Lab 1

An Introduction to R and R markdown

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Summary *This lab will outline some of the basics in R, as well as introduce R markdown as a file format for making dynamic documents for assignments. This lab assignment is* ***not*** *for marks. In the future, your assignments will involve creating Rmd files and submitting the resulting HTML outputs as your work. However,* ***for this lab, there's no need to submit anything.***

By the end of this lab students will be able to:

- do basic calculations in R

Software

In DATA 311, we will use R (and RStudio) in lab and for completing assignments. R is free, open-source, and multi-platform, so you should be able to install it on your machine of choice. RStudio is proprietary, but has free-for-personal-use versions, and can be used on all major platforms — Windows, Mac, Linux.

If you are unable to get Rstudio, you are free to use an alternative method for creating readable assignments (eg. word documents, Jupyter notebook) but it is *highly recommended* that you use Rstudio. If you are using a chromebook for example, there are workarounds for getting Rstudio installed (eg first two google searches: 1, 2)

To complete all the steps of this lab you will need to do the following:

1. Install R: https://cran.r-project.org/. Download links are top and center on the website.

2. Install RStudio: https://rstudio.com/products/rstudio/download/. You'll want RStudio Desktop.

Even if you have these programs installed on your computer you should update them to ensure that you have the latest version.

R basics

Calculations

Much of R works as you might expect. It can function as a basic calculator...

```
3 + 4
```

```
[1] 7
```

```
3 - 4
```

```
[1] -1
```

```
3/4
```

```
[1] 0.75
```

```
3^2
```

```
[1] 9
```

```
pi^2
```

```
[1] 9.869604
```

Creating variables

You can make objects and assign values...

```r
x <- 3
y <- 4
x + y
```

```
[1] 7
```

Note that in R you can use `<-` or `=` as the assignment operator. Namely, we could have written:

```r
x = 3
y = 4
```

R is case-sensitive

```r
X
```

```
Error in eval(expr, envir, enclos): object 'X' not found
```

And be careful about leaving out operators...

```r
2(x+y)
```

```
Error in eval(expr, envir, enclos): attempt to apply non-function
```

versus

```r
2*(x+y)
```

```
[1] 14
```

Data Structures

Vectors

We can create a vector using `c` (for combine)

```r
vec <- c(x,y,5,6,2,1)
```

Vectors can contain strings instead of numbers:

```
z = c("apples","bananas","oranges", "pineapples")
```

We can also make quick sequences...

```
j <- 5:300
j
```

```
  [1]   5   6   7   8   9  10  11  12  13  14  15  16  17  18  19  20  21  22
 [19]  23  24  25  26  27  28  29  30  31  32  33  34  35  36  37  38  39  40
 [37]  41  42  43  44  45  46  47  48  49  50  51  52  53  54  55  56  57  58
 [55]  59  60  61  62  63  64  65  66  67  68  69  70  71  72  73  74  75  76
 [73]  77  78  79  80  81  82  83  84  85  86  87  88  89  90  91  92  93  94
 [91]  95  96  97  98  99 100 101 102 103 104 105 106 107 108 109 110 111 112
[109] 113 114 115 116 117 118 119 120 121 122 123 124 125 126 127 128 129 130
[127] 131 132 133 134 135 136 137 138 139 140 141 142 143 144 145 146 147 148
[145] 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166
[163] 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184
[181] 185 186 187 188 189 190 191 192 193 194 195 196 197 198 199 200 201 202
[199] 203 204 205 206 207 208 209 210 211 212 213 214 215 216 217 218 219 220
[217] 221 222 223 224 225 226 227 228 229 230 231 232 233 234 235 236 237 238
[235] 239 240 241 242 243 244 245 246 247 248 249 250 251 252 253 254 255 256
[253] 257 258 259 260 261 262 263 264 265 266 267 268 269 270 271 272 273 274
[271] 275 276 277 278 279 280 281 282 283 284 285 286 287 288 289 290 291 292
[289] 293 294 295 296 297 298 299 300
```

We can check how many elements a vector has using `lenght()` function:

```
length(j)
```

```
[1] 296
```

To index an element from a vector, use single square brackets

```
vec[3]
```

```
[1] 5
```

To index multiple elements from a vector we could use:

```
z[2:3]    # extracts the second to third element (inclusive)
```

```
[1] "bananas" "oranges"
```

```
z[c(4,2)] # extracts the fourth and second element (in that order)
```

```
[1] "pineapples" "bananas"
```

```
z[-1]     # extracts every element *except* for the first
```

```
[1] "bananas"    "oranges"    "pineapples"
```

We can also extract elements of our vector that fulfill a certain condition. For example let's extract all of the elements that are larger than 3 from `vec`

```
vec
```

```
[1] 3 4 5 6 2 1
```

```
vec[vec>3]
```

```
[1] 4 5 6
```

Note that `vec>3` is a logical vector:

```
vec > 3
```

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

This logical vector in this case is being used to index all the elements for which this logical check returns true. In this case, we are extracting elements 2, 3, 4. To extract that index in R we could use the `which()` function

```
which(vec>3)
```

```
[1] 2 3 4
```

Checks can also be done on strings. For example,

```r
z[z=="apples"]
```

```
[1] "apples"
```

```r
z[grepl("apples", z)]  # chekcs for any element that has the word "apples" in it
```

```
[1] "apples"     "pineapples"
```

There is almost always more than one way of accomplishing a task. For example, finding the average of our vector `vec`

```r
# tedious/long/hard
(3 + 4 + 5 + 6 + 2 + 1) / 6
```

```
[1] 3.5
```

```r
# better
sum(vec) / 6
```

```
[1] 3.5
```

```r
# Generalizable
sum(vec) / length(vec)
```

```
[1] 3.5
```

```r
# easiest
mean(vec)
```

```
[1] 3.5
```

Notice the use of `#` to indicate the start of a comment.
For another example, how about the standard deviation of `vec`?

```
#"Hard" sample std dev
sqrt((sum( vec ^ 2 - mean(vec) ^ 2)) / (6 - 1))
```

```
[1] 1.870829
```

```
#Easy
sd(vec)
```

```
[1] 1.870829
```

But without having manually calculated the sample standard deviation beforehand, how could we be confident that the "sd" function is using the unbiased divisor "(n - 1)"? Type the following in your console (bottom left window under default RStudio settings), then hit enter:

```
?sd
```

You should see a help document pop up in the bottom right window (again, default Rstudio settings). If you read through the Details section of that document, it will specify the denominator it is using.

Caution: R is open-source, and even packages hosted on the official CRAN repository will vary in terms of the actual helpfulness of the help files.

Matrices

By default, matrices are constructed columnwise.

```
(m <- matrix(1:6, nrow=2, ncol =3)) # fill columnwise
```

```
     [,1] [,2] [,3]
[1,]    1    3    5
[2,]    2    4    6
```

You can always change to row-wise by specifying the argument `byrow=TRUE`

```
(m <- matrix(1:6, nrow=2, ncol =3, byrow=TRUE)) #fill row-wise
```

```
     [,1] [,2] [,3]
[1,]    1    2    3
[2,]    4    5    6
```

The following extracts a column, row, and cell from matrix `m`,

```
# extract the third column of m
m[,3]
```

```
[1] 3 6
```

```
# extract the first row of m
m[1,]
```

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

```
# extract the element in the 1st row and 3rd column
m[1,3]
```

```
[1] 3
```

Data frames

Data frames are perhaps the most used data structure used in statistics. They can store different data types and can contain additional attributes such as column and row names. When combining vectors in a data frame all must have the same size (i.e. length). Missing observations will be recorded as `NA`.

Here is an example of how to create a data frame and add to it:

```
Person=c('John', 'Jill', 'Jack')
Grade=c('45','92','91')
(Lab=data.frame(Person, Grade))
```

```
  Person Grade
1   John    45
2   Jill    92
3   Jack    91
```

To extract the first column, we can either reference it by number:

```
Lab[,1]
```

```
[1] "John" "Jill" "Jack"
```

OR we can reference it by name:

```
Lab[,"Person"]
```

```
[1] "John" "Jill" "Jack"
```

A third option is to extract a column of this data frame using the $ operator:

```
Lab$Person
```

```
[1] "John" "Jill" "Jack"
```

Adding a column to the data frame is as easy as typing:

```
Lab$Passed=c(FALSE,TRUE,TRUE)
Lab
```

```
  Person Grade Passed
1   John    45  FALSE
2   Jill    92   TRUE
3   Jack    91   TRUE
```

Alternatively, we could have let R figure out whether the student passed or not based on the grade and typed:

```
Lab$Passed = Lab$Grade >= 50
Lab
```

```
  Person Grade Passed
1   John    45  FALSE
2   Jill    92   TRUE
3   Jack    91   TRUE
```

Importing data into R

Using R data sets

Many data sets are available in "base" R and a larger collection can be accessed via R packages. For example, if we want to gain access to the *Old Faithful* data frame, we could type:

```
data("faithful")
```

To learn more on this data set type `?faithful` into the R console. To see the first few rows of this data set type:

```
head(faithful)
```

```
  eruptions waiting
1     3.600      79
2     1.800      54
3     3.333      74
4     2.283      62
5     4.533      85
6     2.883      55
```

Another cool feature is we can get a summary of each column using:

```
summary(faithful)
```

```
   eruptions        waiting
 Min.   :1.600   Min.   :43.0
 1st Qu.:2.163   1st Qu.:58.0
 Median :4.000   Median :76.0
 Mean   :3.488   Mean   :70.9
 3rd Qu.:4.454   3rd Qu.:82.0
 Max.   :5.100   Max.   :96.0
```

As before, we can extract column names using the dollar sign and perform operations on those vectors, for example

```
mean(faithful$eruptions) # to give the average eruption time
```

```
[1] 3.487783
```

Rather than calling the columns from the data frame using `$`, you could instead "attach" the data set (see `?attach`). This essentially means the columns will be saved to variables that you can call directly. For example, the following code will produce an error since,

```
mean(eruptions) # will produce an Error if we use before calling attach(faithful)
```

However, once we attach the faithful data set, R will have a vector called `eruptions` and `waiting`:

```
attach(faithful)
mean(eruptions)
```

```
[1] 3.487783
```

Importing from csv

In a practical setting, we will most likely be required to load our own data into R at some point. The easiest way to do this is by saving your data in csv (comma separated values) format and using the `read.csv()` function; see `?read.csv` for more details. Assuming your data is stored in your **working directory** (more on this in a second), you can load your csv file into R using the `read.csv` function:

`read.csv(`*name_of_file.csv*`)`.

Typically, we would like to save the data set to some object that can perform actions on. For example, I can load a simple data matrix (stored in file `datamatrix.csv`) and save it to an object called `dat`:

```
dat <- read.csv("datamatrix.csv")
dat
```

```
  gender sleep intro_extra countries dread
1   male   5.0   extravert         3     3
2 female   7.0   extravert         7     2
3 female   5.5   introvert         1     4
4   male   7.0   extravert         2     2
5  other   3.0   introvert         1     3
6 female   3.0   extravert         9     4
```

The above code assumes you data is stored in you working directory. Read on to see how to specify this in R. This data set is available on Canvas for you to test.

Alternatively, we can pull a csv file straight from the web:

```
penguins <- read.csv("https://irene.vrbik.ok.ubc.ca/data/penguins.csv")
head(penguins)
```

```
  X species    island bill_length_mm bill_depth_mm flipper_length_mm
1 1  Adelie Torgersen           39.1          18.7               181
2 2  Adelie Torgersen           39.5          17.4               186
3 3  Adelie Torgersen           40.3          18.0               195
4 4  Adelie Torgersen             NA            NA                NA
5 5  Adelie Torgersen           36.7          19.3               193
6 6  Adelie Torgersen           39.3          20.6               190
  body_mass_g    sex year
1        3750   male 2007
2        3800 female 2007
3        3250 female 2007
4          NA   <NA> 2007
5        3450 female 2007
6        3650   male 2007
```

Setting your working directory

Independent of R, it is usually a good idea to put school projects into some organized folder system. For instance, in my **Documents** folder on my Mac I currently have the following filing organization:

```
data311/
|-- labs/
|   |-- Lab00.Rmd
|   |-- practice00.Rmd
|   |-- datamatrix.csv
|-- assignemnts/
|   |-- template.Rmd
|   |-- example.csv
```

Suppose I am working on this lab and I want to read in the `datamatrix.csv` file. I *could* access the file using the whole path. For example:

```
dat <- read.csv("/Users/ivrbik/Documents/data311/labs/datamatrix.csv")
```

but I don't recommend this (and if fact this won't work within Rmd documents–more on this below).

Alternatively (and preferably) you should save this into your *working directory*. The working directory is just a file path on your computer that sets the default location of any files you read (or write out) into R. To set your working directory use `setwd`. Following from the file organization example above, if I want my working directory to be the `labs` folder, I would need to specify that path as the sole argument in the `setwd` function:

```
setwd("/Users/ivrbik/Documents/data311/labs/")
```

Once you set your working directory to the same folder in which your data file is stored you can reference it with no path.

```
dat <- read.csv("datamatrix.csv")
```

N.B. You can check what your working directory is use `getwd()`. **If you are working within an R Markdown document your working directory is the folder that contains the Rmd file** (more on this below)

R packages

Most standard statistical analyses are built-in, but a vast array of more complex analyses are available. We will often require installation of additional packages to complete assignments and labs. For example, if you want to install the `ISL2` package (the package associated with our text book) type:

```
install.packages("ISLR2")
```

The above needs only to be done once. With every new R session/script/Rmd file, if you want to gain access to all of the contents within this package, we first need to load or "attach" it using:

```
library("ISLR2")
```

By loading this library into our session, we can now access any functions and data sets within this package. The manual and details can be found on the CRAN website: https://cran.rstudio.com/web/packages/ISLR2/index.html

Writing Functions - basics

Let's learn the structure of writing our own functions in R. To learn the syntax, we'll simply make a function that adds 10 to any inputted value.

```
shift10 <- function(x){
  newx <- x + 10
  return(newx)
}
```

Note that the final line in the function will be the outputted value. Let's test it:

```
shift10(40)
```

```
[1] 50
```

Example

In many of the 'artistic' olympic sports, the judging panel is comprised of several countries, and any participant's score is averaged (or totaled) after removing both the minimum and maximum values. Let's write a function in R which performs this type of averaging for any inputted vector of numeric values. Call it `olymean`.

```
# x = vector of scores
olymean <- function(x){
  trimmed_x <- sort(x)[-c(1, length(x))] # removes the smallest and largest number from x
  mean(trimmed_x)
}
```

Let's test out this function on the fictious data scores in the *cheer.csv* file which contains the scores for two Cheerleeding teams (Navarro and Trinity Valley) across five judges. First let's read in the data set and view it:

```
scores <- read.csv("cheer.csv")
scores
```

```
  Judge Navarro Trinity.Valley
1     1     9.8            9.9
2     2     9.6            9.9
3     3     9.7            9.8
4     4     9.7            9.7
```

```
5     5     9.9           9.5
```

N.B. spaces are automatically replaced by `.` in column names since R does not allow spaces in variable names.

```
mean(scores$Navarro) # overall average
```

```
[1] 9.74
```

```
olymean(scores$Navarro) # average of the middle three scores
```

```
[1] 9.733333
```

```
mean(scores$Navarro)
```

```
[1] 9.74
```

```
olymean(scores$Trinity.Valley)
```

```
[1] 9.8
```

What happens if your input data includes missing values? While these are not scores, let's try and apply this function to the `Ozone` values in the `airquality` data set which indeed contain `NA`s (i.e. missing values)

```
airquality$Ozone
```

```
  [1]  41  36  12  18  NA  28  23  19   8  NA   7  16  11  14  18  14  34   6
 [19]  30  11   1  11   4  32  NA  NA  NA  23  45 115  37  NA  NA  NA  NA  NA
 [37]  NA  29  NA  71  39  NA  NA  23  NA  NA  21  37  20  12  13  NA  NA  NA
 [55]  NA  NA  NA  NA  NA  NA  NA 135  49  32  NA  64  40  77  97  97  85  NA
 [73]  10  27  NA   7  48  35  61  79  63  16  NA  NA  80 108  20  52  82  50
 [91]  64  59  39   9  16  78  35  66 122  89 110  NA  NA  44  28  65  NA  22
[109]  59  23  31  44  21   9  NA  45 168  73  NA  76 118  84  85  96  78  73
[127]  91  47  32  20  23  21  24  44  21  28   9  13  46  18  13  24  16  13
[145]  23  36   7  14  30  NA  14  18  20
```

By default, we will get an error when we try to calculate the average of these values:

```
mean(airquality$Ozone)
```

```
[1] NA
```

If we look at the documentation for the `mean` function (`?mean`) you will see that there is an argument `na.rm` that tells R whether `NA` vluaes should be removed before the computation proceeds. By default this argument set to `FALSE`. If, we change this to `TRUE`, R will calculate the average with the `NA`s removed:

```
mean(airquality$Ozone, na.rm = TRUE)
```

```
[1] 42.12931
```

Interestingly, our `olymean` function works fine:

```
olymean(airquality$Ozone)
```

```
[1] 42.48696
```

This is because the `sort` function removed `NA`s by default (see `?sort`):

```
sort(airquality$Ozone)
```

```
  [1]   1   4   6   7   7   7   8   9   9   9  10  11  11  11  12  12  13  13
 [19]  13  13  14  14  14  14  16  16  16  16  18  18  18  18  19  20  20  20
 [37]  20  21  21  21  21  22  23  23  23  23  23  23  24  24  27  28  28  28
 [55]  29  30  30  31  32  32  32  34  35  35  36  36  37  37  39  39  40  41
 [73]  44  44  44  45  45  46  47  48  49  50  52  59  59  61  63  64  64  65
 [91]  66  71  73  73  76  77  78  78  79  80  82  84  85  85  89  91  96  97
[109]  97 108 110 115 118 122 135 168
```

Since we are calling `sort` before calling the `mean` function this will run without error, however, it is important to note that this function is removing the smallest number, the largest number, *AND* any missing values before computing the mean.

R Markdown

R Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents; see http://rmarkdown.rstudio.com. This lab[1] is an example of an R Markdown document created using the RMarkdown R package. You can install the necessary packages using:

```
install.packages("rmarkdown")
install.packages("knitr")
```

This section of the lab will help you from going from an `.Rmd` as shown on the left-hand side of figure below to a html or pdf document (which is the document you are currently viewing!).

R markdown files support basic markdown (a "lightweight" markup language) syntax with the additional benefit of allowing you to include R code and output (generated from the embedded R code) directly within the same document. Please read through this markdown cheatsheet to get familiar with the simple syntax. For example, we use `_italics_` for *italics*, `**bold**` for **bold**, `#` to denote level 1 headers, `##` for level 2 headers, etc… We can create simple lists

- A
- B
- C

Numbered lists

1. one
2. two
3. three

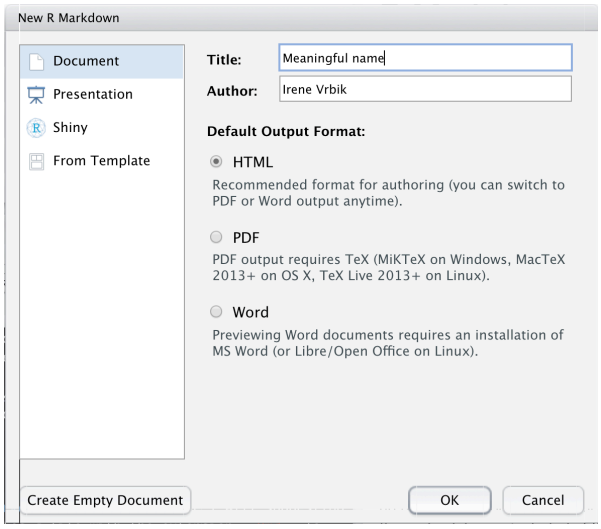
and Tables:

Tables	Are	Cool
left-aligned	centered	right-aligned
more	data	here

Create an `.Rmd` file

To create an R markdown file, click *New File* > *R Markdown*. In the pop-up window you can specify a name, author, and output format.

[1]3. While you may not understand all of the syntax used in this document, you can open the Lab0.Rmd file to see all the underlying syntax that went into building this lab



For this course I will suggesting that you create HTML documents. Press the **Create Empty Document** button if you would do not want your file to have any auto-populated text (although when you are first starting out you may find the example text helpful).

Warning In order to knit to pdf documents you must have installed a LaTex distribution in your system. Similarly, in order to knit to a Word Document, you will need Microsoft Word (or a similar program) installed. You can read about install LaTex in Ch 1 of the *R Markdown: The Definitive Guide* book. Knitting to PDF/Word will not be necessary for this course so please feel free to stick to knitting to HTML for simplicity.

YAML

One you have pressed "OK" it will open an Untitled R markdown file. At the very top of the document you will see the YAML (which stands for **Y**et **A**nother **M**arkup **L**anguage). It contains the meta-data used to configure of your document. In it's simplest form you should have the following information in your YAML

```
---
title: "something meaninful"
author: "FULL name and student number"
date: "date created or last edited are reasonable"
output: html_document
---
```

To complete your assignments you can edit this file, or download and use the assignment template that I have uploaded to Canvas (`template.Rmd`). Please use a more meaningful

name than `Untitled.Rmd` or `template.Rmd`. Notably, I will usually be asking you to submit the rendered html document to Canvas for grading. That is, the source .Rmd file will not be required for submission unless otherwise requested.

TIP Knit as you you go! If you leave the knitting to the very end, you will often get cryptic error messages and it will be impossible to pin point where you went wrong. I tend to knit every time a paragraph or new chunk is created. That way, if an error happens, I know exactly where in my .Rmd file I should concentrate on debugging.

Knitting an `.Rmd` file

The creator of `knitr` Yihui Xie designed the package to be an "engine for dynamic report generation with R". In order to convert your `.Rmd` file into a more readable html or pdf document, we will need to *render* AKA *compile* AKA *knit* it in RStudio. The easiest way to do this is to click the **Knit** button (located in the Editor window–look for the yarn and needle icon) or to use the keyboard shortcut `Ctrl` + `Shift` + `K` (`Cmd` + `Shift` + `K` on macOS). When you "knit", either a html or pdf document will be generated that converts any markdown syntax into formated text, and executes and embeds any R code seamlessly within the document. Whether or not it gets converted to an html or pdf document will depend on the specification you made in your YAML (again, I recommend knitting to HTML).

The rendered document will appear in a pop-up window. If your prefer (as I do) to view this document in the Viewer pane, click the gear icon (located beside the Knit button) and select **Preview in Viewer Pane**.

Including R code

You can embedded R code within an Rmd document in two ways:

1. in a code "chunk", ie code separated into its own "paragraph" or "block"
2. inline code to appear, well in line, with text.

Inline R code

Then general syntax for inline R code is: `` `r expression` ``, where `r` tells RStudio that `expression` should be treated and executed as R code. For example, For example: `` `r 2 + 4` `` gets rendered to: 6. Notice how this inline code does not appear on its own line and embeds seamlessly within our text.

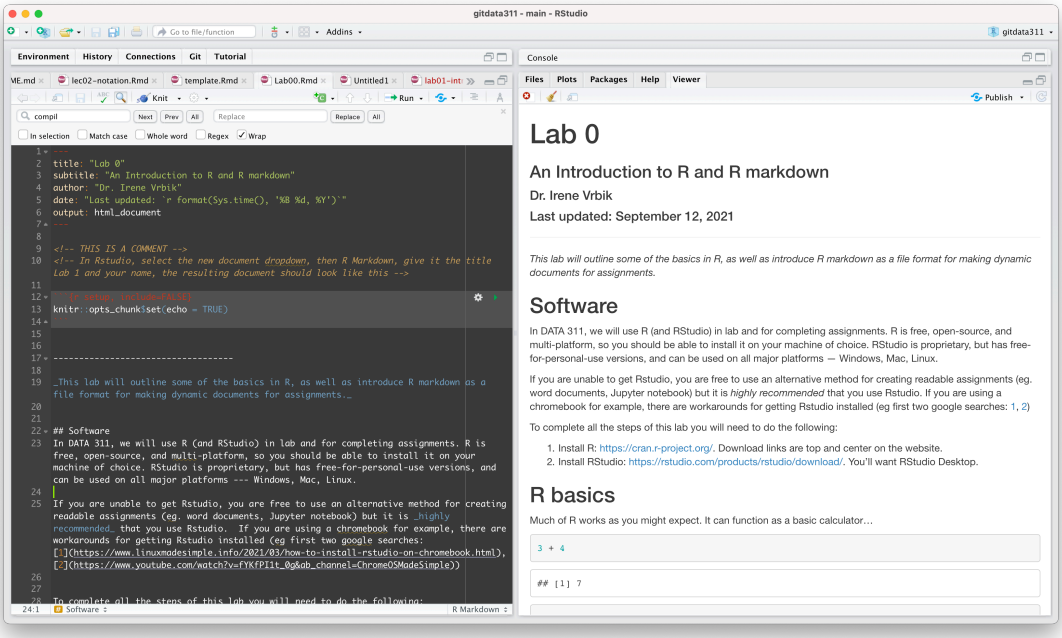


Figure 1: The left window shows a Rmd file that was knitted to the html file you are currently viewing.

R chunks

You can embed an R code in a "chunk". For example:

````
```{r}
# this is a comment
summary(cars)
```
````

gets rendered to

```
# this is a comment
summary(cars)
```

```
     speed           dist       
 Min.   : 4.0   Min.   :  2.00  
 1st Qu.:12.0   1st Qu.: 26.00  
 Median :15.0   Median : 36.00  
 Mean   :15.4   Mean   : 42.98  
 3rd Qu.:19.0   3rd Qu.: 56.00  
 Max.   :25.0   Max.   :120.00  
```

Unlike inline R code, chunks appear in a block that is distinct from the written text. Notice how the R input is highlighted in a dark grey box, while the output is boxed with a white background. There is a number of code chunk options you can specify inside the `{}` (and after the `r`). For instance, to suppress the R input, you can specify `echo = FALSE` in the code chunk options. If you wish to suppress the R output, you can include `results="hide"`.

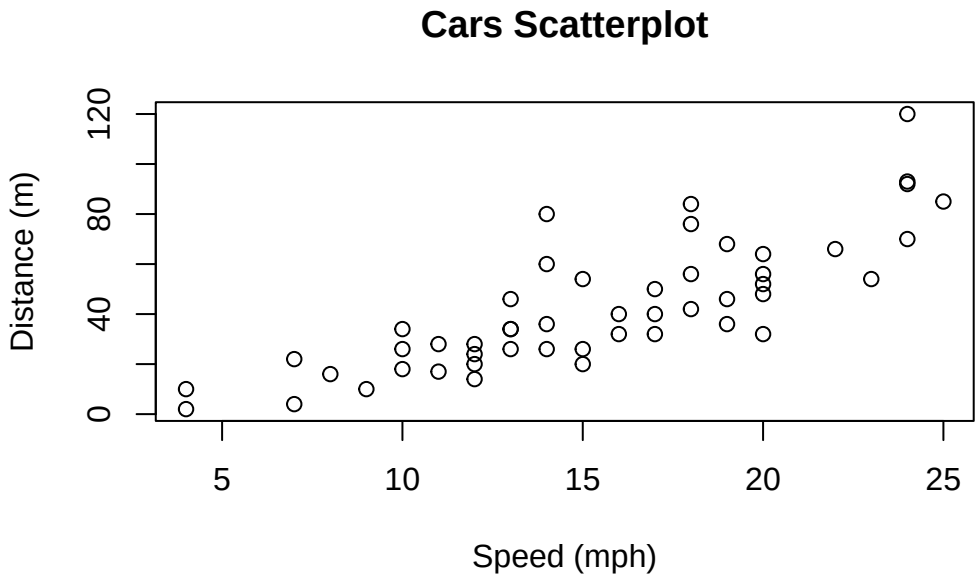
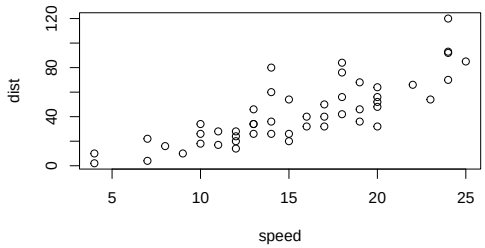
Example 1: suppress R input

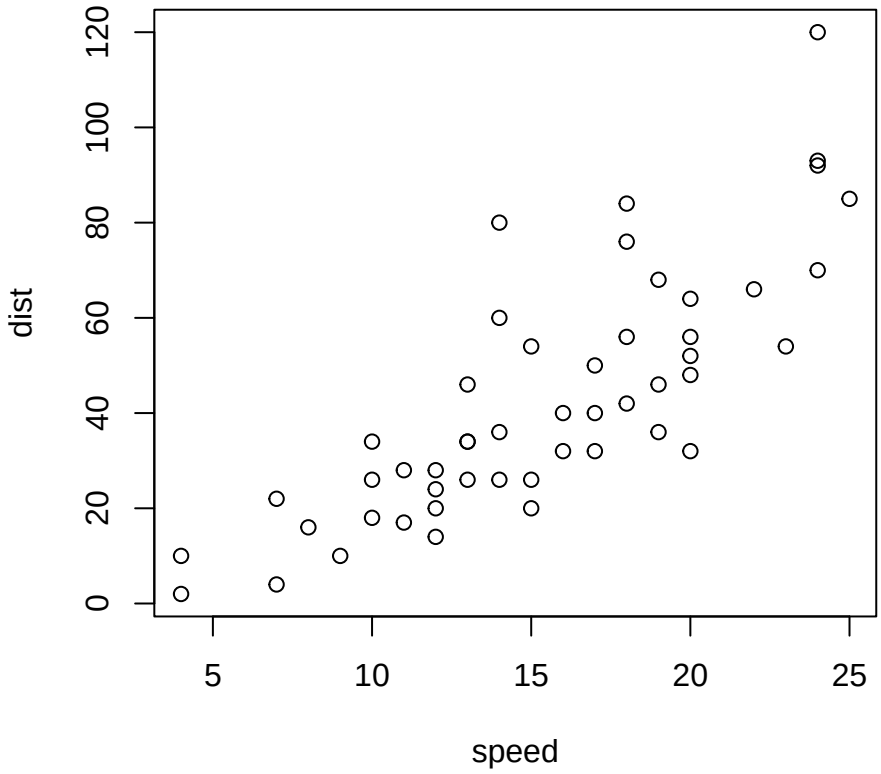
````
```{r echo=FALSE}
x = 4
y = 3
x +y
```
````

gets rendered to

```
[1] 7
```

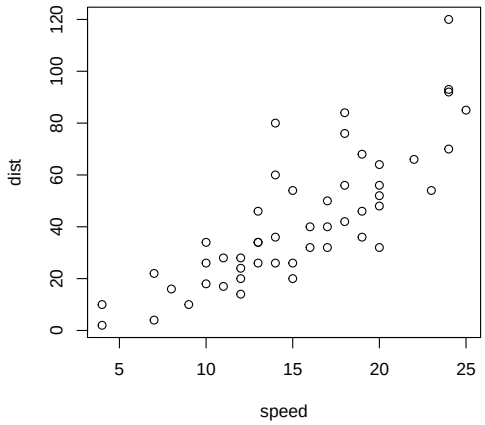
Example 2: suppress R output

```
```{r results="hide"}
x = 4
y = 3
x +y
```
```

gets rendered to

```
x = 4
y = 3
x +y
```

Example 3 embedding plots:

```
attach(cars) # creates the variables speed and dist from the columns of cars
plot(speed, dist, xlab= "Speed (mph)", ylab = "Distance (m)",
main = "Cars Scatterplot")
```



If you so desire, you can alter some of the default settings for these R generate plots, eg. resize, alignment, captions. (see code chunk options). For example, we could scale the image to take up 40% of the page width using:

```
```{r echo=FALSE, out.width='40%'}
plot(speed, dist)
```
```

```
```



We can also resize the image with `fig.height` and `fig.width` (the defaults for both is 7 inches):

```
```{r echo=FALSE, fig.height=5, fig.width=5}
plot(speed, dist)
```
```



Below I've done a combination of both scaling and resizing and centered the image:

```{r echo=FALSE, out.width='40%', fig.height=5, fig.width=5, fig.align="center"}
plot(speed, dist)
```



Working directories for Rmd files

If you are working within an R Markdown document your working directory is the folder that contains the Rmd file. For instance, a recommended folder system might look something like this:

```
data311/
|-- labs/
|   |-- Lab00.Rmd
|   |-- practice00.Rmd
|   |-- datamatrix.csv
|   |-- data/
|   |   |-- salaries.csv
|-- assignments/
|   |-- template.Rmd
|   |-- example.csv
|-- data/
|    |-- energydata.csv
```

In the `practice00.Rmd` file, I could import `datamatrix.csv` without a path since it is in our working directory. More generally, when you refer to external files you will need to specify the path relative to the working directory of the Rmd file.

```r
# code from practice00.Rmd:
dat <- read.csv("datamatrix.csv")
sal <- read.csv("data/salaries.csv")
energy <- read.csv("../data/energydata.csv")
```

Notably, you **cannot** change the working directory within a R markdown file using `setwd()`. You can read more on the subject in Ch 16.6 or the *R markdown Cookbook* book.

Exercises

1. Create an Rmarkdown document (directions) and save it to a meaningful location on your computer. Call this document `lab00_x.Rmd` where `x` is replaced by your student number.
2. Edit the YAML of this document to have the following information:
   - title: My first R markdown
   - author: Your FULL name and student number
   - date: The date in which you are creating this document
   - output: html_document
3. Delete any auto-populated text within the document (apart from the YAML) an create the following:
   - A level 1 header saying "My information"
   - Within the section create an R chunk assigning the objects (be sure to set the `echo=FALSE` as an R chunk option to hide the R input from view):
     - `st_name` your full name
     - `st_num` your student number Test your use of inline R code by referencing the variables you just created in the following sentence:

     Hello! My name is <*insert name here*>. My student number is <*insert student number here*>.
4. Display the current version of R your are running using the command `version$version.string`. If you are not running the current version (see https://www.r-project.org/). Please update your R and recompile this Rmd file.
5. Read in some data.

- Download the `datamatrix.csv` file from Canvas and save it to the same folder as your `lab00_x.Rmd` file.
- Create level 2 header named "Subsection" complete the following:
- Create an R chunk that loads the data into R and save it to the variable name `mat`
- print the contents of `mat`

6. Do some calculations. Be sure to set `echo = TRUE` so that your calculations are printed to screen and *clearly number/label/indicate* (either using comments in the R chunks or plain text) what you are calculating.

   a. Create a level 2 header named "Calculations"
   b. calculate the maximum value in the `sleep` column
   c. determine the number of `female` entries in the `gender` column
   d. find the average number of countries visited by females

7. Create a scatterplot. Using the `mat` data frame create a scatterplot with the folling attributes:

   - `sleep` on the x-axis and `dread` on the y-axis
   - the title *Simple Scatterplot*,
   - the x-axis labeled *Sleep (in hours)* and y-axis labeled *Dread Scale*
   - Resize the image so that it is taller than it is wide and shrink it such that it takes up 60% of the page width.

Additional resources for R markdown

- A quick tour: https://rmarkdown.rstudio.com/authoring_quick_tour.html
- Markdown site: http://daringfireball.net/projects/markdown/
- RMarkdown book: https://bookdown.org/yihui/rmarkdown/
- RMarkdown's creator: Yihui Xie's website
- RMarkdown cheat sheet: https://www.rstudio.com/wp-content/uploads/2015/02/rmarkdown-cheatsheet.pdf