R Tutorial for STAT 350 Lab 8

Author: Leonore Findsen, Chunyan Sun, Sarah H. Sellke, Jeremy Troisi

Example 1: (Data Set: eduproduct.txt)

Evaluation of a New Educational Product Your company markets educational materials aimed at parents of young children. You are planning a new product that is designed to improve children's reading comprehension. Your product is based on new ideas from educational research, and you would like to claim that children will acquire better reading comprehension skills utilizing these new ideas than with the traditional approach. Your marketing material will include the results of a study conducted to compare two versions of the new approach with the traditional method.[5] The standard method is called Basal, and the two variations of the new method are called DRTA and Strat.

Education researchers randomly divided 66 children into three groups of 22. Each group was taught by one of the three methods. The response variable is a measure of reading comprehension called COMP that was obtained by a test taken after the instruction was completed.

a) Make side-by-side boxplots and an effects plot of the data. Also, make a table giving the sample size, mean, and standard deviation for each treatment group. From this information, do you think that all of the means are the same? Be sure to comment on each of the plots.

b) Examine the assumptions necessary for ANOVA. Is it appropriate to continue the analysis? Be sure to state each of the assumptions and comment on each of them using the appropriate plots/data. Remember, you need to generate the normal probability plots and histograms for each population.

c) Report the results of the ANOVA significance test (4* steps) using a significance level of 0.05. Are your results in this step consistent with part a?

d) Use an appropriate multiple-comparison method to determine if the different types of educational methods affects reading comprehension. Explain why you chose this method. Present a graphical representation of the results if appropriate for your method. Write a short statement for your conclusion.

e) Write a short report explaining the effect of this study. Be sure to answer the question posed in this question and how far this study can be generalized. This paragraph should be written in complete English sentences and should be understandable to someone who has not taken a course in Statistics.

Solution:

First you need to read in the data as before.
I named the table, 'ed'.

```
# read in the data as before
# I named my table ed
# ed has two variables: Comp is quantitative and Group is categorical

library(lattice)

# When you use the subset command, you sometimes need to drop the levels
#   that are no longer used. I strongly recommend that you use the following
#   command.
```

Author: Leonore Findsen, Chunyan Sun, Sarah H. Sellke, Jeremy Troisi

```
ed.new <- droplevels(ed)

#After you finish changing your dataset and making all of your
#   transformations, you can attach your table
attach(ed.new)

#boxplot:
# Method 1: I used the code from lattice in Lab 7
# Method 2: boxplot(numeric variable ~ categorical variable, table name)
> boxplot(Comp~Group,ed.new)

# effects plot

# the first line generates a dummy variable of the correct length with
#    value 1
# the second line generates the Effects Plot for the mean
> trace <- rep(1,length(Group))
> interaction.plot(Group,trace,Comp,fun=mean,legend=F)

#Calculating the sample size, sample mean and standard deviation
> tapply(Comp, Group, length)
> tapply(Comp, Group, mean)
> tapply(Comp, Group, sd)

#I used lattice to generate the histograms and QQ plots. See Lab 7

#ANOVA
# the command is aov(quant~qual, data = name above)
#  the Group variable (qual) has to be categorical variable
#  to print out the results, you need to use the summary command
#  note: this does not print out the 'total' line, you may calculate it
#     by hand or via R if required.
fit <- aov(Comp ~ Group, data=ed.new)
summary(fit)

#Tukey method
> test.Tukey<-TukeyHSD(fit,conf.level=0.95)
> test.Tukey
```

a) Make side-by-side boxplots and an effects plot of the data. Also, make a table giving the sample size, mean, and standard deviation for each treatment group. From this information, do you think that all of the means are the same? Be sure to comment on each of the plots.

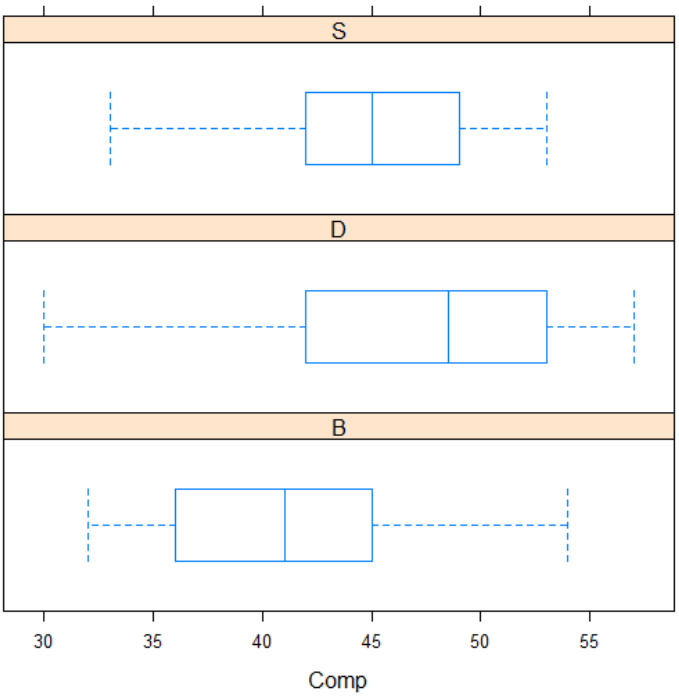
Solution:

side-by-side boxplots:

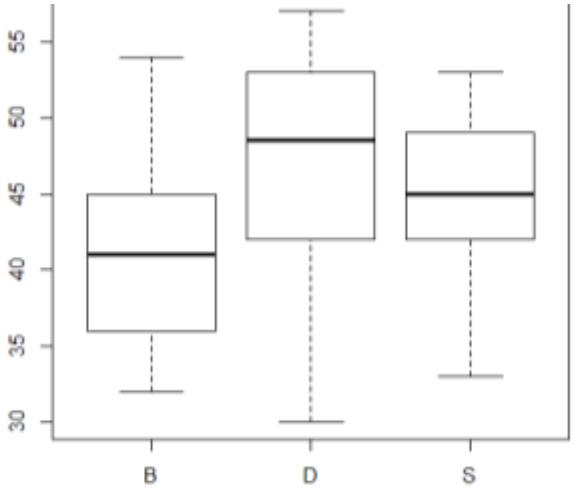
Method #1:
Note: For the layout function, layout = c(number of columns, number of rows).

R Tutorial for STAT 350 Lab 8

Author: Leonore Findsen, Chunyan Sun, Sarah H. Sellke, Jeremy Troisi



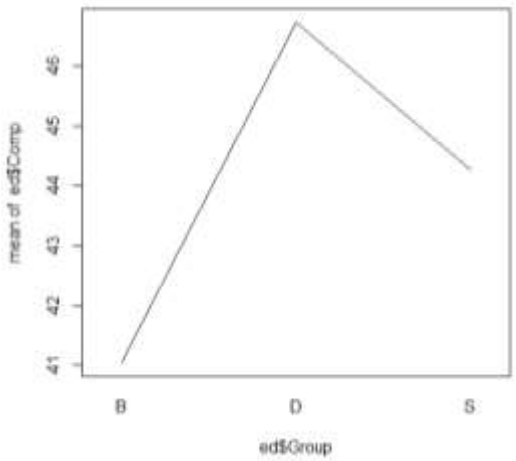
Method #2



From this plot, I would state that all of the means are close to being the same.

effects plot:

Author: Leonore Findsen, Chunyan Sun, Sarah H. Sellke, Jeremy Troisi



From the effects plot, it looks like B might be different from D and S, but it is hard to tell because of the scale.

Calculating the sample size, mean and standard deviation per category:

sample size:

```
> tapply(Comp, Group, length)
 B  D  S
22 22 22
```

mean:

```
> tapply(Comp, Group, mean)
       B        D        S
41.04545 46.72727 44.27273
```

standard deviation:

```
> tapply(Comp, Group, sd)
       B        D        S
5.635578 7.388420 5.766750
```

Group	n	sample mean	sample standard deviation
B	22	41.04545	5.635578
D	22	46.72727	7.388420
S	22	44.27273	5.766750

It appears group D is higher than the other two. Inference needs to be determine, both (c) and (d) to determine if the impressions are correct or not.

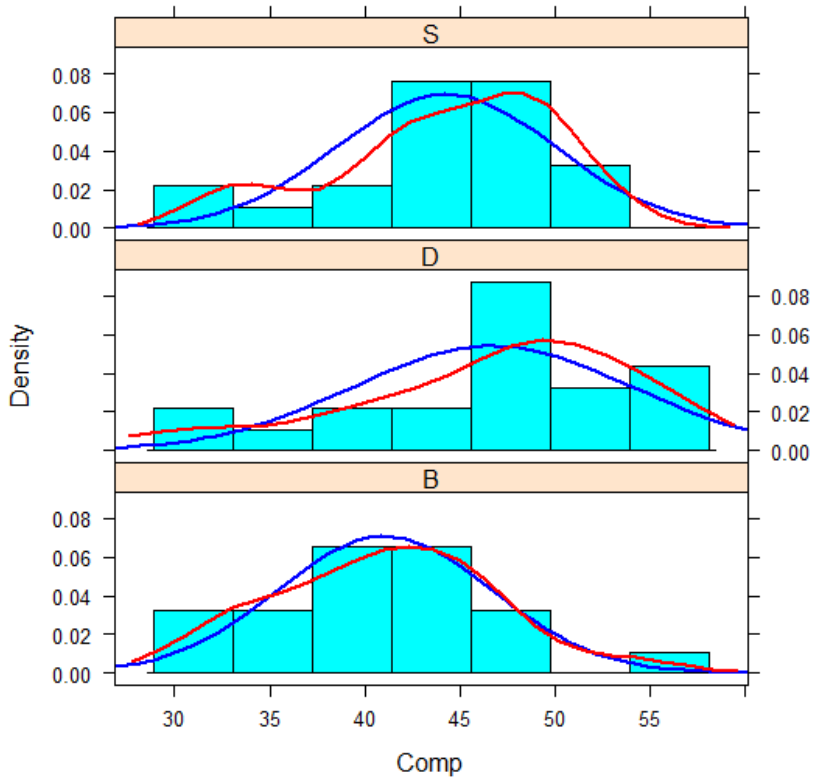
b) Examine the assumptions necessary for ANOVA. Is it appropriate to continue the analysis? Be sure to state each of the assumptions and comment on each of them using the appropriate plots/data. Remember, you need to generate the normal probability plots and histograms for each population.

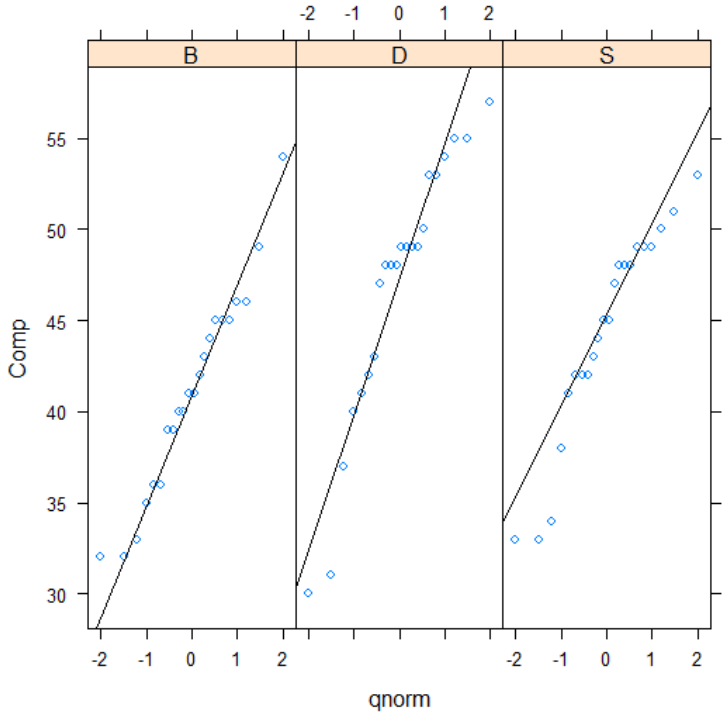
Solution:

R Tutorial for STAT 350 Lab 8

Author: Leonore Findsen, Chunyan Sun, Sarah H. Sellke, Jeremy Troisi

Normality:





Author: Leonore Findsen, Chunyan Sun, Sarah H. Sellke, Jeremy Troisi

With a sample size of 22 *3 = 66, these distributions are close enough to being normal.

Constant standard deviation

Group	n	sample mean	sample standard deviation
B	22	41.04545	5.635578
D	22	46.72727	7.388420
S	22	44.27273	5.766750

$\frac{s_{max}}{s_{min}} = \frac{7.388420}{5.635578} = 1.31 < 2$
Therefore the constant standard deviation assumption is valid.

c) Report the results of the ANOVA significance test (4* steps) using a significance level of 0.05. Are your results in this step consistent with part 1?

Solution:

```
            Df Sum Sq Mean Sq F value Pr(>F)
Group        2  357.3  178.65   4.481 0.0152 *
Residuals   63 2511.7   39.87
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

Step 1: Definition of the terms
μ_B is the population mean COMP score for the Basal method.
μ_D is the population mean COMP score for the DRTA method.
μ_S is the population mean COMP score for the Strat method.

Step 2: State the hypotheses
H_0: $\mu_B = \mu_D = \mu_S$
H_a: at least two μ_i's are different.

Step 2: Find the *Test Statistic, p-value, report DF*

F_{ts} = 4.481
DF1 = 2, DF2 = 63
P-value = 0.0152

Step 4: Conclusion:
α = 0.05
Since 0.0152 < 0.05, we should reject H_0

The data provides sufficiently strong evidence (P-value = 0.0152) to the claim that the population mean values of at least one of the education methods is different from the rest.

d) Use an appropriate multiple-comparison method to determine if the different types of educational methods affects reading comprehension. Explain why you chose this method. Present a graphical representation of the results if appropriate for your method. Write a short statement on your conclusion.

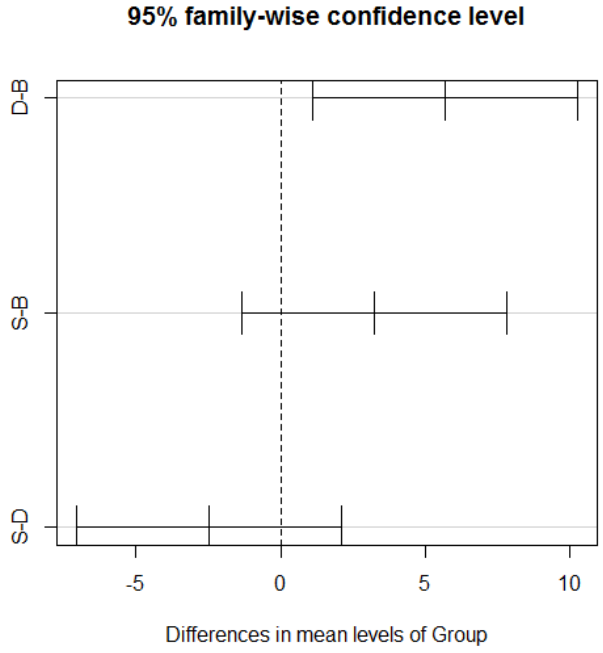
Solution:

The Tukey method was chosen because we want to compare all of the means in a pairwise fashion.

```
> test.Tukey<-TukeyHSD(fit,conf.level=0.95)
> test.Tukey

  Tukey multiple comparisons of means
    95% family-wise confidence level

Fit: aov(formula = Comp ~ Group, data = ed)

$Group
          diff       lwr       upr     p adj
D-B  5.681818  1.112137 10.251499 0.0111135
S-B  3.227273 -1.342408  7.796953 0.2149995
S-D -2.454545 -7.024226  2.115135 0.4064363
```

The following option lets you see eaiser which of the intervals contain 0. This is NOT a graphical representation of the data.

```
> plot(test.Tukey)
```



In this case, D and B are different and that B and S as well as D and S are the same.

This is easily seen using the following procedure:
1) Order the means in descending (or ascending order)
2) Draw a line when the groups are the same:

D (46.727) S (44.273) B (41.045)

Therefore the best method would be D.

e) Write a short report explaining the effect of this study. Be sure to answer the question posed in this question and how far this study can be generalized. This paragraph should be written in complete English sentences and should be understandable to someone who has not taken a course in Statistics.

From the original question, we want to determine if the new methods D and S are better than the traditional method, B. We determined that our assumptions are correct therefore, we can look at the results of the study. These results show that method S is the same as method B (traditional method). However, it can be seen that method D is better than the original method.

When answering this question, you do need to know whether a better score or a worse score is better.