Tutorial Week2
STAT2008

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Install R Studio

- You should download both R and R studio and install R before installing your R studio
  - For R (Console):
    - https://cran.r-project.org/
  - For R studio:
    - https://www.rstudio.com/products/rstudio/download/
- For more information about installing:
  - Log on to Wattle - STAT2008 – Statistical Computing – Introduction to R

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Open R Studio

- Opening Computer
  - **Log on** to your computer with your Uni ID and your Password
- Download data from Wattle
  - Log on to Wattle (https://wattlecourses.anu.edu.au)
  - STAT2008 – Statistical Computing – Tutorial0- Download "**worksheet2_women**" (**DO NOT OPEN**)
    - For Mac Users, you may find it's hard to download data by using "Safari", you can use browsers such as "Firefox" and "Google Chrome" to download your data.
- Open R Studio [The following is for Windows 8 ONLY]
  - Click  (bottom-left)
  - Top-Right => Search => "RStudio"
  - Or, bottom-left => arrow down  => RStudio

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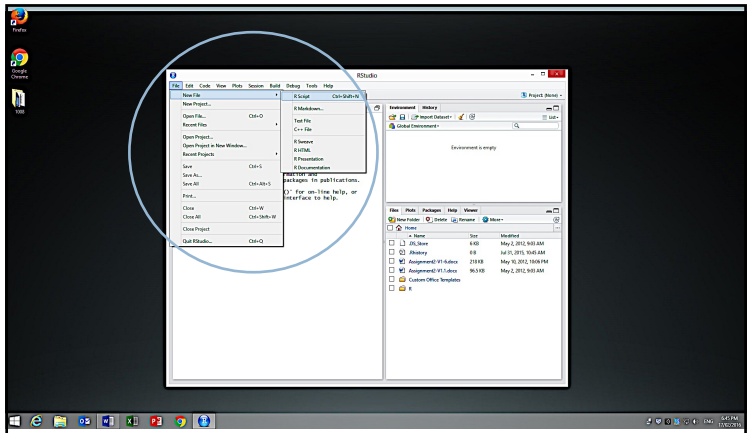

- **Create R Script**
  - **RStudio – File – New File – R Script**

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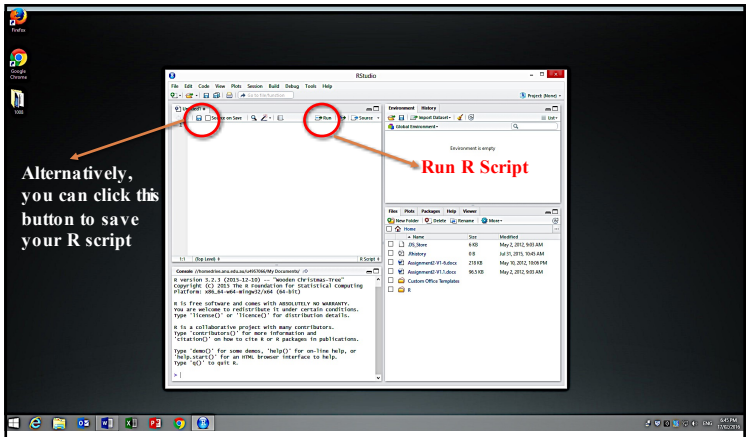

- Save your R Script: File – Save
- To Run your R Script: Select the code
  - Click the Run button
  - Or Press "Ctrl + Enter" / For Mac: Command + Enter

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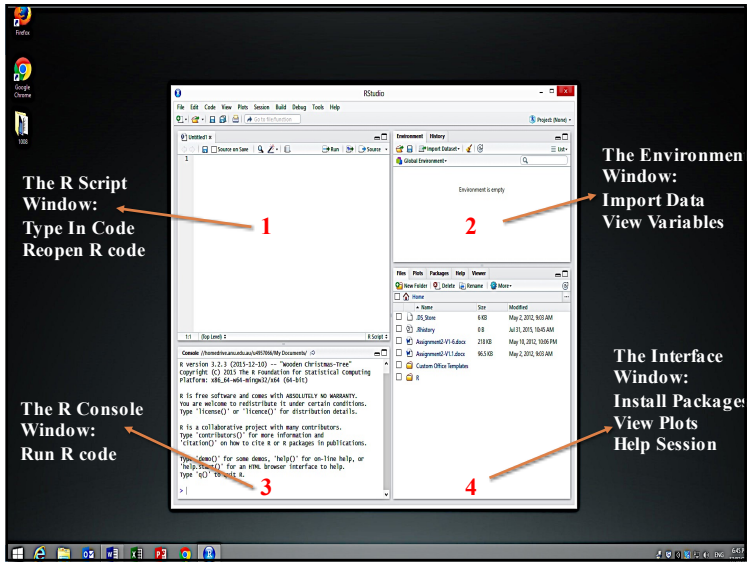

R INTRODUCTION

Some notes

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Some Properties for R

- R Code:
  - Case Sensitive
  - Separate by new line (Enter/Return) Or ***Semicolon (;)***
- R Code (Command) are either
  - **Expressions:**
    - a sequence of symbols interpreted by R
    - Eg:
      - > **2+2**
      - > **c+c**
  - **Assignments** (of a value to a name)
    - Evaluate an expression
    - pass the value to a variable but the result is not automatically printed
    - Eg:
      - > matrics
      - > value
      - > **Happy <- 3+2**

      [Happy = a name; 3+2= value; <- means to assign 3 to this name]
- Object: the entities that R creates and manipulates
  - Eg: variables, vectors, matrics, data sets, results, lists
  - If display the objects currently stored in R:
    - > **objects ()**

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Some Properties for R

- **<-**
  - Assign
- **c(…)**
  - Combine arguments into a vector
- **seq(x)**
  - Generate a sequence from 1 to x
- **seq(from,to,by)**
  - Generate sequence with increment by
- **from:to**
  - Generate sequence from…to…
- **rep(x,times)**
  - Replicate x

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Data Structure of R

- Vector
  - 1 single entity consisting of an ordered collection of numbers
- Matrics / Arrays
  - Multi-dimensional vectors
- Lists
  - Vector in which various elements need not to be of the same type
- Data frames
  - Matrix-like structure
  - Columns can be of different type

(Source: ANU STAT2008 Lecture Notes 2013 Semester 1)

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EXERCISE 2

Part (f) – How to open a CSV file

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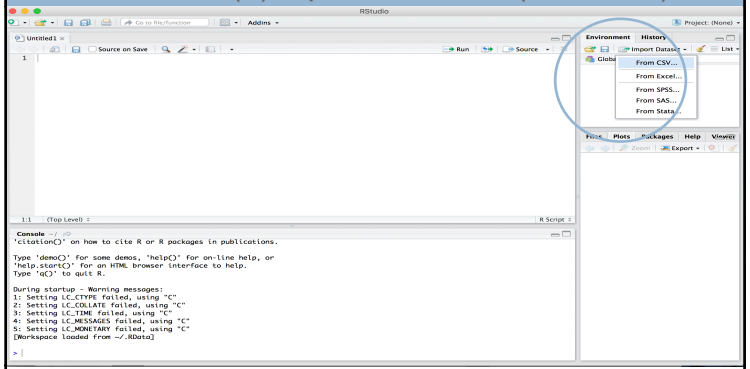
Exercise 2 Part (e): Open a CSV file (Method 1)



- Open the CSV file
  - RStudio – Environment – Import Dataset – From CSV– Choose "**worksheet2_women**"
    (If R asks you whether you want to install this package now, choose yes)

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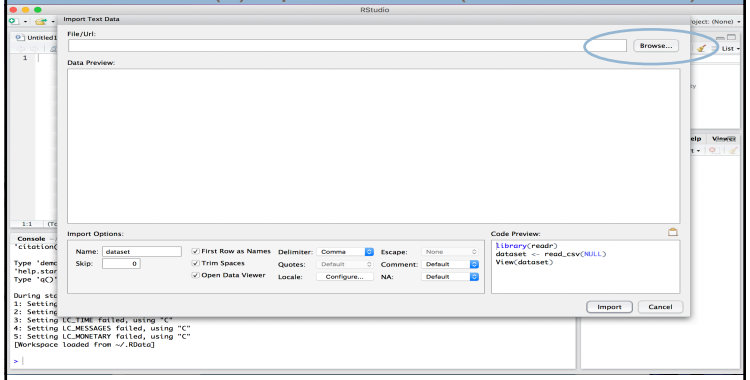
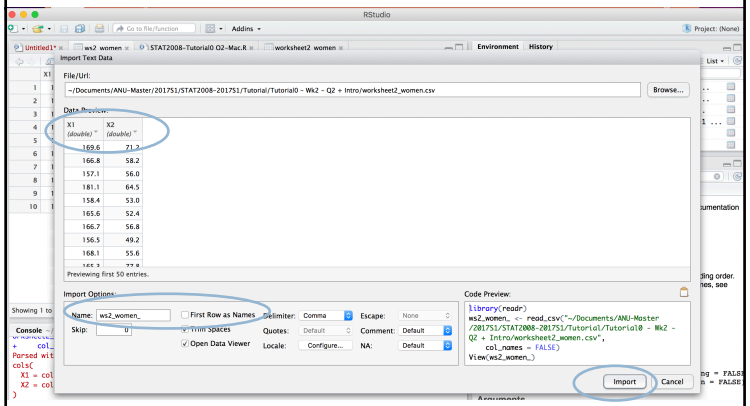
Exercise 2 Part (e): Open a CSV file (Method 1 continue)



- Open the CSV file
  - Click "Browse" – Select the data "**worksheet2_women.csv**" you downloaded from Watt previously – Open – **Unclick** "First Row as Names", **Rename it as** "ws2.women - Import

Exercise 2 Part (e): Open a CSV file (Method 1 continue)

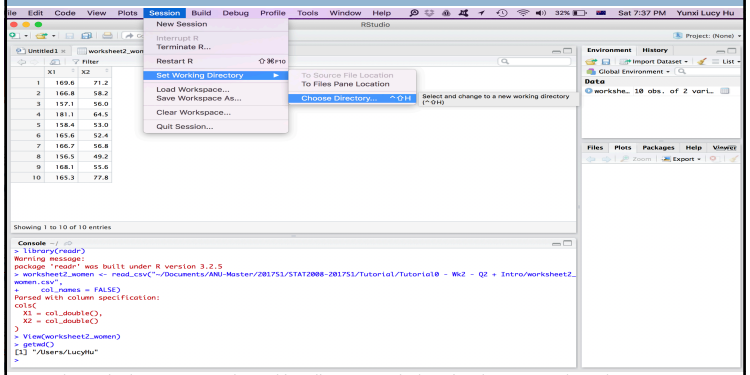


Unclick "First Row as Names". **Rename it as** "ws2.women" - Import

Exercise 2 Part (e): Open a CSV file (Method 1 continue)

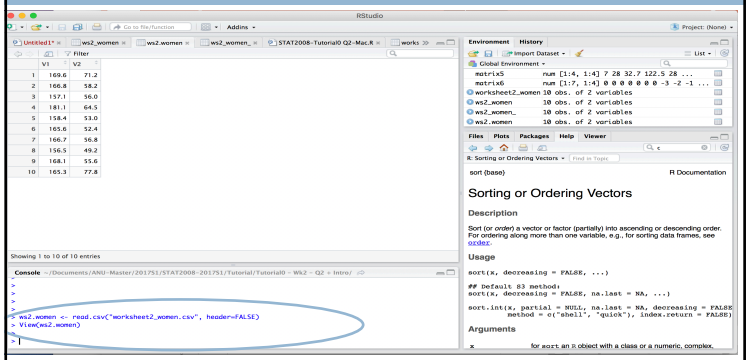
- Now you will see your worksheet (csv file) in your R studio!
- The whole process for Method 1 is equivalent to the process of typing the following code in Console (Run automatically)/ in R Script (but you need to click the Run button)
  - **ws2.women <- read.csv("*the location for your data*/worksheet2_women.csv", header=FALSE)**
    - NB: for me, it is:
      - **ws2.women <- read.csv("~/Documents/ANU-Master/2017S1/STAT2008-2017S1/Tutorial/Tutorial0/worksheet2_women.csv", header=FALSE)**
      - Since the first row in our worksheet is NOT the variable, we choose FALSE for the header
      - Use all "/" instead of "\" for your directory
      - The directory should be used by applying " " NOT " "
  - **View(ws2.women)**
- [NB: here we can rename the worksheet to ws2.women]

Exercise 2 Part (e): Open a CSV file (Method 2 – setwd – open file directly)



- Alternatively, we can set the working directory to the location that we stored our data "**worksheet2_women.csv**" previously by typing: **setwd("*the location for your data*")** in the console
  - For me, it's **setwd("~/Documents/ANU-Master/2017S1/STAT2008-2017S1/Tutorial/Tutorial0 - Wk2 -Q2 +Intro/R")**
- Or, choose Session – Set working directory – Choose Directory [The location that you stored the worksheet **"worksheet2_women.csv"**]

Exercise 2 Part (e): Open CSV file (Method 2 – setwd – open file directly)



- After setting the working directly, we can now type the following commend in Console (Run automatically)/ in R Script (but need to click the Run button) to open our worksheet **"worksheet2_women.csv"** [NB: here we can rename the worksheet]
  - **ws2.women <- read.csv("worksheet2_women.csv", header=FALSE)**
  - **View(ws2.women)**
- NB: by using "setwd" command, there is no need for you to type the whole directory of your csv file as you have already set up the working directory!

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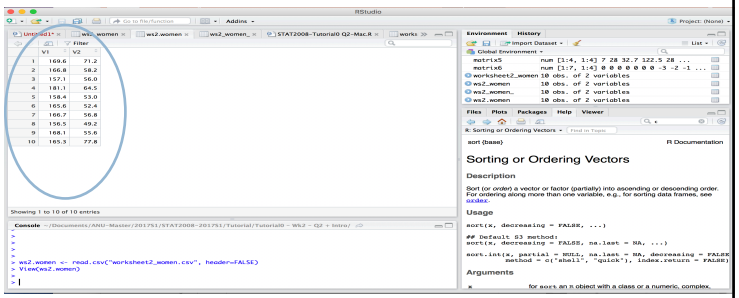
Exercise 2 Part (e): Open CSV file (Method 2 – setwd – open file directly)

- **getwd()**
  - To know the current working directory
- **setwd("")**
  - To reset the working directory
- **View(ws2.women)**
  - To view our worksheet in R Studio



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EXERCISE 2

Part (a)

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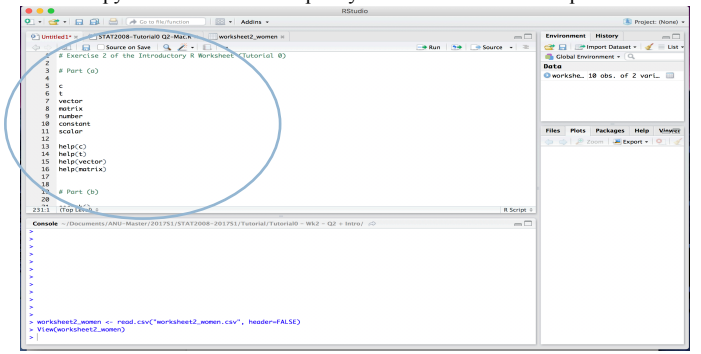
Copy and Paste R Script

- Cope R Script from Wattle
  - Log on to Wattle (https://wattlecourses.anu.edu.au)
  - STAT2008 – Statistical Computing – Tutorial0- Open "Tutorial0ex2.R" File
  - Copy and Paste this R Script to your local R Studio R Script Window



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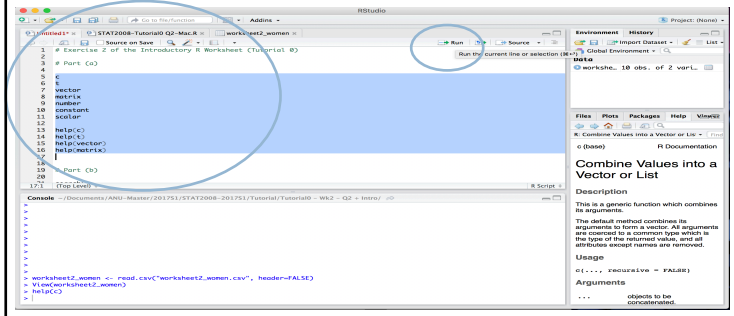
Exercise 2 – Part (f): Run your R Script



- Select R code for **Part (a)**
- Click the "Run" button
- Or,
  - For Windows: Ctrl + Enter
  - For Mac: Command + Enter

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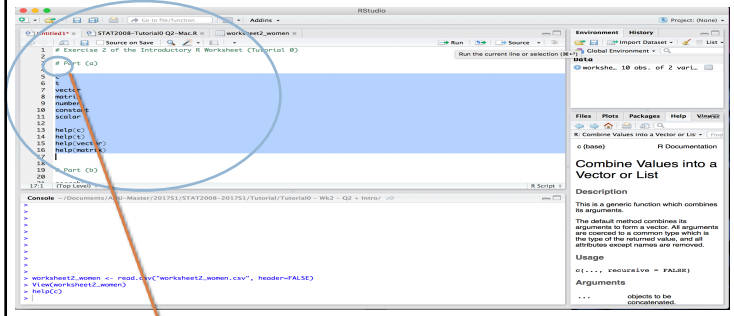
Exercise 2 – Part (a): Function



- R Code:
  - Case Sensitive
  - When type # at the beginning of each line and run this line, this line will be treated as a comment, and R Console will no longer run this line's code (that's why you see the green fonts in your R Script since it is a comment ONLY rather than a function)

NB: This rules works for all cases even if you put # in the middle of one R code line (and all the words after # in the middle will be treated as a comment)

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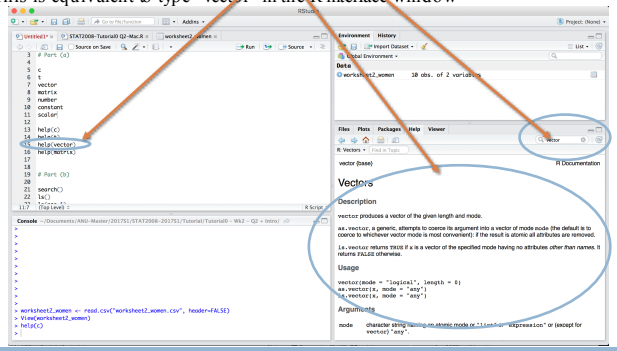
Exercise 2 – Part (a): Getting Help with R

- To run the following is equivalent to type the "topic" in the R interface window
  - **help(*topic*)**
- Eg: Run **help(*vector*)** in your R Script, the interface window will then show you how *vector* function works.
- This is equivalent to type "vector" in the R interface window



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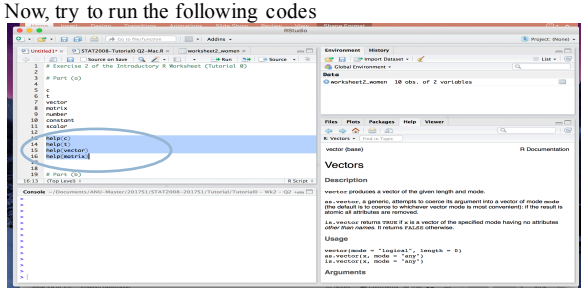
Exercise 2 – Part (a): Getting Help with R

- The `help()` function and `?` help operator in R provide access to the documentation pages for R functions, data sets, and other objects, both for packages in the standard R distribution and for contributed packages. To access documentation for the standard `lm` (linear model) function, for example, enter the command `help(lm)` or `help("lm")`, or `?lm` or `?"lm"` (i.e., the quotes are optional).

(Source: https://www.r-project.org/help.html)

- Now, try to run the following codes



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Exercise 2 – Part (a): Functions

- **c()**
  - Combine values into a vector or list
- **t()**
  - Matrix transpose
- **vector()**
  - A vector of the given length and mode
- **matrix()**
  - Creates a matrix from the given set of values

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EXERCISE 2

Part (b)

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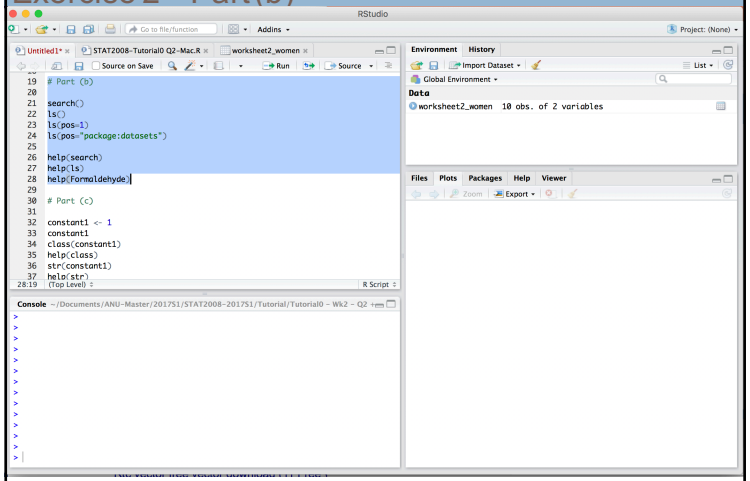
Exercise 2 – Part (b)



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Exercise 2 – Part (b)

- **search()**
  - # to see which packages are already included in your search path
- **ls()**
  - # list the contents of the packages in your search path
  - # to see all the objects defined
- **ls(pos=1)**
  - # By default, ls() lists the contents of position 1
- **ls(pos="package:datasets")**
  - # show you the sample datasets that come with standard R

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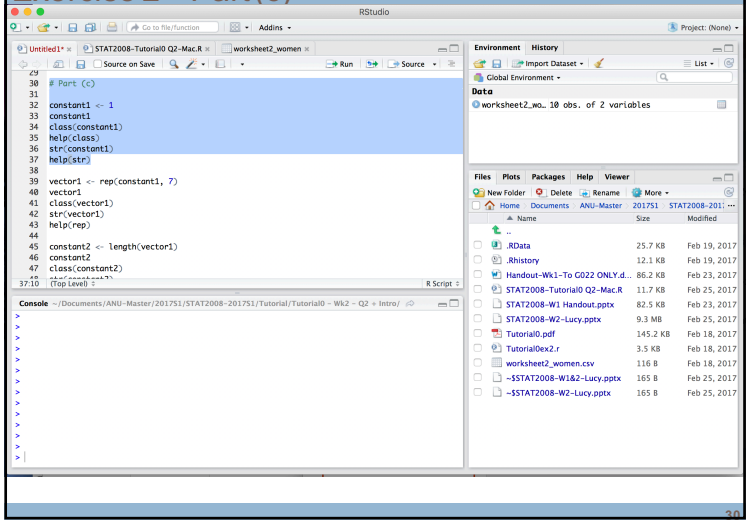
EXERCISE 2

Part (c)

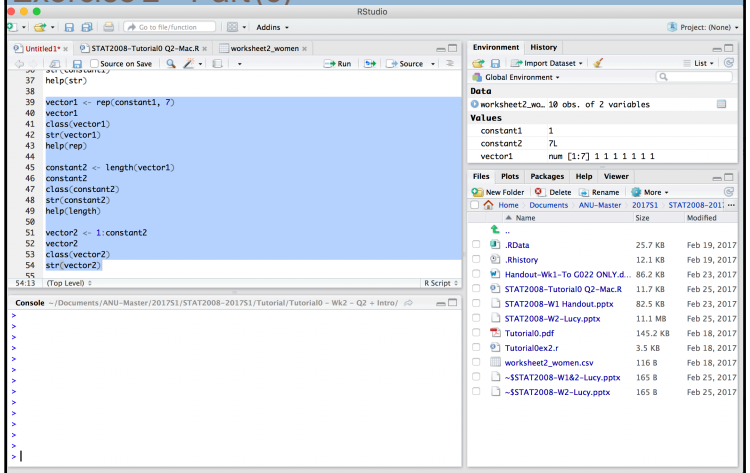
Exercise 2 – Part (c)



Exercise 2 – Part (c)

- **constant1 <- 1**
  - # assign 1 to the object name"constant1"
  - # <- equals to =
- **constant1**
  - # assign 1 to the object name"constant1"
  - # <- equals to =
- **class(constant1)**
  - # class: check data type
- **help(class)**
- **str(constant1)**
  - # str: display the internal structure of an R object => number/integer..+ value
- **help(str)**

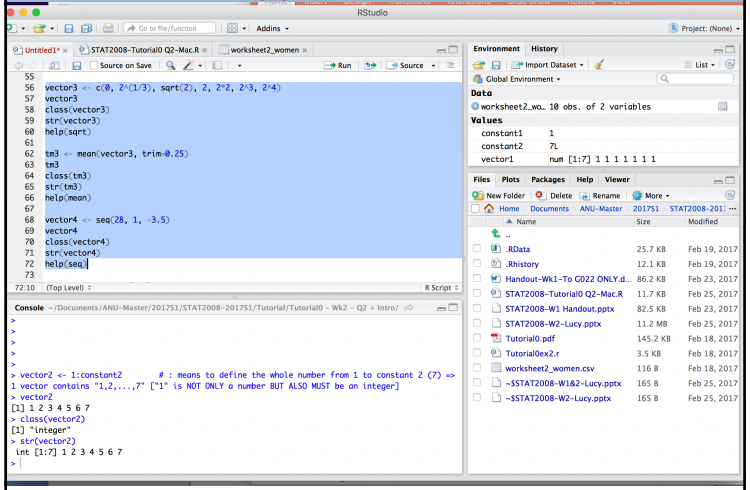
Exercise 2 – Part (c)



Exercise 2 – Part (c)

- **vector1 <- rep(constant1, 7)**
  - # rep: repeat value of constant1 (which is 1) for 7 times => 1 vector contains 7 "1" ["1" is ONLY a number]
- **constant2 <- length(vector1)**
  - # length: calculate the length of vector 1
  - # which is 7
- **vector2 <- 1:constant2**
  - # : means to define the whole number from 1 to constant2 (which is 7)

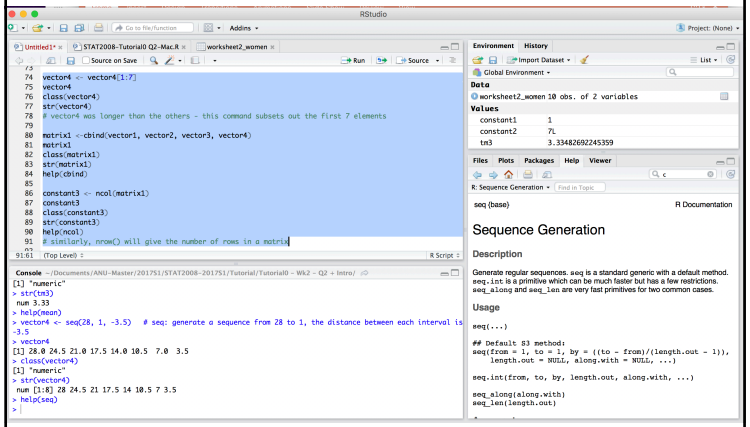
Exercise 2 – Part (c)



Exercise 2 – Part (c)

- **vector3 <- c(0, 2^(1/3), sqrt(2), 2, 2*2, 2^3, 2^4)**
  - # c: Combine Values into a Vector or List
- **tm3 <- mean(vector3, trim=0.25)**
  - # take the average of vector3 when get rid of the LB and UB @ area equals to 0.25
  - LB,UB = lower bound, upper bound
  - # another example
    - **a<-c(1,4,8,60,80,90,100)**
      - # 1= 1st obs, 100=7th obs
    - **mean(a, trim=0.2)**
    - # For LB: n=7, LHS area=0.2 => position = (7+1)* 2/100= 1.6 => LB = 1.6th observation = 1+(4-1)*0.6=2.8
    - # For UB: n=7, RHS area=0.2 => position = (7+1)* 2/100= 1.6 => 7+1-1.6=6.4th observation => UB= 90+(100-90)*0.4=94
    - # average: (2.8+4+8+60+80+90+94)/7
- **vector4 <- seq(28, 1, -3.5)**
  - # seq: generate a sequence from 28 to 1, the distance between intervals is -3.5
  - # Rule: seq(from,to,by)
- **seq(x)**
  - #generate sequence from 1 to x

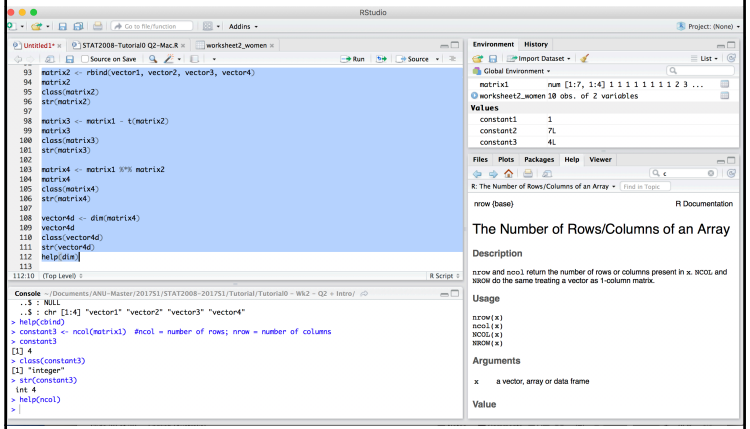
Exercise 2 – Part (c)



Exercise 2 – Part (c)

- **vector4 <- vector4[1:7]**
  - # take out the first 7 elements from "vector4"
  - # **from:to** means to generate sequence from…to
- **matrix1 <-cbind(vector1, vector2, vector3, vector4)**
  - # Create a matrix
  - # cbind = different columns bind [c=column + bind]
  - # cbind (c(Col1Row1,Col1Row2,Col1Row3),c(Col2Row1,Col2Row2,Col2Row3))
- **constant3 <- ncol(matrix1)**
  - #ncol = number of rows;
  - #nrow = number of columns

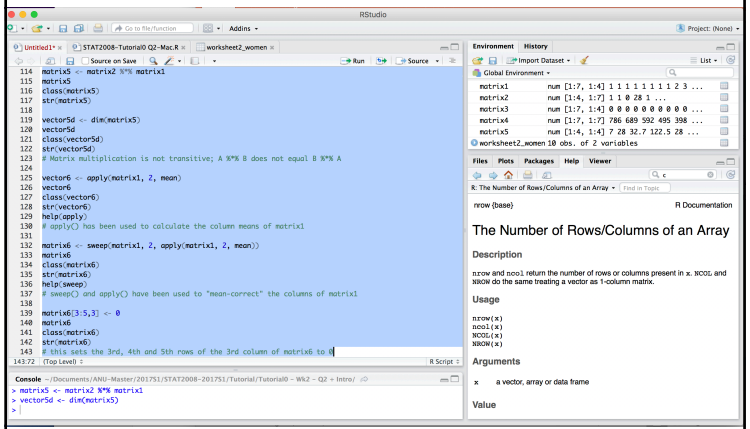
Exercise 2 – Part (c)



Exercise 2 – Part (c)

- **matrix2 <- rbind(vector1, vector2, vector3, vector4)**
  - # rbind = different rows bind [r=row + bind]
  - # rbind (c(Col1Row1,Col2Row1,Col3Row1),c(Col1Row2,Col2Row2,Col3Row2))
- **matrix3 <- matrix1 - t(matrix2)**
  - # t = transpose of 1 matrix
- **matrix4 <- matrix1 %*% matrix2**
  - # "A %*% B" means want to use A MATRIX * B MATRIX;
  - # if we only use "A*B" - use EACH element in matrix A to multiply EACH element in matrix B
- **vector4d <- dim(matrix4)**
  - # dim = dimension

Exercise 2 – Part (c)



Exercise 2 – Part (c)

- **vector6 <- apply(matrix1, 2, mean)**
  - # apply() has been used to calculate the column means of matrix1
  - # apply (where to apply, 1=apply to row and 2=apply to column, what function to apply) => to calculate the mean of each column for matrix1
- **matrix6 <- sweep(matrix1, 2, apply(matrix1, 2, mean))**
  - # sweep() and apply() have been used to "mean-correct" the columns of matrix1
  - # sweep (where to apply, 1=apply to row and 2=apply to column, what function to apply)
  - # here we use "apply(matrix1, 2, mean)" to calculate the average of each column, then use each column element of "matrix1" to minus this column's average

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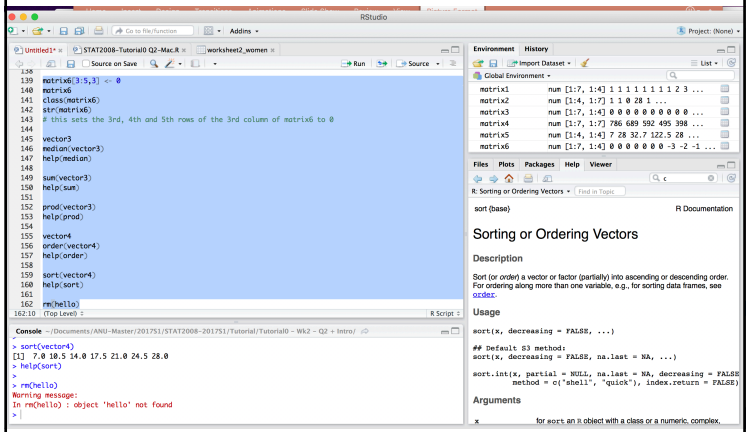
Exercise 2 – Part (c)



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Exercise 2 – Part (c)

- **matrix6[3:5,3] <- 0**
  - # assign 0 to [3:5,3] over row 3 to 5, and column 3
- **prod(vector3)**
  - # get the product of all element from vector 3
- **order(vector4)**
  - # get the order of vector 4 based on an ascending order
- **sort(vector4)**
  - # get the ascending order of vector 4
- **rm(hello)**
  - # define "hello" as the a object before, and now remove it
- **ls()**
  - # to see all the objects defined
- **objects()**
  - # to see all the objects defined

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EXERCISE 2

Part (d)

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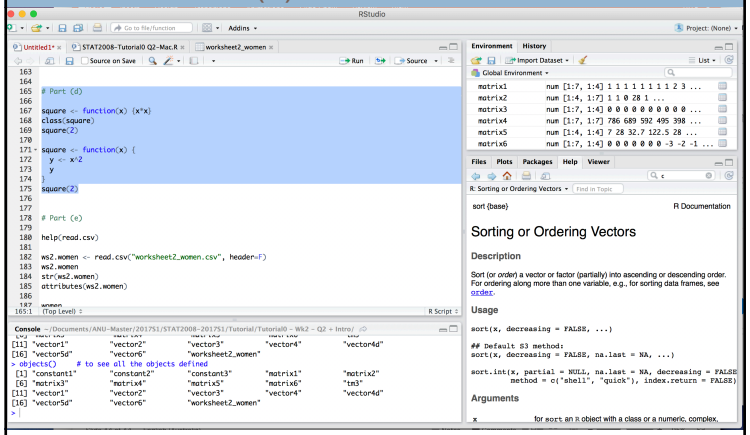
Exercise 2 – Part (d)



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Exercise 2 – Part (d)

- # here, "function()" means for this function, there is an empty input ["()" means the input]
- # In general, we can use
  - **function (input) {output}**
  - for example:
    - # **happy=function(x) {x+10}**
    - # x is the input, and x+10 is the output
    - # **happy(2)**
    - # () means to make input (x) equal to 2, and then run the function of "x+10", and get the output :2+10=12
- NB
  - # "**happy**" only shows the definition of happy, which is function(x) {x+10}
  - # "**happy ()**" runs this x+10 function

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EXERCISE 2

Part (e) continue

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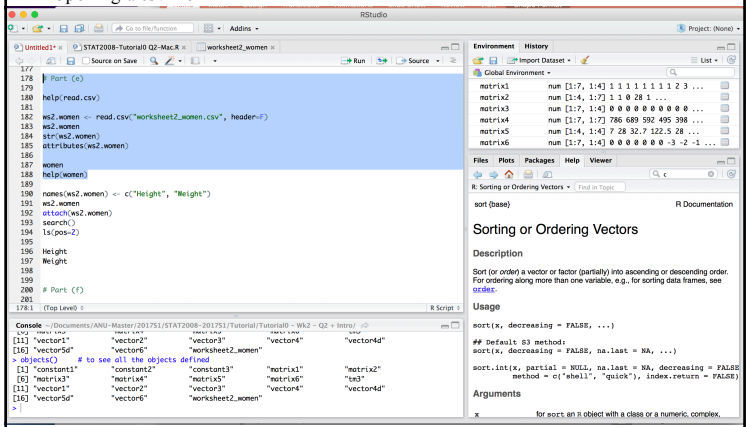
Exercise 2 – Part (e)

- The codes below is equivalent to what I have mentioned earlier, the 2nd method of opening a csv file



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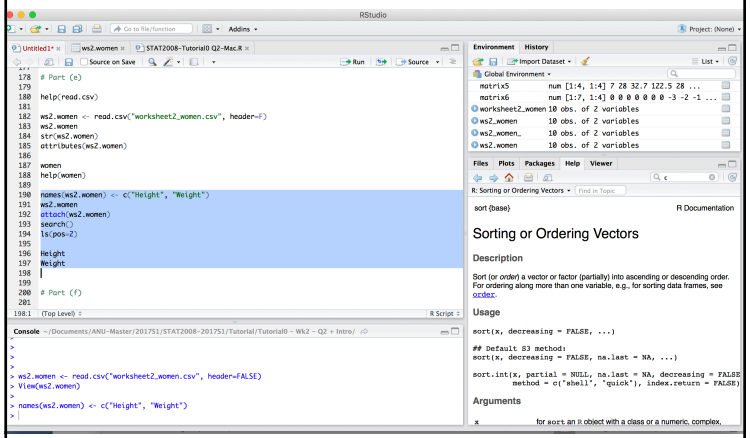
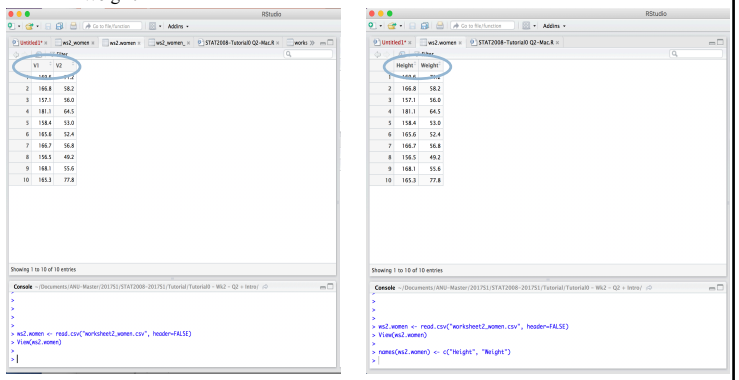
Exercise 2 – Part (e)



Exercise 2 – Part (e)

- **names(ws2.women) <- c("Height", "Weight")**
  - # rename each variable (each column)
  - # previous we see V1 and V2 as our variable names, now they change to Height and Weight



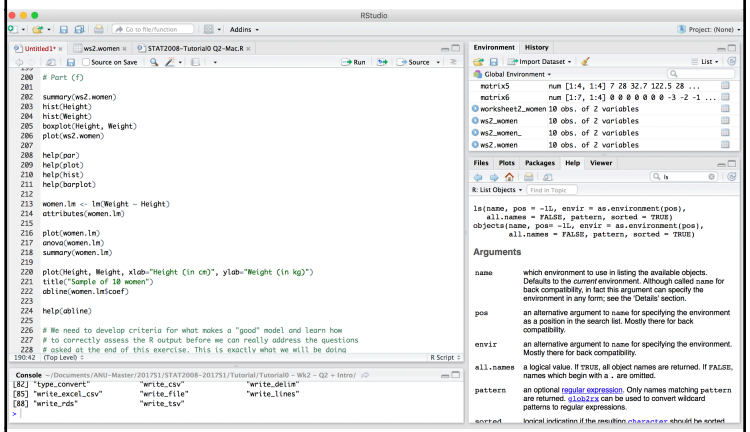
Exercise 2 – Part (e)

- **attach(ws2.women)**
  - # we can directly apply the variable names from our worksheet, i.e: "Height, Weight" in R Studio
  - # When there is no such code, if we want to apply the "Height" column variable from our worksheet, we have to type
    - **ws2.women$Height**
  - NB: $ means to apply the variable name from the worksheet

EXERCISE 2

Part (f) continue

Exercise 2 – Part (f)



Exercise 2 – Part (f)

- **summary(ws2.women)**
  - # statistic summary for each variable in our worksheet
- **hist(Height)**
  - # histogram for Height
- **boxplot(Height, Weight)**
  - # boxplot for Height and Weight
- **plot(ws2.women)**
  - # scatter plot for Height and Weight
- **women.lm <- lm(Weight ~ Height)**
  - # fit a Simple linear regression, Y=Weight, X=Height
- **attributes(women.lm)**
  - # check all the properties (names) for this regression
- **plot(women.lm)**
  - # residual plots for Y versus X
- **anova(women.lm)**
  - # anova for Y versus X
- **summary(women.lm)**
  - # summary for Y versus X
- **plot(Height, Weight, xlab="Height (in cm)", ylab="Weight (in kg)")**
  - # scatter plot for Y versus X
- **title("Sample of 10 women")**
  - # add title
- **abline(women.lm$coef)**
  - # add the regression function line with its coefficients (slope and intercept) to the scatter plot

Extra Notes

- **reg.y.on.x <- lsfit(Height, Weight)**
  - # LSE (least squares regression)
  - # include
    - A vector of the parameter estimates (bo,b1)
      - **reg.y.on.x$coef**
    - Residuals
      - **reg.y.on.x$resid**

EXERCISE 1

Extra Notes

Some Notes for Exercise 1

- **sqrt(4)**
  - # square root of 4
- **abs(4)**
  - # absolute value of 4
- **log(4)**
  - # ln(4) since The default for the log() function is to compute logarithms to the base e
  - # for common logarithms (logs to the base 10), you can use log10(number) or log(number, base=10)
  - # for binary logarithms use log(number, base=2).
- **4 > 2**
  - # whether "4>2" is true?
- **4 < 2 || 4 > 2**
  - # whether "4<2" OR "4>2" is true?
  - # & and && indicate logical AND
  - # | and || indicate logical OR.
- **rm()**
  - # to remove the unwanted object defined previously
  - Eg: if we defined hello previously, then type **rm(hello)** means to remove the object hello
- **q()**
  - # to quit R, which equals to choose File - Quit R studio
- **ls()**
  - List objects in workspace
- **rm(list = ls())**
  - Remove all objects from workspace
- **save.images ()**
  - Saves workspace
- **#**
  - comments

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