Lab 2

MTH 3220

19 September 2017

1 "To Alcohol! The cause of and solution to all of life's problems." - Homer Simpson

In one of my experimental design courses in grad school, I had to design and carry out an actual experiment. Here's the set-up of my experiment:

"Beer connoisseurs are often interested in foam retention of their beverage of choice. One usually favors a slow rate of foam collapse while drinking a beer so the liquid stays carbonated longer. In order to determine ideal conditions for maximum beer foam, or head retention, four two-level factors are included in this experiment. A test run is a single beer poured from a can or bottle into a chilled or room temperature glass that has been washed in one of two types of detergent and is held at one of two angles. The response measured is total time (in seconds) foam stays at the top of the beer."

A couple of notes before you begin:

- Check where R looks for and outputs files by running `getwd()` (get working directory). If you would like to change the path, run e.g. `setwd("D:/mystuff")` (set working directory).
- If code is provided for you, be sure to copy/paste it into your .R script that you'll save and upload at the end of the lab.
- Don't forget to save and upload your code (and plots) at the end of the lab. If you want to upload a single .pdf that you compiled using `knitr` and a .Rnw file (like the one I posted on Blackboard) then do that.

1.1 Part A: Tests for Population Variances

1. Do the following to load the data into R and view it:

    - Read in the data "beer.txt" by running the following (note this assumes the file is in your working directory; if it isn't, you need to specify the full path):

    ```
    read.table("beer.txt", header = TRUE)
    ```

    - Attach the data using `attach()`.
    - Now look at the structure of the dataset using `str()` as well as by displaying the dataset (just type in the object name and run it).

2. Do the following to write some plots to a pdf (and does not display them in RStudio):

    - Run this to open a device (in your working directory) to which R will print:

    ```
    pdf("plot1.pdf")
    ```

    - Run this to create a two-by-two array in the pdf into which four figures may be drawn:

    ```
    par(mfrow = c(2, 2))
    ```

    - Make four (4) comparative boxplots, each one using time as the response (y) and one of the other four variables as the factor (x). For example:

    ```
    boxplot(time ~ angle)
    ```

    Color the boxes and label the plots as you wish.

    - Close the open pdf device by running

    ```
    dev.off()
    ```

    You should now have in your working directory a pdf titled "plot1.pdf" with all four plots in one page[1].

[1] Note that if you played around with colors and labels your plots get overwritten so re-run the code from the `pdf()` call when you have finalized your plots.

3. Test whether the variance of times is different between the two pouring angles by doing the following:

    - The F statistic of interest is s_1^2/s_2^2. To get the 2 variances in one line of code, use `tapply()` (see notes or run `?tapply` for arguments) and note that the function you are interested in for the third argument is `var` (for variance). Assign the output of `tapply()` to an object called `myvars`.
    - Now calculate the F statistic by extracting the two variances using bracket notation:

    ```
    f <- myvars[1]/myvars[2]
    ```

    - To get the p-value, you'll need to use `pf()`. Read the help file to see what arguments are required and exactly what is output. Recall that you are doing a two-tailed test and ν_1 and ν_2 are both 7.

1.2 Part B: ANOVA

1. Test whether pouring angle has an effect on head retention time using

    `t.test(response ~ factor)` where you replace `response` and `factor` with the appropriate names of the variables. Be sure to assign the output of the test to an object for use later on.

2. Test whether pouring angle has an effect on head retention time using

    `summary(aov(response ~ factor))` where you replace `response` and `factor` with the appropriate names of the variables. Be sure to assign the output of the test to an object for use later on.

3. Verify the t-statistic in problem 1 is the square root of the F-statistic in problem 2 by taking the difference of the two quantities of interest (should be approximately 0). Use the square bracket notation to extract elements of your two objects. Note: for the ANOVA output, you will have to also use double brackets, e.g. if the object is `ftest`, the p-value is

```
ftest[[1]]["angle", "Pr(>F)"]
```