STA5206 Final Project

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Question One

We seek to find out whether a liquid diet has successfully lowered the weight of 12 adult subjects. For the purpose of this study, we will use the Wilcoxon Ranked Sum Test to test the following hypothesis:

The Null Hypothesis -> $H_0 : \mu_{t1} = \mu_{t2}$

The Alternative Hypothesis -> $H_1 : \mu_{t1} > \mu_{t2}$

- t1 represents the weights of the 12 subjects before the liquid diet and t2 represents the weights of the 12 subjects after the liquid diet has been completed.

```r
# create the columns for time 1 and time 2
t1 <- c(186, 171, 177, 168, 191, 172, 177, 191, 170, 171, 188, 187)
t2 <- c(188, 177, 176, 169, 196, 172, 165, 190, 166, 180, 181, 172)
# form a dataframe for our data
df <- data.frame(t1, t2)
# we must use a paired test here
  # t1 and t2 have data from the same subject -> paired
wilcox.test(df$t1, df$t2, paired = TRUE, alternative = "greater")
```

```
##
##  Wilcoxon signed rank test with continuity correction
##
## data:  df$t1 and df$t2
## V = 38, p-value = 0.3442
## alternative hypothesis: true location shift is greater than 0
```

With a p-value of 0.3442, we can comfortably state that the null hypothesis cannot be rejected. This is analogous to say that the diet plan had no positive effect on the weight of the subjects after the diet was completed.

Question Two

We are asked to determine whether the yields of sweet potatoes from 4 different samples are the same. For the purpose of this problem we will use the Kruskal Wallis Test.

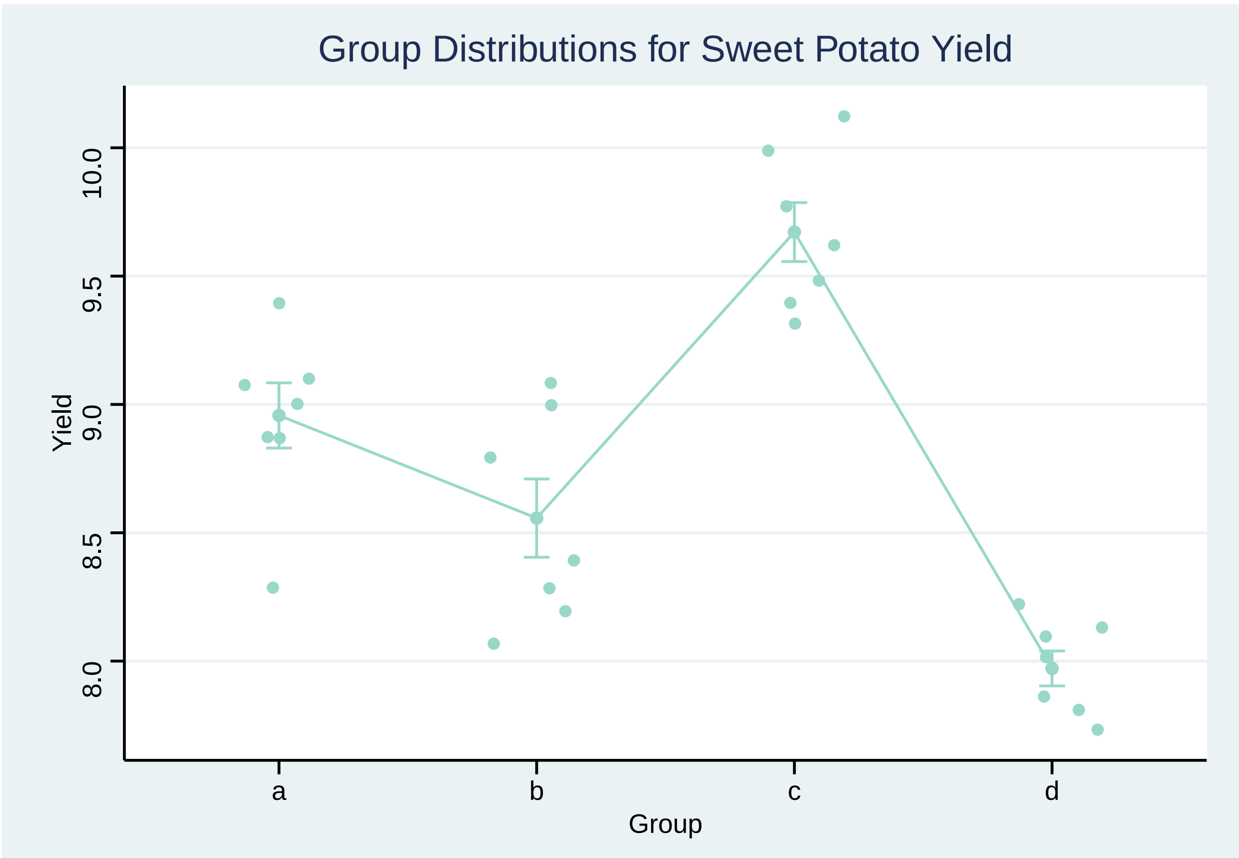
The Null Hypothesis: The is no difference between the distribution of the 4 samples

The Alternative Hypothesis: There is a significant difference between the distributions of the 4 samples

```
# create the column for yield
yield <- c(8.3, 9.4, 9.1, 9.1, 9.0, 8.9, 8.9, 9.1, 9.0, 8.1, 8.2, 8.8,
           8.4, 8.3, 10.1, 10.0, 9.6, 9.3, 9.8, 9.5, 9.4, 7.8, 8.2,
           8.1, 7.9, 7.7, 8.0, 8.1)
# create the column for group
group <- c("a", "a", "a", "a", "a", "a", "a", "b", "b", "b",
           "b", "b", "b", "b", "c", "c", "c", "c", "c", "c", "c",
           "d", "d", "d", "d", "d", "d", "d")
# create the dataframe
sp_df <- data.frame(yield, group)
```

```
# we should get an idea of what our data looks like first
library("ggpubr")
library("ggthemes")
# use ggplot to create a jitter of each group and connect them by MSE
ggline(sp_df, x = "group", y = "yield",
       color = "#99D8C9",
```

```
       add = c("mean_se", "jitter"),
       order = c("a", "b", "c", "d"),
       ylab = "Yield", xlab = "Group",
       title = "Group Distributions for Sweet Potato Yield",
       ggtheme = theme_stata())
```



We can see here that our 4 samples do appear to have differences in their distributions (and their means for that matter, even though that isn't what we're testing here). It should be expected to find significance when we run our test.

```
# Kruskal Wallis rank sum test using 'yield' by 'group'
kruskal.test(yield ~ group, data = sp_df)
```

```
##
##  Kruskal-Wallis rank sum test
##
```

```
## data:  yield by group
## Kruskal-Wallis chi-squared = 22.683, df = 3, p-value = 4.701e-05
```

As we expected based upon our visualization, we have found our p-value to be essentially zero, therefore we state that there is a significant difference between the distributions of the four samples in this test.

Question Three

We have a random sample of 401 single persons split by gender and asked "Would you consider marrying someone who was $25,000 or more in debt?" because it is common for people out of college to have built up a lot of debt from their studies. We are first tasked with finding (a) the expected counts for the 2x3 table of survey results.

```r
# create the 2x3 table as given in the question
tbl_debt <- as.table(rbind(c(125, 59, 21), c(101, 79, 16)))
dimnames(tbl_debt) <- list(Gender = c("Women", "Men"),
                      Response = c("Yes", "No", "Uncertain"))
# run a Chi-Square test on the contingency table
ChiSQ_debt <- chisq.test(tbl_debt)

# create a new table to display observed counts with expected counts in parentheses
tbl_debt2 <- tbl_debt;
tbl_debt2[] <- paste(tbl_debt,paste0("(",round(ChiSQ_debt$expected, digits = 2),")"))

# print the new table
tbl_debt2
```

```
##        Response
## Gender  Yes          No         Uncertain
##   Women 125 (115.54) 59 (70.55) 21 (18.92)
##   Men   101 (110.46) 79 (67.45) 16 (18.08)
```

Next, we are tasked with (b) testing whether gender and the survey response are associated. We will use the Chi-Square test for independence with the following hypotheses:

The Null Hypothesis -> Gender and Survey Results are independent in this study

The Alternative Hypothesis -> Gender and Survery Results are not independent and therefore linked in some way in this study

We will test at the $\alpha = 0.05$ level.

```
# display the Chi-Square test produced in the last section
ChiSQ_debt
```

```
##
##  Pearson's Chi-squared test
##
## data:  tbl_debt
## X-squared = 5.9239, df = 2, p-value = 0.05172
```

With a p-value of 0.05172, we can conclude that at the 0.05 significance level we do not have sufficient evidence to reject the null hypothesis. This means we are unable to conclude that Gender and Survey Results are significantly linked. It is important to note that are p-value is very close to the 0.05 significance level and would be rejected at the 0.1 significance level. For the purpose of our study, however, we are unable to come to that conclusion.

Question Four

An experiment takes place where 5 executives are asked to rate three different methods of measuring risk on a scale of 0 to 20; the higher the number the higher the confidence in the method. These scales are to be taken as normally distributed. Given that the variance of all scores is found to be 26.257, we will now (a) find the missing values to our ANOVA table.

```r
# type out the data
response <- c(1.3, 4.8, 9.2, 2.5, 6.9, 14.4, 7.2, 9.1, 16.5, 6.8,
              13.2, 17.6, 12.6, 13.6, 15.5)
executive <- gl(n = 5, k = 3)
method <- gl(3, 1, length = 15)

# run aov on the data
aov_exec <- aov(response ~ method + executive)

# print the anova table
anova(aov_exec)
```

```
## Analysis of Variance Table
##
## Response: response
##           Df  Sum Sq Mean Sq F value    Pr(>F)
## method     2 185.536  92.768  24.884 0.0003678 ***
## executive  4 152.244  38.061  10.210 0.0031282 **
## Residuals  8  29.824   3.728
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

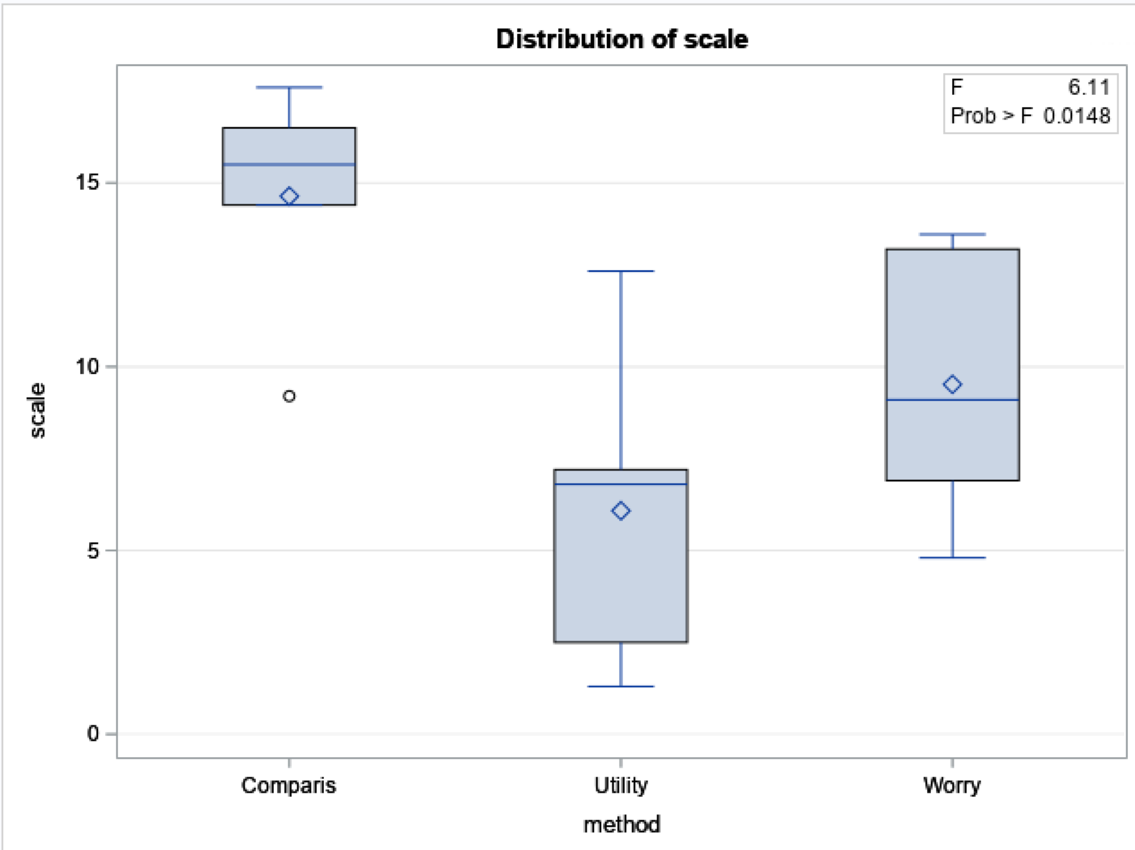
Most of our required results can be displayed here. The values 1-11 are as follows

1. 2
2. 4
3. 8
4. 14
5. 185.54
6. 152.24
7. 367.6
8. 92.77
9. 38.06
10. 3.73
11. 24.88

(b) Test for the equality of confidence ratings among the methods

Source	DF	Type I SS	Mean Square	F Value	Pr > F
method	2	185.5360000	92.7680000	6.11	0.0148

Source	DF	Type III SS	Mean Square	F Value	Pr > F
method	2	185.5360000	92.7680000	6.11	0.0148

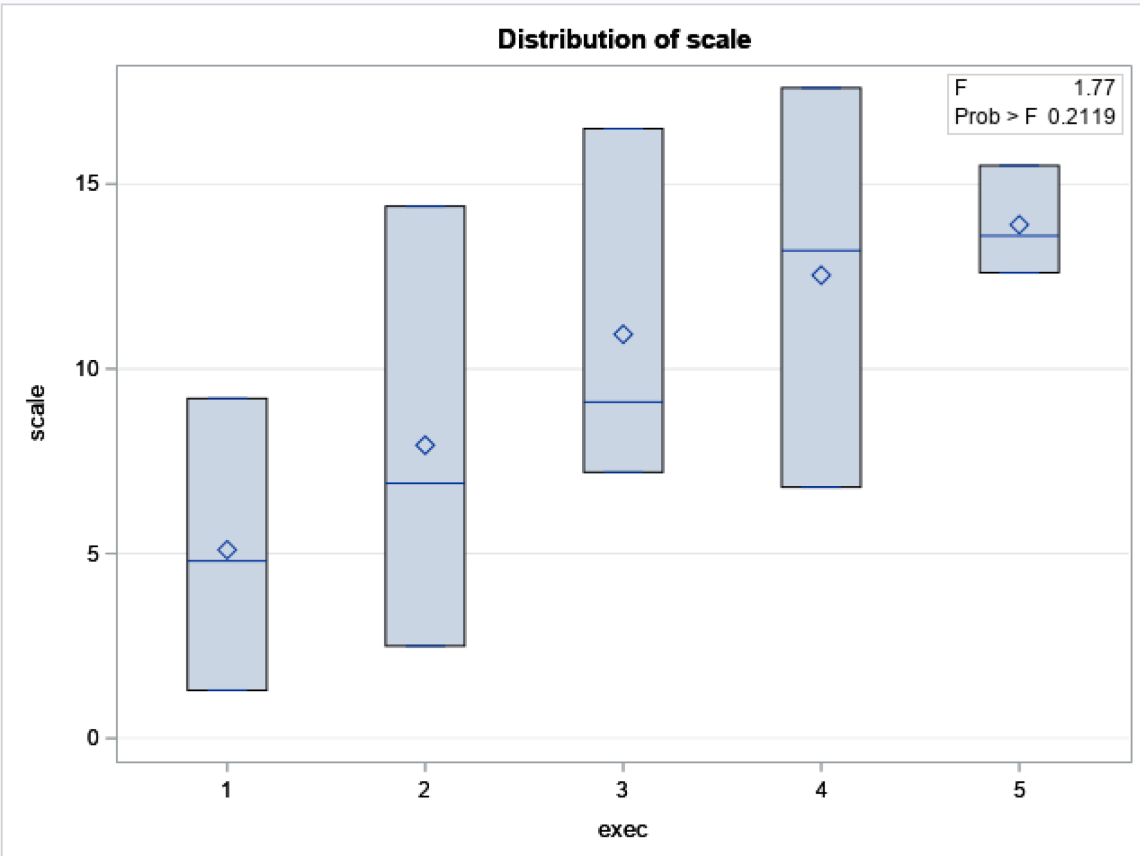


We can see here that our p-value comes out to be 0.0148 which does not exceed our alpha level of 0.05. Therefore, we reject the null hypothesis and claim that the method does have a heavy impact on what confidence rating is given on a scale of 0 to 20.

(c) Test for the equality of confidence ratings among the executives

Source	DF	Type I SS	Mean Square	F Value	Pr > F
exec	4	152.2440000	38.0610000	1.77	0.2119

Source	DF	Type III SS	Mean Square	F Value	Pr > F
exec	4	152.2440000	38.0610000	1.77	0.2119



We can see here that our p-value comes out to be 0.2119 which does not exceed our alpha level of 0.05. Therefore, we fail to the reject the null hypothesis and cannot claim that the executive block has a heavy effect on the confidence rating on a scale of 0 to 20.

(d) Test for the equality of confidence ratings among any pair of executives

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
Comparing 1st and 3rd executives	1	51.04166667	51.04166667	2.37	0.1547
Comparing 1st and 4th executives	1	82.88166667	82.88166667	3.85	0.0782

With neither p-value exceeding our alpha level of 0.05, we cannot conclude that the 1st executive differs significantly from the 3rd or the 4th executive.

(e) Test for the equality of confidence ratings among any pair of methods

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
Comparing Utility and Worry	1	183.1840000	183.1840000	12.07	0.0046
Comparing Utility and Comparison	1	65.5360000	65.5360000	4.32	0.0598

Here, we have a p-value of 0.0046 for the comparison between utility and worry. We will reject the null and conclude that utility and worry do show equality at the significance level of 0.05. We cannot conclude the same for utility and comparison as we fail to reject the null.