Week 1 Exercise: Basic R

Z620: Quantitative Biodiversity, Indiana University

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In this exercise, we provide an introduction to some of the basic features of the R computing environment. We emphasize calcuations, data types, and simple commands that will be useful for you during the course and beyond.

This is an R Markdown document. Markdown is a simple formatting syntax for authoring HTML, PDF, and MS Word documents. For more details on using R Markdown see http://rmarkdown.rstudio.com.When you click the **Knit** button a document will be generated that includes both content as well as the output of any embedded R code chunks within the document.

RETRIEVING AND SETTING YOUR WORKING DIRECTORY

```
getwd()
```

```
## [1] "/Users/lennonj/GitHub/Quantitative_Biodiversity/Assignments/Week1"
```

```
#The following line needs to be updated
#setwd("~/GitHub/Quantitative_Biodiversity/Assignments/Week1")
```

USING R AS A CALCULATOR

addition

```
1 + 3
```

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

subtraction

```
3 - 1
```

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

multiplication (with exponent)

```
3 * 10^2
```

```
## [1] 300
```

division (using a built-in constant)

```r
10 / pi
```

```
## [1] 3.183
```

trigonometry with a simple built-in **function** (i.e., *sin*) and **argument** (i.e., '4')

```r
sin(4)
```

```
## [1] -0.7568
```

logarithms (another example of function and argument)

```r
log10(100)
```

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

```r
log(100)
```

```
## [1] 4.605
```

DEFINING VARIABLES

In R, you will often find it useful and necessary to assign values to a variable. Generally speaking, it's best to use `<-` rather than `=` as an assignment operator.

```r
a <- 10
b <- a + 20
```

What is the value of b?

```r
a <- 200
```

Now what is the value of b? Can you explain? Fix? It can help to examine variables with the following function

```r
ls()
```

```
## [1] "a" "b"
```

You can clear variables from R memory with following function (example of nested function)

```r
rm(list=ls())
```

You can also examine variables in the Environment windwow of R Studio. By clikcing 'clear' in this window, you can erase variables from memory

–> **Time for discussing R as a caculator and assigning of variables**

WORKING WITH SCALARS, VECTORS, AND MATRICES

There is a hierarchy of mathematical elements. First, a **scalar** is single numeric value. Let's assign a numeric value to a character:

```
w <- 5
```

A **vector** (or array) is a one-dimensional row of numeric values. You can create a vector in R: like this:

```
x <- c(2, 3, 6, w, w + 7, 12, 14)
```

What is the function `c()`? The `help()` function is your friend. Let's try it out:

```
help(c)
```

What happens when you multiply a vector by a scalar?

```
y <- w * x
```

What happens when you multiply two vectors?

```
z <- x * y
```

Here is how you reference an element in a vector

```
z[2]
```

```
## [1] 45
```

Here is how you reference multiple elements in a vector

```
z[2:5]
```

```
## [1]  45 180 125 720
```

Here is how you can change the value of an element in a vector

```
z[2] <- 583
```

It's pretty easy to perform summary statistics on a vector using built-in fuctions

```
max(z)     # maximum
```

```
## [1] 980
```

```r
min(z)    # minimum
```

```
## [1] 20
```

```r
sum(z)    # sum
```

```
## [1] 3328
```

```r
mean(z)   # mean
```

```
## [1] 475.4
```

```r
median(z) # median
```

```
## [1] 583
```

```r
var(z)    # variance
```

```
## [1] 133881
```

```r
sd(z)     # standard deviation
```

```
## [1] 365.9
```

What happens when you take the standard error of the mean (`sem`) of z? The standard error of the mean is defined as $SEM = \frac{sd(x)}{\sqrt{n}}$ Sometimes you need to make your own functions. Let's give it a try:

```r
sem <- function(x){
  sd(x)/sqrt(length(x))
  }
```

Often, datasets have missing values (designated as 'NA' in R)

```r
i <- c(2, 3, 9, NA, 120, 33, 7, 44.5)
```

What happens when you apply your *sem* function to vector i? One solution is to tell R to remove NA from the dataset:

```r
sum(i, na.rm = TRUE)
```

```
## [1] 218.5
```

There are three common ways to create a matrix (two dimensional vectors) in R. **Approach 1** is to combine (or concatenate) two or more vectors. Let's start by creating a vector using a new function *rnorm*

```r
j <- c(rnorm(length(z), mean = z))
```

What does the *rnorm* function do? What are arguments doing? Now we will use the function *cbind* to create a matrix

```r
k <- cbind(z, j)
```

Use the *help* function to learn about *cbind* Use the *dim* function to describe the matrix you just created

Approach 2 to making a matrix is to use the matrix function:

```r
l <- matrix(c(2, 4, 3, 1, 5, 7), nrow = 3, ncol = 2)
```

Approach 3 to making a matrix is to import or 'load' a dataset from your working directory (or elsewhere)

```r
m <- as.matrix(read.table("matrix.txt", sep = "\t", header = FALSE))
```

Often, when handling datasets, we want to be able to transpose a matrix. This is easy in R:

```r
n <- t(m)
```

Also, you will find that you need to subset data in a matrix:

For example, maybe you want to take first three rows of a matrix:

```r
n <- m[1:3, ]
```

Or maybe you want the first two columns of a matrix:

```r
n <- m[, 1:2]
```

Or perhaps you want non-sequential columns of a matrix. How do we do that? It's easy when you understand how to reference data within a matrix:

```r
n <- m[, c(1:2, 5)]
```

Basic Plotting

Included in R and various R packages are some basic datasets that are useful for testing functions and learning about R features and functions. One such dataset is **cars**. To learn about this dataset you can simple use the `{r} help` function

```r
help(cars)
```

Use the `{r} str()` and '{r} summary()' functiosn to see basic summary statistics about this dataset

```r
str(cars)
```

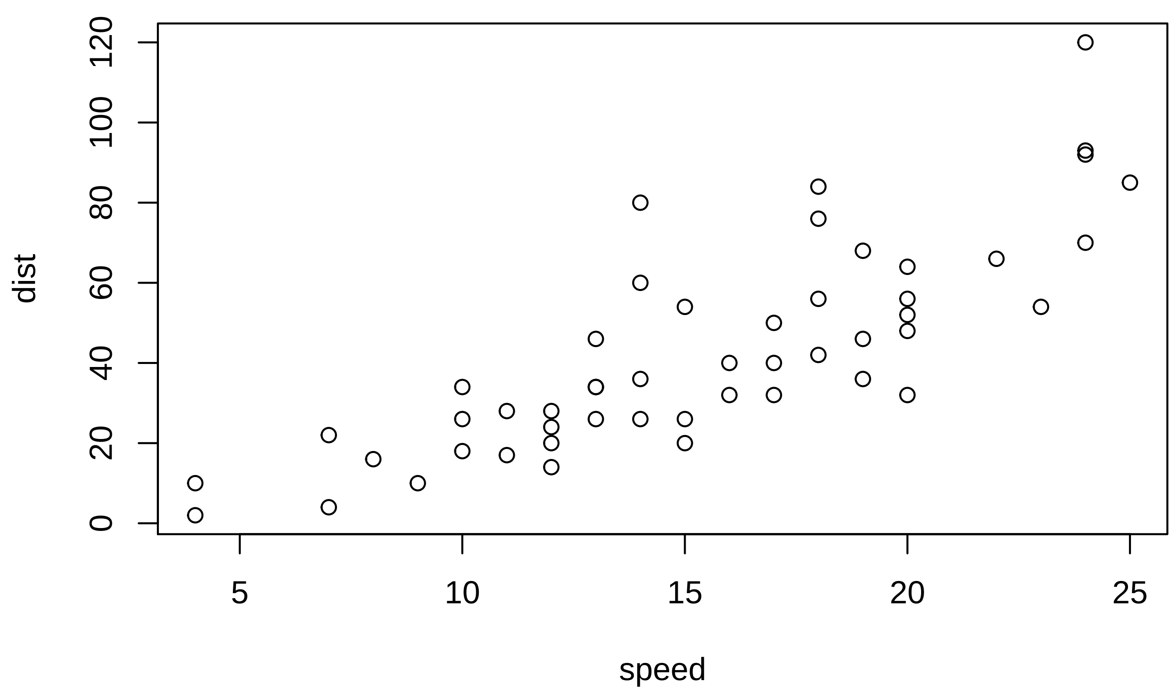
```
## 'data.frame':    50 obs. of  2 variables:
##  $ speed: num  4 4 7 7 8 9 10 10 10 11 ...
##  $ dist : num  2 10 4 22 16 10 18 26 34 17 ...
```

```r
summary(cars)
```

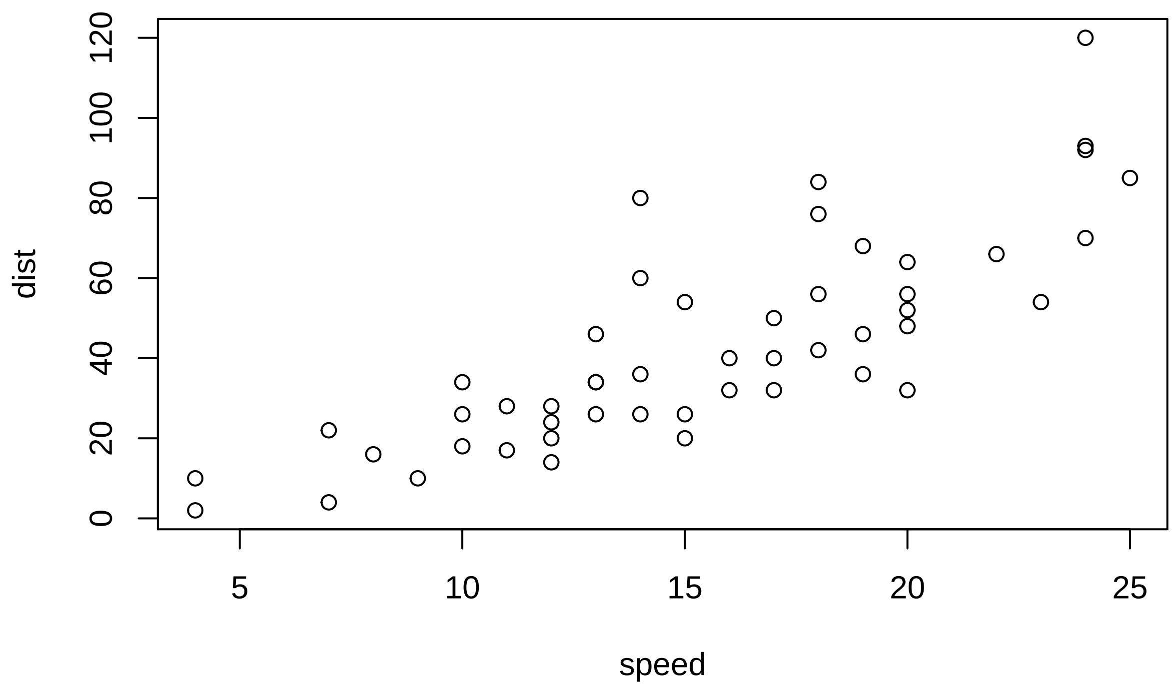
```
##      speed           dist       
##  Min.   : 4.0   Min.   :  2  
##  1st Qu.:12.0   1st Qu.: 26  
##  Median :15.0   Median : 36  
##  Mean   :15.4   Mean   : 43  
##  3rd Qu.:19.0   3rd Qu.: 56  
##  Max.   :25.0   Max.   :120
```

To visualize this data you can generate a simple plot with the `{r} plot()` function

```r
plot(cars)
```



You can also embed plots, for example: # JTL, line by line, got an error; plus not sure how useful? what's point?



Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.'

Other Useful Features and Fucntions: Sorting, Subsetting, Sampling

JTL: seems like some of this could be combined with stuff above

Sorting We can use another dataset (mtcars) to practice sorting (ordering) data. Learn about mtcars via `{r} help(mtcars)`

sort by mpg

```
newdata <- mtcars[order(mtcars$mpg),]
```

sort by mpg and cyl # JTL: not sure how effect the cyl sort is

```
newdata <- mtcars[order(mtcars$mpg, mtcars$cyl),]
```

sort by mpg (ascending) and cyl (descending) #JTL: same as above?

```
newdata <- mtcars[order(mtcars$mpg, - mtcars$cyl),]
```

Now, Let's make a new vector of data

```r
z <- c(1.5, 1/6, 1/3)
```

If we only want to view the first two decimal places of z

```r
round(z,2)
```

```
## [1] 1.50 0.17 0.33
```

Now, we can reverse the order of the elements in z

```r
rev(z)
```

```
## [1] 0.3333 0.1667 1.5000
```

And we can order z from smallest to largest

```r
sort(z)
```

```
## [1] 0.1667 0.3333 1.5000
```

We can also identify the ordering of z #JTL: with respect to what?

```r
order(z)
```

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

i.e., the 2nd number is the min and the 1st number is the max

Additionally, we can idenify the maximum values this way:

```r
max(z)
```

```
## [1] 1.5
```

Subsetting Let's create a original object vector, x:

```r
x <- c(3, 4, 7)
x
```

```
## [1] 3 4 7
```

Now, let's subset this vector and keep only the first three values

```r
x[-3]
```

```
## [1] 3 4
```

Now, let's subset this vector and keep only the velues greater than or equal to 5

```r
x[x >= 5]
```

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

Notice that we did this using a logic statement `{r} >=`. Here is a list of other logica operators that you might find useful:

|Logic Operator|Meaning| # confusing to start using new symbols "|"? |! x | Is Not "x"| |x & y| "x" and "y" (element by element) | |x && y| "x" and "y" (across all elements)| |x | y | "x" or "y" (element by element)| |x || y | "x" or "y" (across all elments)|

You can learn more about this commands ('{r} help(Logic, package=base))

Sampling

First, let's create a sequence of numbers

```r
seq(1,3,length=5)
```

```
## [1] 1.0 1.5 2.0 2.5 3.0
```

```r
# Create the same sequence in a slightly different way:
seq(1,3,by=0.5)
```

```
## [1] 1.0 1.5 2.0 2.5 3.0
```

```r
# Create another sequence by going from 3 to 1:
seq(3,1,by= -0.5)
```

```
## [1] 3.0 2.5 2.0 1.5 1.0
```

To randomly sample from an existing vector:

```r
sample(x,10,replace=T)
```

```
##  [1] 4 7 7 4 7 3 4 3 3 7
```

Or to randomly sample from a sequence of numbers from 1 to 500:

```r
sample(1:500,10,replace=F)
```

```
##  [1] 394 172 203 147 199 308   1 144 208 406
```