Exercise 12

Homework exercise

To be solved at home before the exercise session.

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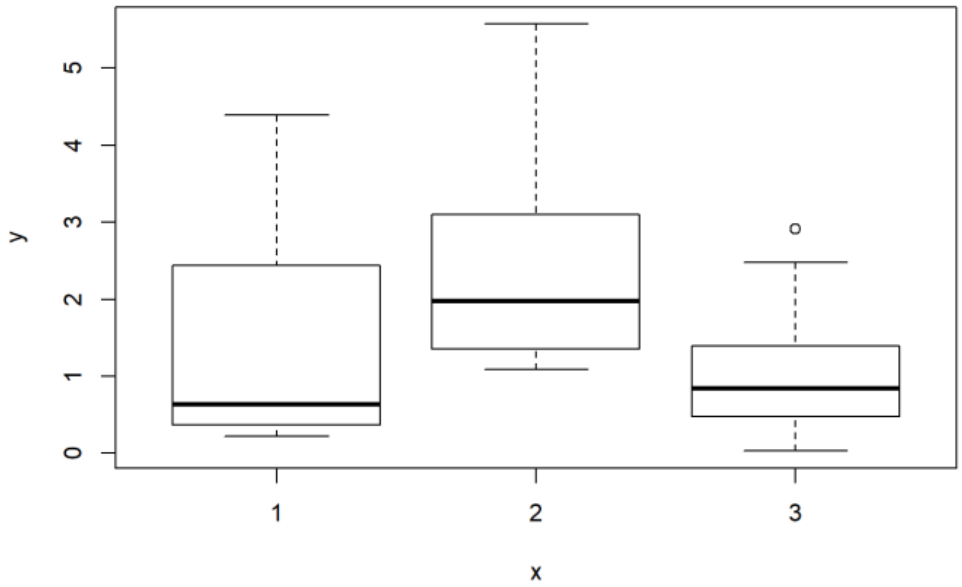
1. Consider a data set with measurements of the variable `y` for three groups (`x`). Each group has sample size 15. Below are shown boxplots of the groups, along with outputs given by ANOVA and the Kruskal-Wallis test for the data.
    a. What are the conclusions of the two tests?
    b. Which test (if either) would you trust and why?
    c. How would you continue the analysis?

```
boxplot(y ~ x, data = my_data)
```




```
summary(aov(y ~ x, data = my_data))
```

```
##             Df Sum Sq Mean Sq F value Pr(>F)
## x            1   1.13   1.129   0.586  0.448
## Residuals   43  82.89   1.928
```

```
kruskal.test(y ~ x, data = my_data)
```

```
##
##  Kruskal-Wallis rank sum test
##
## data:  y by x
## Kruskal-Wallis chi-squared = 10.185, df = 2, p-value = 0.006142
```

a. What are the conclusions of the two tests?
- Null hypothesis for ANOVA test: H0 : μ1 = μ2 = · · · = μk (no difference in mean between the sample groups)
Conclusion of ANOVA test: F-value is quite low. The expected value of the F-value is (n-k)/(n-k-2) which is (15 *3 - 3)/(15 *3 - 3 - 2) = 1.05. Since the F-value is close to the expected value, ANOVA test accepts the null hypothesis
- Null hypothesis for Kruskal-Wallis test: H0 : m1 = m2 = · · · = mk (no difference in median between the sample groups)
- Conclusion of Kruskal-Wallis test: p-value of this test is 0.006142 < alpha = 0.05, which indicates that the null hypothesis is false

b. Which test (if either) would you trust and why?
Normal / gaussian distribution should be analyzed with ANOVA while a non-normal / non-gaussian distribution should be analyzed with the Kruskal-Wallis. Moreover, Kruskal-Wallis test assumes that the distribution have the same \shape" but possibly different medians/ locations. Looking at the bar plots above, it seems that the samples do not have the same distribution => ANOVA can be trusted.

c. How would you continue the analysis?
The analysis is continued to find out which pairs are statistically significant different, using pairwise t-test. However, we should take into account of multiple test problem, where we may commit type I error => Bonferroni correction should also be applied to find out the statistically significant pairs.