Lab 01

Psychology 310

Instructions. Work through the lab, saving the output as you go. You will be submitting your assignment as an R Markdown document.

Preamble. Today's assignment involves course grades – getting them into R, analyzing them, rescaling them, and checking them for errors.

Assume that the professor you work with hands you the following grade sheet that he has been maintaining on a piece of paper in his office:

Last.Name	First.Name	ID	MidTerm	Final
Allison	Bartley	57743227	87	79
Zukhov	Marsha	76767802	82	88
Chou	Patricia	13248884	76	69
Fillion	Herve	19092881	100	88
Braich	Kenny	76589944	90	85
Farce	Stanley	89000347	97	68
Farce	Max	88292233	65	96
Yang	Ming-Mei	56092221	80	80
Edwards	Victoria	08911090	93	97
Campbell	Kimberly	10001010	62	58
Trudeau	Pierre	19972323	55	59

1. The professor wants these grades analyzed. Your first step is to get them into R. One of the things you discover quickly in graduate school is that getting the data into a statistical program can sometimes be more trouble than it should be. R is extraordinarily powerful, but it can sometimes be difficult to figure out, because it is not menu-driven.

   There are several ways of organizing data in R, but perhaps the most effective and the most common is the "data frame," which is essentially a matrix with columns that can be different variable types.

   R distinguishes between `character` and `numeric` variables, and you will quickly become familiar with them.

   Here is a hint. Some universities have ID numbers with leading zeros. If you are at such a university, and you enter the ID as a numeric variable, your statistical program will remove the leading zero. For example, if the student's ID number is 00932883 in a system where all ID numbers have 8 digits, you might see 932883 in your data file. In this case, you could make your ID number a `character` variable and solve the problem, because now the software would treat the ID number as a string of characters, and maintain all the characters you enter. In addition, for reasons that will become clearer when we do more advanced work, it is a good idea whenever variables are non-numeric, to declare their type explicitly on input.

You can practice entering the data yourself, or you can download the file *Grades.csv* from the website and use that file.

Create a working directory called *Lab01* and switch R to that working directory, using the *File–>ChangeDir* command from the menu. Make sure the *Grades.csv* file is in that directory.

Import the file into R using the following syntax.

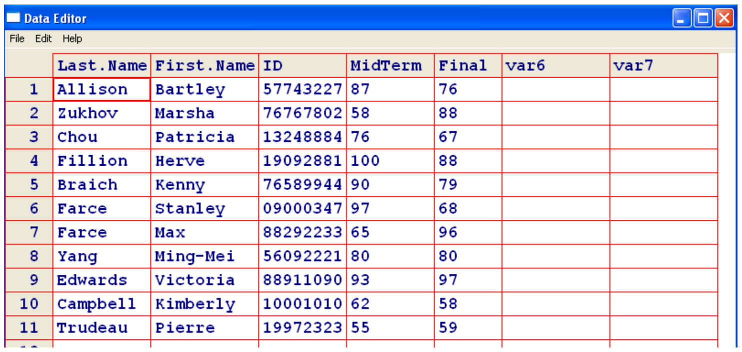
```
> grades <- read.csv("Grades.csv", colClasses = c("character", "character",
+     "character", "numeric", "numeric"))
```

The filename comes first *in quotes*, Then we provided a vector of column classes, defining which kind of variable is in each column. Notice that we forced the variable ID to be a character variable.

To verify that your data have successfully been entered, type the following command:

```
> fix(grades)
```

This will open up an editor window.



	Last.Name	First.Name	ID	MidTerm	Final	var6	var7
1	Allison	Bartley	57743227	87	76		
2	Zukhov	Marsha	76767802	58	88		
3	Chou	Patricia	13248884	76	67		
4	Fillion	Herve	19092881	100	88		
5	Braich	Kenny	76589944	90	79		
6	Farce	Stanley	09000347	97	68		
7	Farce	Max	88292233	65	96		
8	Yang	Ming-Mei	56092221	80	80		
9	Edwards	Victoria	88911090	93	97		
10	Campbell	Kimberly	10001010	62	58		
11	Trudeau	Pierre	19972323	55	59		

Now, add one line of data to the data frame

Wasserman Iggy 23148878 80 82

Note. Alternatively, you may edit any csv file directly in Microsoft Excel, or, indeed, with any text editor. You have lots of options with csv files, which is why they are so useful.

2. *Finding an error.* Congratulations! Your data frame is now ready to analyze. Check your data frame using the `fix` function, and see if in fact you can see the additional line. Then go to *www.statmethods.net*, and figure out how to save your data frame to a comma-delimited csv file, and save your `grades` data frame in a file called *Grades2.csv*.

Next, let's call for a quick numerical summary of the grades with the following command:

```
> summary(grades)

  Last.Name          First.Name             ID               MidTerm     
 Length:12          Length:12          Length:12          Min.   : 55.0  
 Class :character   Class :character   Class :character   1st Qu.: 73.2  
 Mode  :character   Mode  :character   Mode  :character   Median : 81.0  
                                                          Mean   : 80.6  
                                                          3rd Qu.: 90.8  
                                                          Max.   :100.0  
     Final     
 Min.   :58.0  
 1st Qu.:68.8  
 Median :81.0  
 Mean   :79.1  
 3rd Qu.:88.0  
 Max.   :97.0  
```

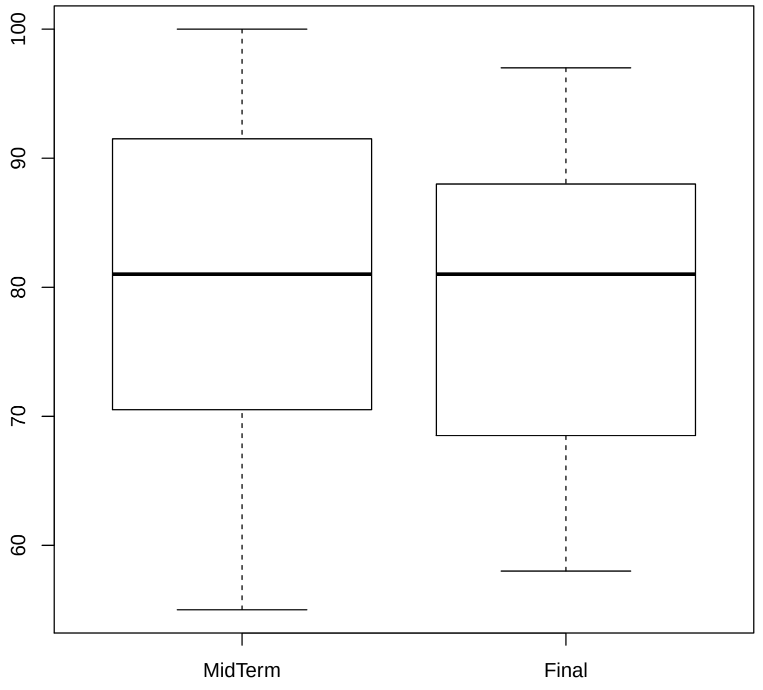
You can see that the performance on the exams was rather similar. You can get graphical representations of that in several ways. You can also, of course, call for summary statistics of the variables. For example, suppose you wanted to know the mean of the `MidTerm` exam grades. Note: Unless you have attached the data frame, you will need to tell the `mean` command the name of the data frame where the variable `MidTerm` is located, using the following syntax.

```
> mean(grades$MidTerm)

[1] 80.58
```

With simple examples like this, it is more convenient to `attach` the file. This makes all variable names in this file immediately available for analysis.

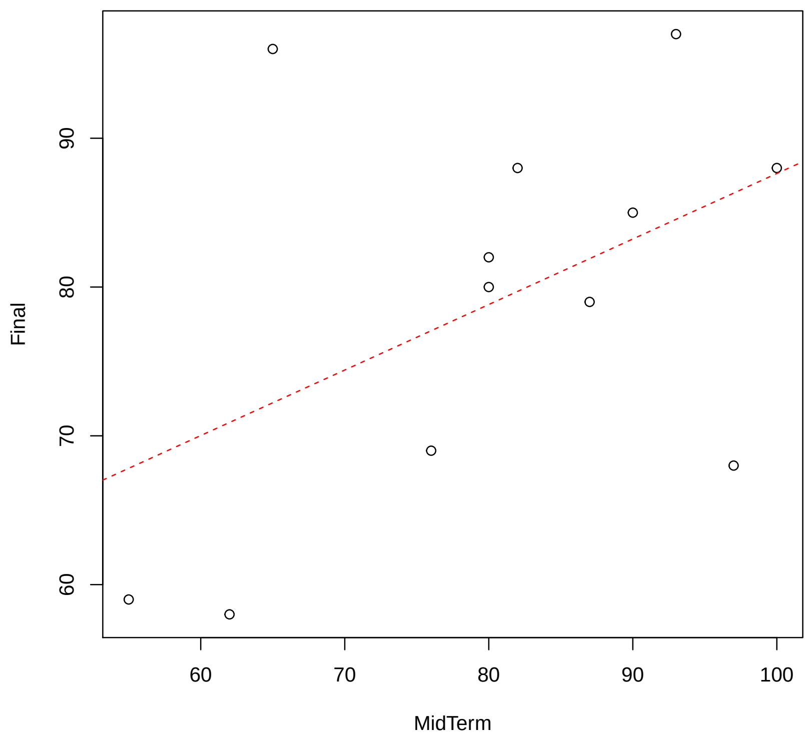
```
> attach(grades)
> mean(MidTerm)

[1] 80.58
```

Using the help file facility in R, find out how to duplicate the following side-by-side boxplot of the MidTerm and Final grades, with the correct axis labels as shown. Read about boxplots in your textbook or on the internet. Which exam showed more variability?



We can also examine the distributions of values in a variety of ways. One way is to look at the joint distribution of `MidTerm` and `Final` Grades with a scatterplot. You can plot the regression line, and get its slope and intercept, from the following commands.

```
> fit <- lm(Final ~ MidTerm)
> fit


Call:
lm(formula = Final ~ MidTerm)

Coefficients:
(Intercept)      MidTerm
      43.60         0.44

> plot(MidTerm, Final)
> abline(fit, lty = 2, col = "red")
```



If you look carefully at the scatterplot, you can see two points that are fairly far removed from the others. They are at the upper left and lower right of the plot. Who are they? In this case, it is pretty easy to tell because there are very few data points in the file. However, R provides a special function to help you identify points on a scatterplot.

Enter the following command:

```
> identify(MidTerm, Final, plot = TRUE, labels = Last.Name)
```

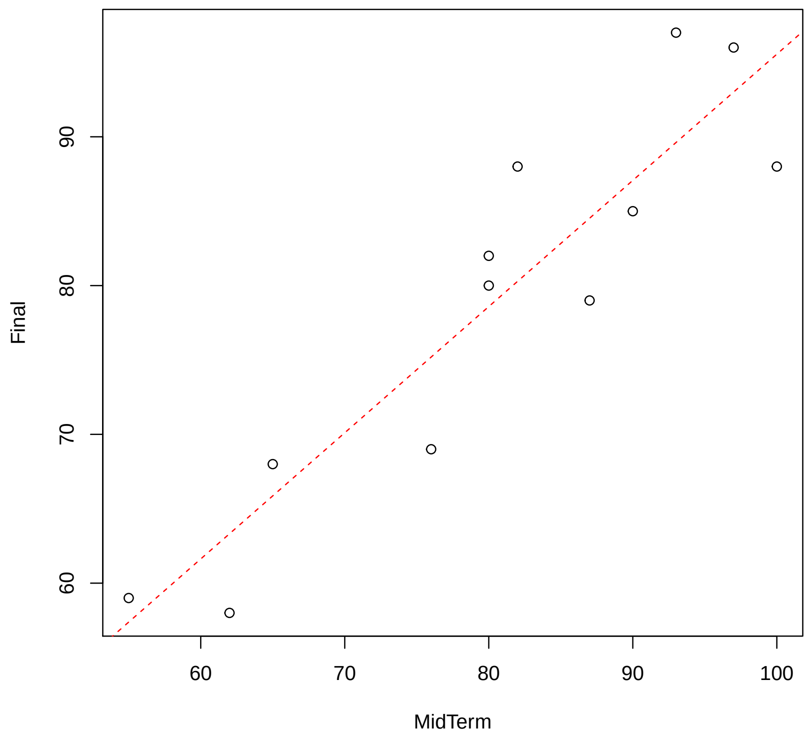
Move the cross-hairs over each of the two outlier points and click on them. You will see the last names of the two individuals represented in the points appear.

See something interesting? Looks like there was almost certainly a recording error. What do you think happened?

The problem is, who made the error, and who has the wrong data? Let's assume that the error was made by the professor when recording the data on the second midterm for these two individuals. Fix the error using the `fix` function discussed earlier.

Then redo the scatterplot. It should look like the one below.

```
> plot(MidTerm, Final)
> fit2 <- lm(Final ~ MidTerm)
> abline(fit2, lty = 2, col = "red")
```



2. *Sorting.* Now let's sort the grades. We want to sort by ascending order. In large classes, I have on one or two occasions had individuals with identical first *and* last names. So sorting should be done on `Last.Name`,`First.Name`, and `ID` in that order.

```
> sorted.grades <- grades[order(Last.Name, First.Name, ID), ]
> sorted.grades

   Last.Name First.Name       ID MidTerm Final
1    Allison    Bartley 57743227      87    79
5     Braich      Kenny 76589944      90    85
10  Campbell   Kimberly 10001010      62    58
3       Chou   Patricia 13248884      76    69
9    Edwards   Victoria 88911090      93    97
7      Farce        Max 88292233      65    68
6      Farce    Stanley 09000347      97    96
4    Fillion      Herve 19092881     100    88
11   Trudeau     Pierre 19972323      55    59
12 Wasserman       Iggy 23148878      80    82
8       Yang   Ming-Mei 56092221      80    80
2     Zukhov     Marsha 76767802      82    88
```

It worked!

3. *Z-Scoring.* You can add new variables to the data frame in numerous ways. If you are transforming data already in the file, you can create the new variable by referencing it in the transformation formula. However, you must reference it with the data frame name included. For example, to create a new variable that is the sum of the midterm and the final grades, you would issue the command `sorted.grades$sum = MidTerm + Final`

   Here's what I want you to do next:

   (a) Create two new variables called Z.Midterm and Z.Final that contain z-scores for the two variables.

   (b) Then, compute the mean and variance of these two new variables to make sure they are actually in z-score form.

   (c) Next, compute the correlation between these two variables.

   (d) Then, compute their covariance.

   (e) Next, create a variable called `z.grade` that is compute with the formula

   `z.grade = (1/3)*z.MidTerm + (2/3)*z.Final`

   (f) Create a single formula in R that will transform these `z.grade` scores to have a mean of 78 and a standard deviation of 12, and store these final grades in a variable called `Course.Grade`.

   (g) Verify that these grades have a mean of 78 and a standard deviation of 12.

   (h) Finally, save your data frame to a file called *Grades3.csv*.

Remember, save all your input, output, and graphics files, and your final data file.

To complete the assignment, email the following 3 files to the course TA.

1. An R-Markup Rmd File, and
2. its HTML compiled version, containing the following:
   - The correctly labeled side-by-side boxplot.
   - The two scatterplots.
3. The final grade file, *Grades3.csv*