109065707

BACS HW – Week 7

Question 1) Let's **develop some intuition** about the data and results:

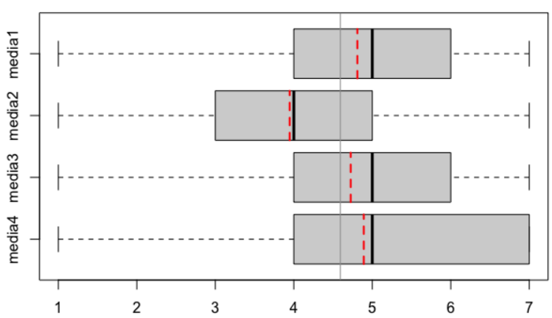
a. What are the *means* of viewers' intentions to share (INTEND.0) on each of the four media types?

```
media_list <- list()
media_list$media1 <- (read.csv("pls-media1.csv",header = TRUE))$INTEND.0
media_list$media2 <- (read.csv("pls-media2.csv",header = TRUE))$INTEND.0
media_list$media3 <- (read.csv("pls-media3.csv",header = TRUE))$INTEND.0
media_list$media4 <- (read.csv("pls-media4.csv",header = TRUE))$INTEND.0
media_means <- sapply(media_list, mean)
cat("The mean of media1 is",media_means[1],"\nThe mean of media2 is",media_means[2],"\nThe mean of media3 is",media_means[3],"\nThe mean of media4 is",media_means[4])
The mean of media1 is 4.809524
The mean of media2 is 3.947368
The mean of media3 is 4.725
The mean of media4 is 4.891304
```

b. Visualize the *distribution and mean* of intention to share, across all four media.

(Your choice of data visualization; Try to put them all on the same plot and make it look sensible)

```
boxplot(rev (media_list), horizontal=TRUE)
segments(x0=unlist(rev(media_means)), y0=c(1,2,3,4)-0.4, x1=unlist(rev(media_means)), y1=c(1,2,3,4)+0.4, lty="dashed", col="red", lwd=2)
abline(v=mean(media_means), col=8)
```



c. From the visualization alone, do you feel that media type makes a difference on intention to share?

I observe that media2 is the most different from the other three media types. Therefore, I think media type could make a difference on intention to share.

Question 2) Let's try **traditional one-way ANOVA**:

a. State the null and alternative hypotheses when comparing INTEND.0 across four groups in ANOVA

H_{null}: $The\ mean\ of\ intentions\ in\ four\ groups\ would\ be\ the\ same.$

$H_{alternative}$: $The\ mean\ of\ intentions\ in\ four\ groups\ would\ not\ be\ all\ the\ same.$

b. Let's compute the F-statistic ourselves:

i. Show the code and results of computing MSTR, MSE, and F

```
# SSTR: I use sapply to compute the length.
SSTR <- sum((sapply(media_list,length)*(sapply(media_list,mean)-mean(media_means))^2))
df_mstr <- length(media_list)-1
MSTR <- SSTR/df_mstr
SSE <- sum((sapply(media_list,length)-1)*sapply(media_list, var))
df_mse <- sum(sapply(media_list,length)) - length(media_list)
MSE <- SSE/df_mse
F <- MSTR/MSE
cat("The value (MSTR):",MSTR,"\nThe value (MSE):", MSE,"\nThe value (F):", F)
The value (MSTR): 7.53239
The value (MSE): 2.869151
The value (F): 2.625303
```

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ii. Compute the p-value of F, from the null F-distribution; is the F-value significant? If so, state your conclusion for the hypotheses.

```
F_cut <- qf(p=0.95, df1=df_mstr, df2=df_mse)
p_value <- pf(F, df_mstr, df_mse, lower.tail=FALSE)
cat("The value (F):", F,"\nThe value (F-cut):", F_cut,"\nThe p-value is",p_value)
The value (F): 2.625303
The value (F-cut): 2.660406
The p-value is 0.05230686
```

Because the p-value(=0.05230686) is larger than 0.05, I couldn't reject the null hypothesis.

c. Conduct the same one-way ANOVA using the aov() function in R – confirm that you got similar results.

```
# Create a new dataframe to combine media1,2,3,4.
m1 <- data.frame(media_num=rep("m1",42), intention=media_list$media1)
m2 <- data.frame(media_num=rep("m2",38), intention=media_list$media2)
m3 <- data.frame(media_num=rep("m3",40), intention=media_list$media3)
m4 <- data.frame(media_num=rep("m4",46), intention=media_list$media4)
medias_intention <- rbind(m1, m2, m3, m4)
summary(aov(medias_intention$intention ~factor(medias_intention$media_num)))
                                    Df  Sum Sq Mean Sq F value Pr(>F)
factor(medias_intention$media_num)  3   22.5     7.508   2.617  0.0529 .
Residuals                           162  464.8   2.869
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Yes, I got similar results.

d. Regardless of your conclusions, conduct a post-hoc Tukey test (feel free to use the TukeyHSD() function in R) to see if any *pairs of media have significantly different means* – what do you find?

```
anova_model <- aov(medias_intention$intention ~ factor(medias_intention$media_num))
TukeyHSD(anova_model, conf.level = 0.05)
              diff         lwr        upr     p adj
m2-m1 -0.86215539 -1.06562977 -0.6586810 0.1085727
m3-m1 -0.08452381 -0.28530983  0.1162622 0.9959223
m4-m1  0.08178054 -0.11218249  0.2757436 0.9959032
m3-m2  0.77763158  0.57175512  0.9835080 0.1825044
m4-m2  0.94393593  0.74470805  1.1431638 0.0573229
m4-m3  0.16630435 -0.03017708  0.3627858 0.9687417
```

From the result, I don't think there are any pairs of media that have significantly different means.

e. Do you feel the classic requirements of one-way ANOVA were met?
(Feel free to use any combination of methods we saw in class or any analysis we haven't covered)

1. Each treatment/population's **response variable is normally distributed**
2. The **variance (s^2) of the response variables is the same** for all treatments/populations
3. The **observations are independent**: the response variables are not related between groups

1. Check normally distributed

I use the Shapiro-Wilk test to check if it is normally distributed.
In the Shapiro-Wilk test, when the p-value > 0.05, it is normally distributed.
But I found that the data in these media types are **not normally distributed** because the p-value is 6.886e-08 which is smaller than 0.05.

My code:

```
shapiro.test(medias_intention$intention
data:  medias_intention$intention
W = 0.92051, p-value = 6.886e-08
```

2. Check variance is the same for multi groups

I try to use Levene's test which is an alternative to Bartlett's test when the data is not normally distributed. In Levene's test for my data, p-value is larger than 0.05 which means that the variance (s^2) of the response variables is the same.

The reference link: http://www.sthda.com/english/wiki/compare-multiple-sample-variances-in-r
My code:

```
install.packages("car")
library("car")
leveneTest(medias_intention$intention ~ medias_intention$media_num, data = medias_intention)
```

```
Levene's Test for Homogeneity of Variance (center = median)
       Df F value Pr(>F)
group   3  1.5403 0.2061
      162
Warning message:
In leveneTest.default(y = y, group = group, ...) : group coerced to factor.
```

3. From the article, it mentions that our researcher runs an experiment where each of these four alternative media is shown to a different panel of randomly assigned people.
   Therefore, I think the observations are independent.

From the previous check, only the first assumption is not met.

Question 3) Let's use the **non-parametric Kruskal Wallis** test:

a. State the null and alternative hypotheses (in terms of distribution or difference of mean ranks)

H_{null}: *The distribution of mean ranks are the same.*
$H_{alternative}$: *The distribution of mean ranks are not all the same.*

b. Let's compute (an approximate) Kruskal Wallis H ourselves:

   i. Show the code and results of computing H

```
# Rank all the combined values across groups
rank_medias <- rank(medias_intention$intention)
# combine rank into medias_intention
medias_rank <- cbind(medias_intention, rank_medias)
# split the same rank into same group
group_rank <- split(medias_rank$rank_medias, medias_rank$media_num)
group_ranksum <- sapply(group_rank, sum)
group_rank_length <- sapply(group_rank, length)
N <- sum(group_rank_length)
H <- (12 / (N * (N + 1))) * sum((group_ranksum^2) / group_rank_length) - 3 * (N + 1)
paste("H value is", H)
[1] "H value is 8.45465979544389"
```

   ii. Compute the p-value of H, from the null chi-square distribution; is the H value significant?
   If so, state your conclusion of the hypotheses.

```
kw_p <- 1 - pchisq(H, df = 4 - 1)
paste("The p-value of H is", kw_p)
[1] "The p-value of H is 0.037492918119218"
```

The p-value of H is smaller than 0.05, which means that the H value isn't significant.
I could reject the null hypothesis.

c. Conduct the same test using the kruskal.wallis() function in R – confirm that you got similar results.

```
kruskal.test(medias_rank$rank_medias ~ medias_rank$media_num, data = medias_rank)

        Kruskal-Wallis rank sum test

data:  medias_rank$rank_medias by medias_rank$media_num
Kruskal-Wallis chi-squared = 8.8283, df = 3, p-value = 0.03166
```

d. Regardless of your conclusions, conduct a post-hoc Dunn test (feel free to use the dunnTest() function from the FSA package) to see if any *pairs of media are significantly different* – what do you find?

Code:

```
dunnTest(medias_rank$rank_medias ~ medias_rank$media_num, data = medias_rank, method =
"bonferroni")
```

Thought:

I found that the p-value of the comparison (m2-m4) is 0.04542535 (<0.05) which means the pair (m2&m4) is significantly different..

```
Dunn (1964) Kruskal-Wallis multiple comparison
  p-values adjusted with the Bonferroni method.

  Comparison           Z      P.unadj       P.adj
1    m1 - m2  2.30087819 0.021398517 0.12839110
2    m1 - m3 -0.09233644 0.926430736 1.00000000
3    m2 - m3 -2.36408588 0.018074622 0.10844773
4    m1 - m4 -0.31452459 0.753122646 1.00000000
5    m2 - m4 -2.65613380 0.007904225 0.04742535
6    m3 - m4 -0.21613379 0.828883460 1.00000000
```