

STAT 1293 - Assignment 4

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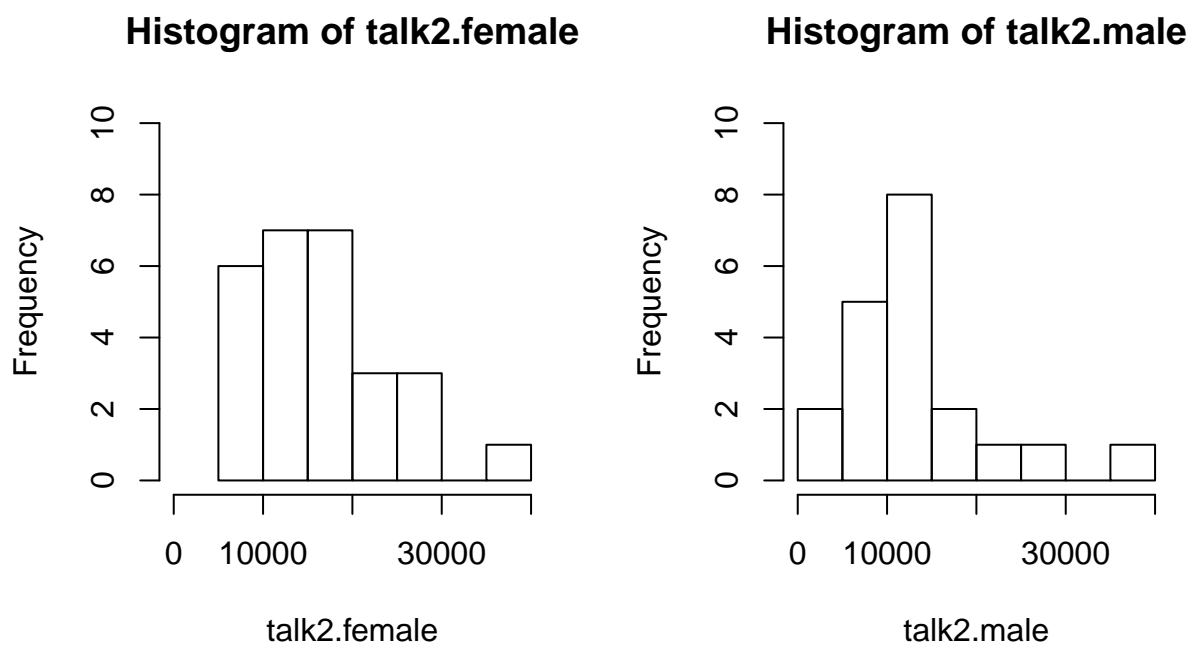
Problem 1: Do women talk more than men? (20 points)

1a) Make histograms for both samples. Make sure the two plots have the same xlim. Are the histograms roughly symmetric or severely skewed? (4 points)

Solution:

```
talk2 <- read.table("C:/Users/gordo/Desktop/talk2.txt", header = TRUE) #read in talk2.txt
talk2.female <- talk2$Words[talk2$Sex == "F"]
talk2.male <- talk2$Words[talk2$Sex == "M"]

par(mfrow = c(1,2), pty = "s")
hist(talk2.female, ylim = c(0, 10), xlim = c(0, 40000))
hist(talk2.male, ylim = c(0, 10), xlim = c(0, 40000))
```

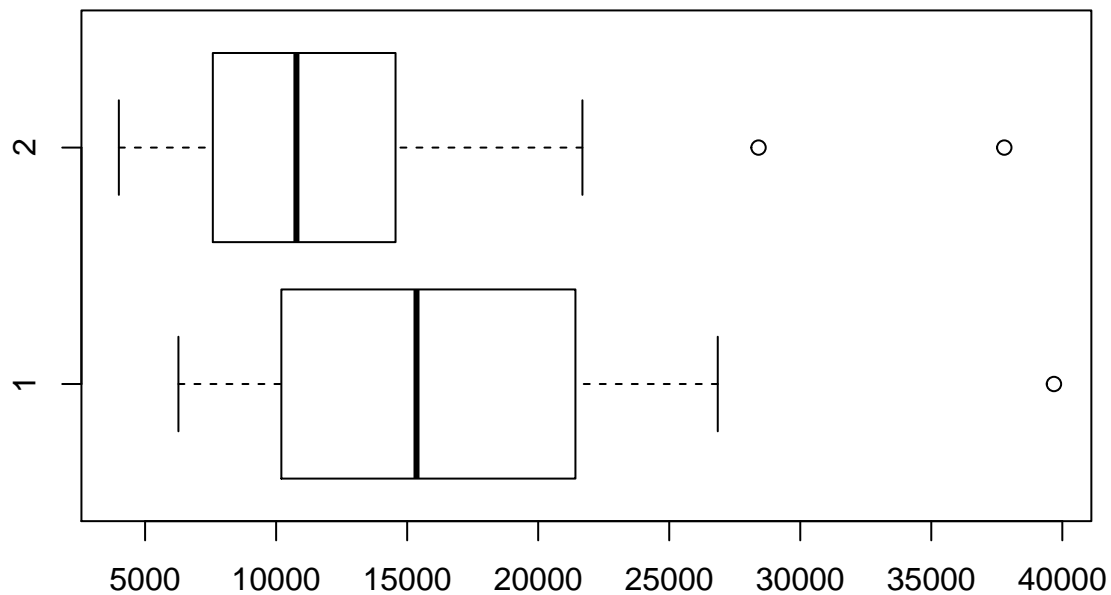


It appears that the histograms are severely skewed right.

1b) Make a side-by-side boxplot for both samples. Any outliers? (4 points)

Solution:

```
boxplot(talk2.female, talk2.male, horizontal = TRUE)
```



Yes there are three outliers. In particular, 39681, 28408, and 37786 are the three outliers.

1c) Use an F test to check if the two variances are approximately equal. (4 points)

Solution:

```
var.test(talk2.female, talk2.male)
```

```
##
## F test to compare two variances
##
## data: talk2.female and talk2.male
## F = 0.9, num df = 26, denom df = 19, p-value = 0.7895
## alternative hypothesis: true ratio of variances is not equal to 1
## 95 percent confidence interval:
## 0.3703635 2.0644894
## sample estimates:
## ratio of variances
## 0.8999957
```

Since $p > 0.05$, we have sufficient evidence to conclude that the variances of the female and male groups are approximately equal.

1d) Based on your conclusion of Part 3), conduct an appropriate two-sample t test. Is there sufficient evidence to claim that women talk more than men, on average? Use significance level $\alpha = 0.05$. (8 points)

Solution:

```
t.test(talk2.female, talk2.male, alternative = "greater", conf.level = 0.95, var.equal = TRUE)

##
## Two Sample t-test
##
## data: talk2.female and talk2.male
## t = 1.5192, df = 45, p-value = 0.06785
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
## -382.8035      Inf
## sample estimates:
## mean of x mean of y
## 16496.11 12866.70
```

4-Step H.T.

Hypothesis: $H_0 : \mu_{female} = \mu_{male}$ vs. $H_a : \mu_{female} > \mu_{male}$

Test statistic: $t_0 = \frac{\bar{x} - \mu_0}{s/\sqrt{n}} = 1.5192$

P-value: $P(T < t_0) = 0.06785$

Conclusion: Fail to reject H_0 , since p-value > 0.05 . So, this means that we do not have sufficient evidence to claim that women talk more than men.

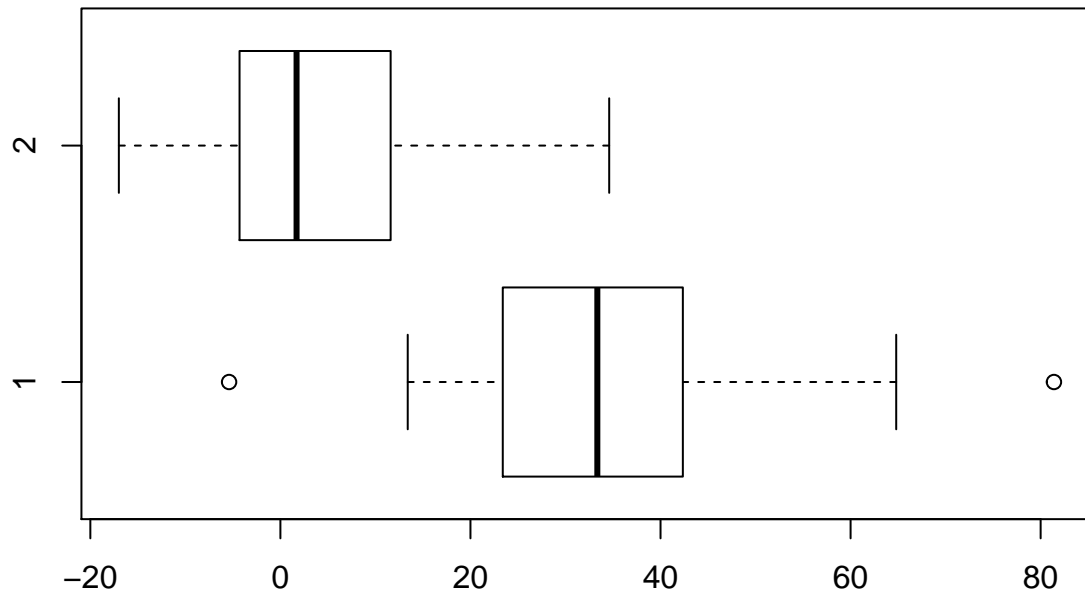
Problem 2: Adolescent obesity. (15 points)

2a) Make side-by-side boxplot for both samples. (7 points)

Solution:

```
adobese <- read.table("C:/Users/gordo/Desktop/adobese.txt", header = TRUE) #read in adobese.txt
adobese.banding <- adobese$Loss[adobese$Treatment == "banding"]
adobese.lifestyle <- adobese$Loss[adobese$Treatment == "lifestyle"]

boxplot(adobese.banding, adobese.lifestyle, horizontal = TRUE)
```



- 1) Are there any obvious deviation from normality? Yes, upon looking at the boxplot for the gastric banding group, there is a upper outlier, which inadvertently implies that the distribution is not symmetric, but rather right-skewed. While, it is important to note that the distribution of the lifestyle group does appear to be rather symmetric.
- 2) Which sample has more loss in general? (2 points) In general, it appears that the gastric banding group has more loss.

2b) Conduct a general two-sample t procedure (no equal-variance assumption). (8 points)

Solution:

```
t.test(adobese.banding, adobese.lifestyle, alternative = "greater", conf.level = 0.95)
```

```
##
## Welch Two Sample t-test
##
## data: adobese.banding and adobese.lifestyle
## t = 6.5866, df = 39.983, p-value = 3.551e-08
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
## 23.71168 Inf
## sample estimates:
## mean of x mean of y
```

34.866667 3.011111

4-Step H.T.

Hypothesis: $H_0 : \mu_{banding} = \mu_{lifestyle}$ vs. $H_a : \mu_{banding} > \mu_{lifestyle}$

Test statistic: $t_0 = 6.5866$

P-value: $P(T < t_0) = 3.551e-08$

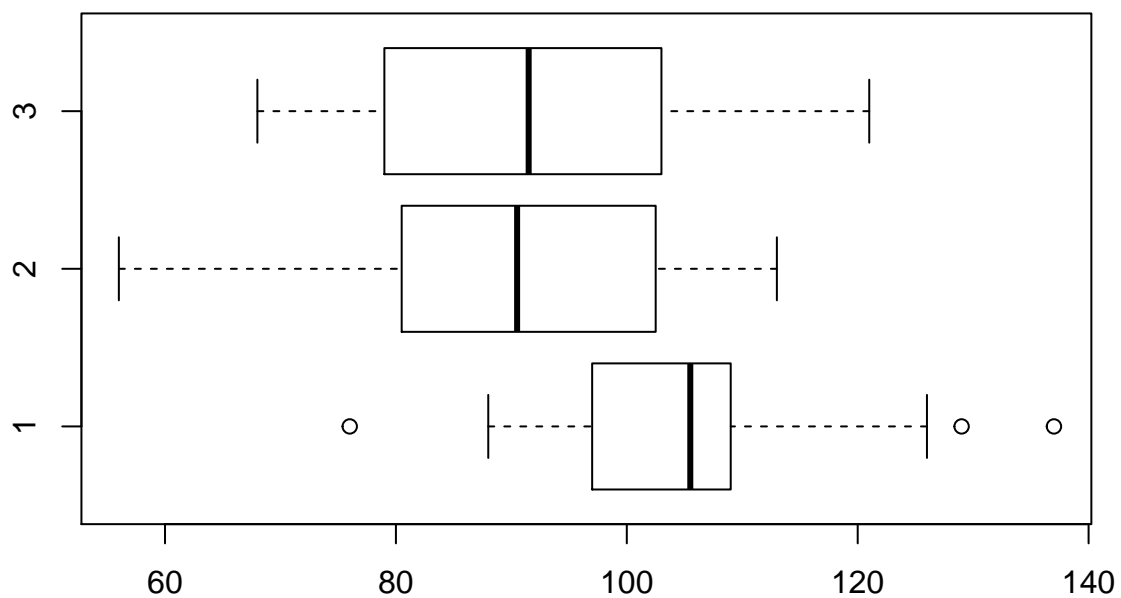
Conclusion: Reject H_0 , since p-value < 0.05 . So, this means that we have sufficient evidence to conclude there the weight loss of the gastric banding group significantly greater than that of the lifestyle group.

Problem 3: Do good smells bring good business? (25 points)

3a) Make a side-by-side boxplot to compare the customer times for each evening. Do any of the distributions show outliers, strong skewness, or other clear deviations from normality? (10 points)

Solution:

```
odors <- read.table("C:/Users/gordo/Desktop/odors.txt", header = TRUE) #read in odors.txt
odors.lavender <- odors$Time[odors$Odor == "lavender"]
odors.lemon <- odors$Time[odors$Odor == "lemon"]
odors.noodor <- odors$Time[odors$Odor == "noodor"]
boxplot(odors.lavender, odors.lemon, odors.noodor, horizontal = TRUE)
```



It seems that the “lavender” and “lemon” groups have similar variances, however the “no odor” group has a significantly different variance. Additionally, based on the boxplots, it appears, that there are 3 outliers for the “no odor” group, in particular, it appears that the data from the “no odor” group has a strong right-skew. Thus, for the “no odor” group, it appears there is a clear deviation from normality.

3b) Conduct an ANOVA F test using R function. (15 points)

Solution:

```
anova(lm(odors$Time ~ odors$Odor))

## Analysis of Variance Table
##
## Response: odors$Time
##           Df Sum Sq Mean Sq F value    Pr(>F)
## odors$Odor  2   4569  2284.51   10.861 6.302e-05 ***
## Residuals  85   17879   210.34
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

- a) Are the means of the three populations the same? Write down the four-step hypothesis test based on the R output (10 points) 4-Step H.T.

Hypothesis: $H_0 : \mu_{lavender} = \mu_{lemon} = \mu_{noodor}$

H_a : Not all the μ_i 's are equal. $\mu_i \neq \mu_j$ for some $i, j \in \text{lavender, lemon, noodor}$ and $i \neq j$

Test statistic: $F_0 = \frac{MSG}{MSE} = 10.861$

P-value: $P(F_{I-1, N-I} > F_0) = 6.302e-05$

Conclusion: Since the p-value is 6.302e-05, we reject the null at the significance level 0.01, and conclude that not all the means are equal. In other words, we have sufficient evidence to conclude that there is a difference in the amount of the time spent using different smells.

- b) Is “Lavender” significantly different with “No Odor”? (2 points)

```
odors$Odor <- relevel(odors$Odor, ref = "lavender") #redefine reference level
summary(lm(odors$Time ~ odors$Odor), data = odors) #print out result of pairwise test

##
## Call:
## lm(formula = odors$Time ~ odors$Odor)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -33.786  -9.200   0.257   9.875  31.300
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)    105.700      2.648  39.919 < 2e-16 ***
## odors$Odorlemon  -15.914      3.811  -4.176 7.15e-05 ***
```

```
## odors$Odornoodor -14.433      3.745 -3.854 0.000225 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 14.5 on 85 degrees of freedom
## Multiple R-squared:  0.2035, Adjusted R-squared:  0.1848
## F-statistic: 10.86 on 2 and 85 DF,  p-value: 6.302e-05
```

Yes, if we regard the lavender group as the reference group, then by performing the pairwise test alongside the no odor group, the p-value is significantly less than 0.01. Thus, we can conclude that the lavender group and no odor group are significantly different.

c) Is “Lemon” significantly different with “No Odor”? (3 points)

```
odors$Odor <- relevel(odors$Odor, ref = "lemon") #redefine reference level
summary(lm(odors$Time ~ odors$Odor), data = odors) #print out result of pairwise test
```

```
##
## Call:
## lm(formula = odors$Time ~ odors$Odor)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -33.786  -9.200   0.257   9.875  31.300
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)      89.786      2.741  32.759 < 2e-16 ***
## odors$Odorlavender  15.914      3.811   4.176 7.15e-05 ***
## odors$Odornoodor    1.481      3.811   0.389  0.699
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 14.5 on 85 degrees of freedom
## Multiple R-squared:  0.2035, Adjusted R-squared:  0.1848
## F-statistic: 10.86 on 2 and 85 DF,  p-value: 6.302e-05
```

No, if we regard the lemon group as the reference group, then by performing the pairwise test alongside the no odor group, the p-value is significantly larger than 0.01 and 0.05. Thus, we cannot conclude that the lemon group and no odor group are significantly different.