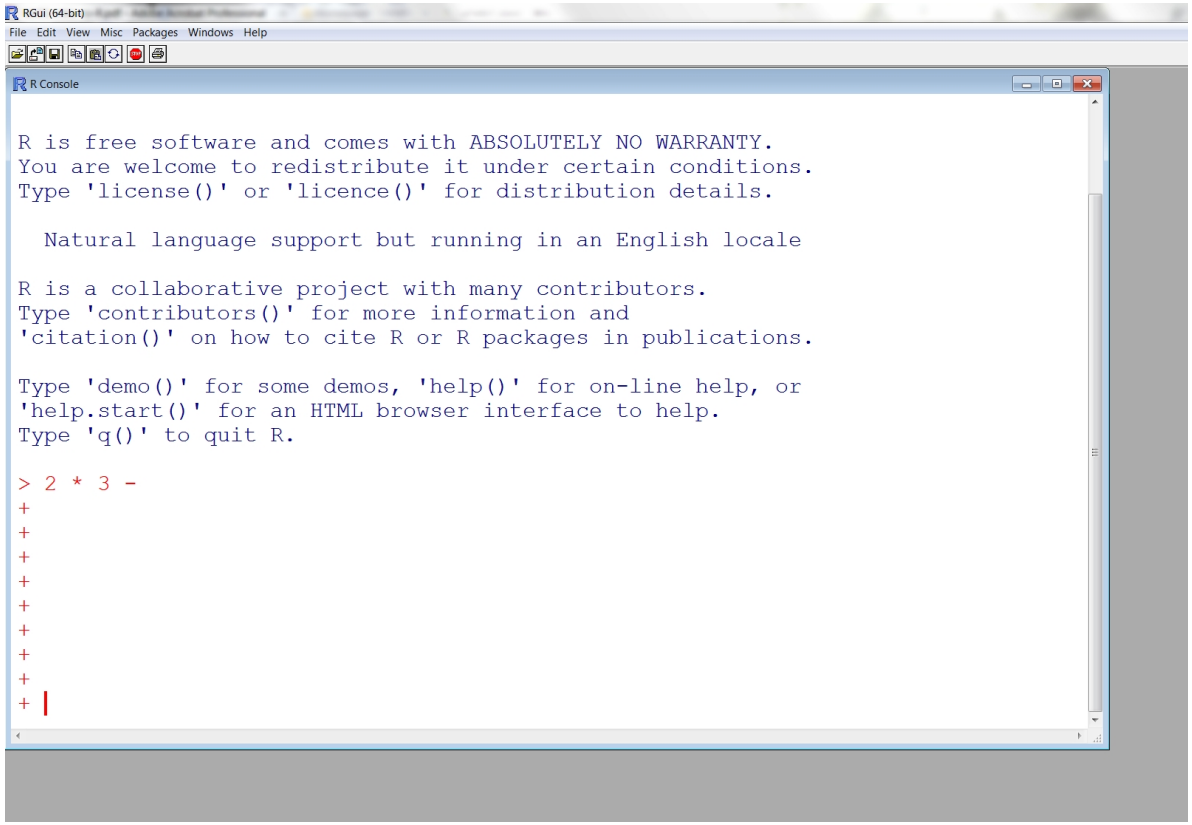

Just hit the "Esc" key or complete the command.

Summarizing vectors

Number of ticks on 5 dogs				
y_1	y_2	y_3	y_4	y_5
4	7	2	3	150

What is the sum of this vector? $\sum_{i=1}^{5} y_i = ???$

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```
y <- c(4,7,2,3,150)
sum(y)

## [1] 166
```

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## [1] 166
```

What is the mean? $\frac{\sum_{i=1}^{5} y_i}{5} = ???$

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```
y <- c(4,7,2,3,150)
sum(y)

## [1] 166
```

What is the mean? $\frac{\sum_{i=1}^{5} y_i}{5} = ???$

```
mean(y)

## [1] 33.2
```

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```
y <- c(4,7,2,3,150)
sum(y)

## [1] 166
```

What is the mean? $\frac{\sum_{i=1}^{5} y_i}{5} = ???$

```
mean(y)

## [1] 33.2
```

And the variance? $\frac{\sum_{i=1}^{5} (y_i - \bar{y})^2}{5-1} = ???$

```
var(y)

## [1] 4266.7
```

Indexing vectors

Extract the first and third elements of a vector

```
y <- c(2, 4, 8, 4, 25)
y.sub1 <- y[c(1,3)]
y.sub1

## [1] 2 8
```

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y <- c(2, 4, 8, 4, 25)
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y.sub1
```

```
## [1] 2 8
```

Remove the second element

```
y.sub2 <- y[-2]
y.sub2
```

```
## [1]  2  8  4 25
```

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y.sub1

## [1] 2 8
```

Remove the second element

```
y.sub2 <- y[-2]
y.sub2

## [1]  2  8  4 25
```

Rearrange the order of the vector

```
y.re <- y[c(5,4,3,2,1)]
y.re

## [1] 25  4  8  4  2
```

Which elements of the vector are greater than 4? (logical test)

```
y <- c(2, 4, 6, 4, 25)
y>4

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

Which elements of the vector are greater than 4? (logical test)

```
y <- c(2, 4, 6, 4, 25)
y>4

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

Extract the elements greater than 4 (logical indexing)

```
y.sub4 <- y[y>4]
y.sub4

## [1]  6 25
```

Data frames

Most basic datasets are stored as `data.frames`

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They have attributes for row names (e.g. the names of the experimental units) and column names (e.g. the names of the response and predictor variables)

Simple example with 3 variables measured at 4 sites

```
y <- c(3, 9, 7, 4)
x1 <- factor(c('High', 'High', 'Low', 'Low'))
x2 <- c(2.2, 3.4, 4.4, 3.9)
mydata <- data.frame(Goats=y, Elev=x1, Temp=x2)
rownames(mydata) <- c('Site1', 'Site2', 'Site3', 'Site4')
mydata
```

```
##       Goats Elev Temp
## Site1     3 High  2.2
## Site2     9 High  3.4
## Site3     7  Low  4.4
## Site4     4  Low  3.9
```

Indexing data frames

Bracket method. Extract data from row 1, columns 1 and 3

```
mydata[1,c(1,3)]
```

```
##       Goats Temp
## Site1     3  2.2
```

Indexing data frames

Bracket method. Extract data from row 1, columns 1 and 3

```
mydata[1,c(1,3)]

##       Goats Temp
## Site1     3  2.2
```

Bracket method. Extract from rows 2 and 3, columns 1 and 3

```
mydata[c('Site2', 'Site3'), c('Goats', 'Temp')]

##       Goats Temp
## Site2     9  3.4
## Site3     7  4.4
```

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```
mydata[1,c(1,3)]

##       Goats Temp
## Site1     3  2.2
```

Bracket method. Extract from rows 2 and 3, columns 1 and 3

```
mydata[c('Site2', 'Site3'), c('Goats', 'Temp')]

##       Goats Temp
## Site2     9  3.4
## Site3     7  4.4
```

Dollar sign method. Pull out column 1

```
mydata$Elev

## [1] High High Low  Low
## Levels: High Low
```

Summarizing data frames

View the data as a 'spreadsheet'

```
View(mydata)
```

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```
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Compute some summary statistics

```
summary(mydata)
```

```
##      Goats        Elev        Temp
##  Min.   :3.00   High:2   Min.   :2.200
##  1st Qu.:3.75   Low :2   1st Qu.:3.100
##  Median :5.50            Median :3.650
##  Mean   :5.75            Mean   :3.475
##  3rd Qu.:7.50            3rd Qu.:4.025
##  Max.   :9.00            Max.   :4.400
```

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##  1st Qu.:3.75   Low :2   1st Qu.:3.100
##  Median :5.50            Median :3.650
##  Mean   :5.75            Mean   :3.475
##  3rd Qu.:7.50            3rd Qu.:4.025
##  Max.   :9.00            Max.   :4.400
```

A very compact summary

```
str(mydata)
```

```
## 'data.frame': 4 obs. of  3 variables:
##  $ Goats: num  3 9 7 4
##  $ Elev : Factor w/ 2 levels "High","Low": 1 1 2 2
##  $ Temp : num  2.2 3.4 4.4 3.9
```

`read.csv` and `write.csv` are easy options, but there are many more possibilities that we won't cover.

Importing and exporting data

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Export the `data.frame` we created earlier

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write.csv(mydata, file="mydata.csv")
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Confirm that it is there:

```
getwd() # Go to this location and look for 'mydata.csv'
```

`read.csv` and `write.csv` are easy options, but there are many more possibilities that we won't cover.

Export the `data.frame` we created earlier

```
write.csv(mydata, file="mydata.csv")
```

Confirm that it is there:

```
getwd() # Go to this location and look for 'mydata.csv'
```

Read it back in:

```
mydata2 <- read.csv("mydata.csv")
```

The working directory

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getwd()

## [1] "d:/exp-design/labs/intro-to-R"
```

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Change your working directory to another location:

```
## Note the forward slashes, which could be replaced by "\\"
setwd("C:/work/courses/")
```

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setwd("C:/work/courses/")
```

At the beginning of every R session, you should use `setwd` to set your working directory

Viewing the objects in your workspace

```
ls()
```

```
##  [1] "BMI"      "clean"    "filestub" "height"   "mydata"   "mydata2"
##  [7] "open"     "reqval"   "rnw.file" "tangle"   "weight"   "x1"
## [13] "x2"       "y"        "y.re"     "y.sub1"   "y.sub2"   "y.sub4"
## [19] "y1"       "y2"       "z"
```

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## [13] "x2"       "y"        "y.re"     "y.sub1"   "y.sub2"   "y.sub4"
## [19] "y1"       "y2"       "z"
```
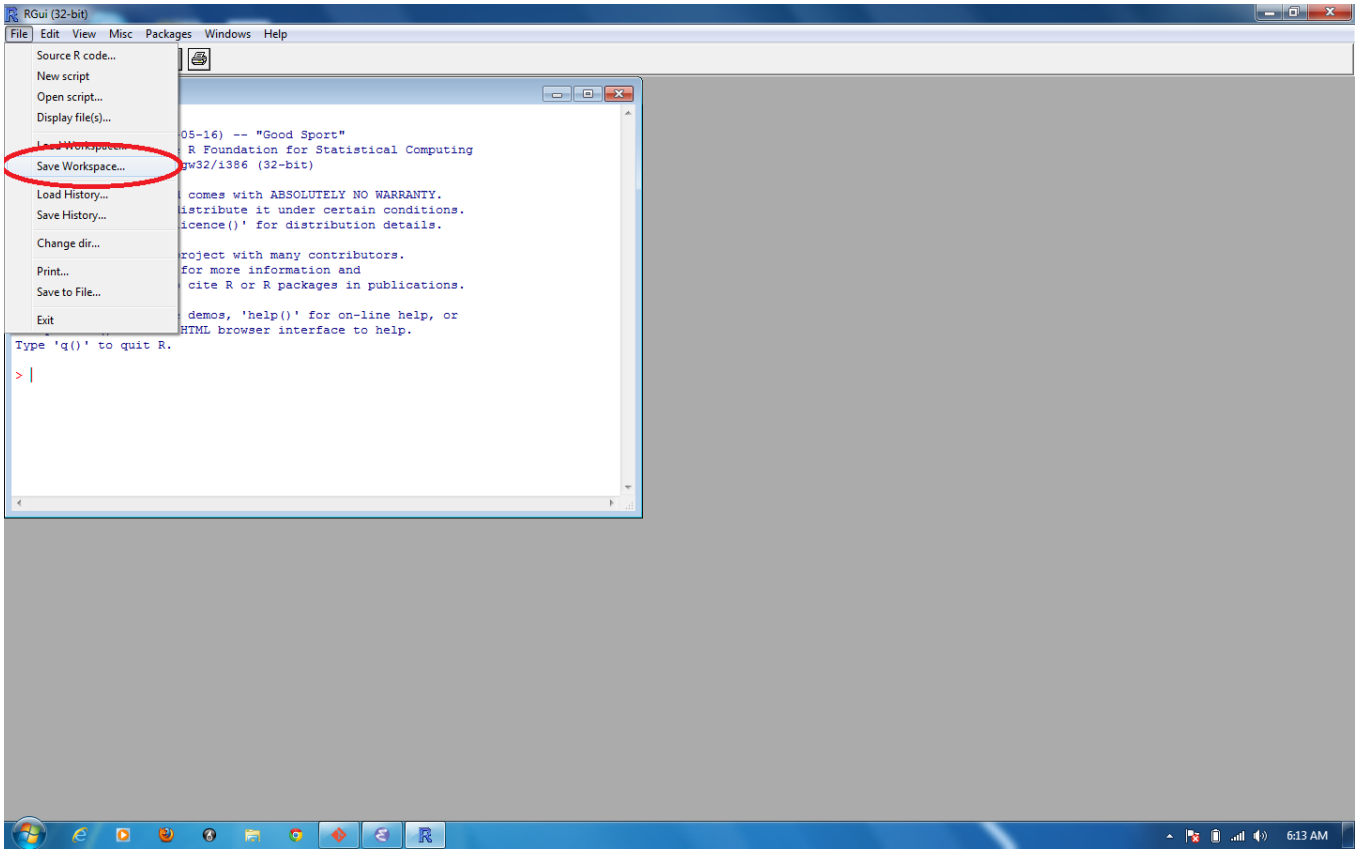

Removing (deleting) some objects

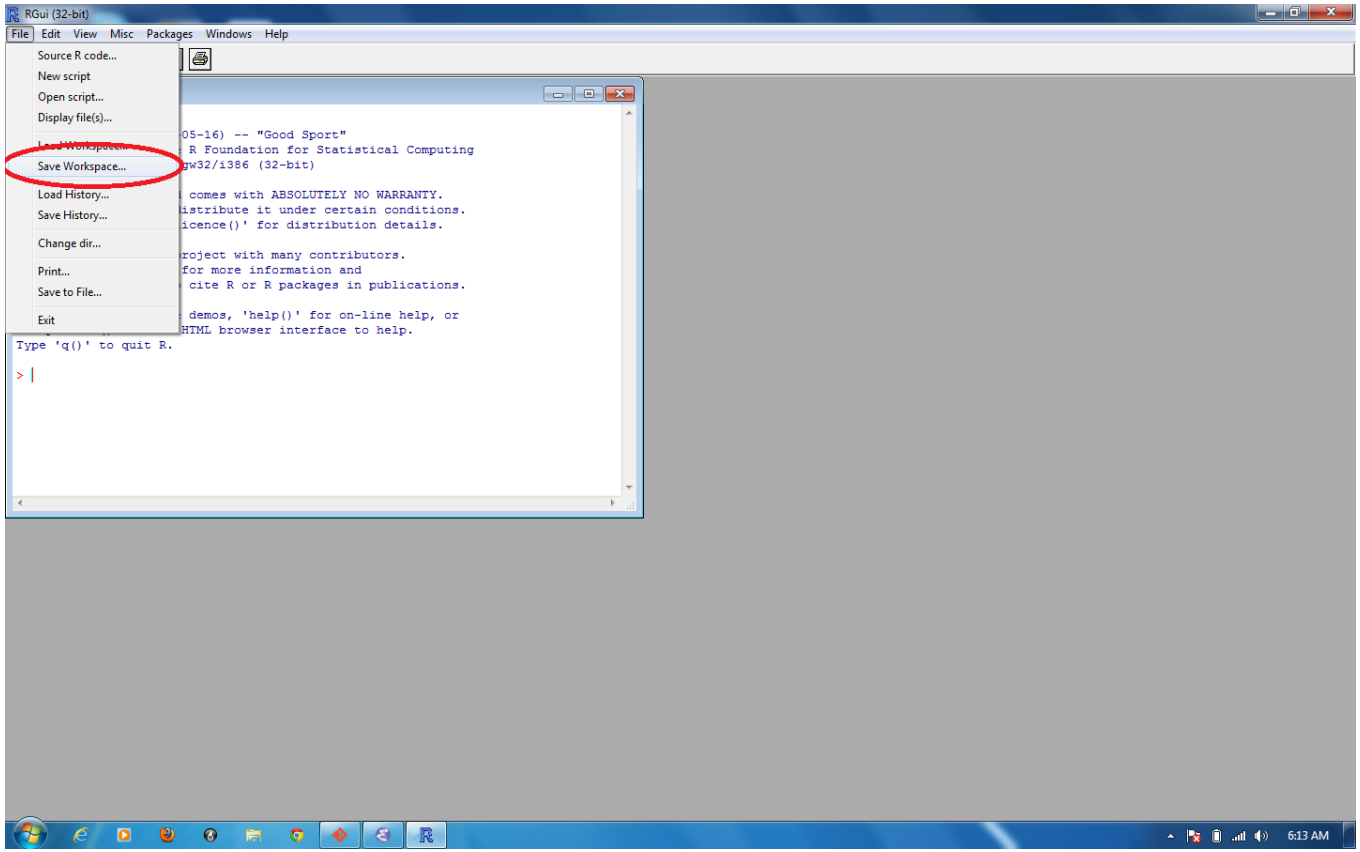
```
rm(x1, x2, mydata2, y, y1, y2, y.re,
   y.sub1, y.sub2, y.sub4, height, weight, BMI, z)
ls()
```

```
## [1] "clean"    "filestub" "mydata"   "open"     "reqval"   "rnw.file"
## [7] "tangle"
```

Saving and restoring the workspace



Saving and restoring the workspace



If you prefer commands over point-and-click:

```
save.image("myimage.RData") # Save all objects to file
load("myimage.RData")       # Load the saved workspace
```

Additional Resources

'Official' manuals

```
help.start()
```

Useful books

- Venables, W.N. and B.D. Ripley. 2002. Modern Applied Statistics with S, 4th ed. Springer.
- Crawley, M.J.. 2013. The **R** Book, 2nd ed. Wiley

Online

- Always Google your error messages
- `http://stackoverflow.com/`
- `https://preludeinr.com/`

Assignment – Part I

(1) Create an **R** script named something like `Chandler-R_lab1.R`

(2) In your **R** script, write code to create a `data.frame` that contains the information shown in the table below

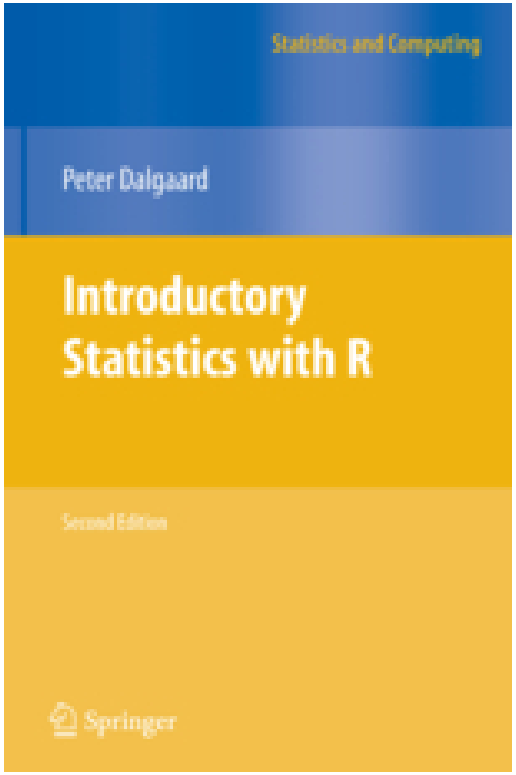
(3) Add code to export the `data.frame` as a .csv file and then import it back into **R**.

Individual	Mass	Weight	Treatment
1	3	4	Control
2	3	5	Control
3	2	4	Control
4	4	6	Treatment
5	5	5	Treatment
6	5	7	Treatment

Upload your **R** script[1] to ELC before your next lab. The script should be self-contained, meaning that it will run correctly when we copy and paste it in the console.

[1] If you are familiar with RMarkdown, you can submit a `.Rmd` file instead of a `.R` file

Assignment – Part II



Read chapters 1, 4, & 5 before next lab

Dalgaard, P. 2008. Introductory Statistics with R. 2nd edition. Springer. Available for free through the UGA library:

`http://preproxy.galib.uga.edu/login?url=http://dx.doi.org/10.1007/978-0-387-79054-1`