Statistical Inference Course Project, Data Science Specialization on Coursera.
John Hopkins University, 2015-5-15
Kun Zhu

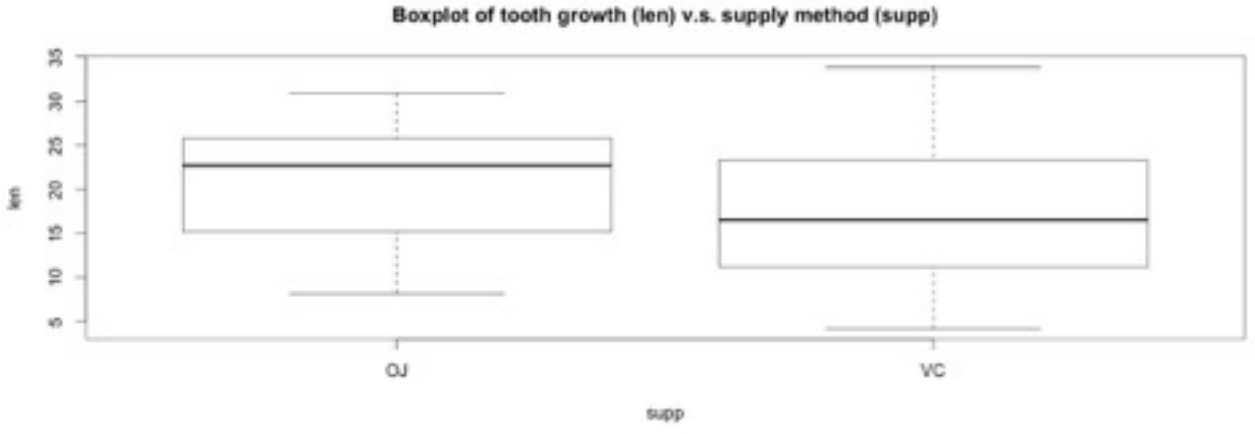
The purpose of this project assignment is to analyze the ToothGrowth data included in the R datasets package. The effectiveness of the supply methods and dose level are studied by conducting t-test. The study results suggest that the supply methods do not impact the tooth growth. On the contrary, the tooth growth can be affected by the supplied dose level.
The ToothGrowth dataset is summarized as following:

len supp dose
Min. : 4.20 OJ:30 Min. :0.500
1st Qu.:13.07 VC:30 1st Qu.:0.500
Median :19.25 Median :1.000
Mean :18.81 Mean :1.167
3rd Qu.:25.27 3rd Qu.:2.000
Max. :33.90 Max. :2.000

The tooth growth differences given different supply methods, VC and OJ, are examined in this study. The assumption is that the variances between the two groups are unequal. The null hypothesis, H0, is that the true difference in means is equal to zero. This is a weaker assumption than the case in which the variances are assumed to be equal. The results of t-test is as following:

Welch Two Sample t-test
data: len by supp
t = 1.9153, df = 55.309, p-value = 0.06063
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
-0.1710156 7.5710156
sample estimates:
mean in group OJ mean in group VC
20.66333 16.96333

The p-value, 0.06, is larger than the default percent confidence interval, 0.05. Therefore, the hypothesis testing fails to reject the null hypothesis H0. In addition, zero lies within the calculated 95 percent confidence interval, -0.171 and 7.571. This also suggests that the possibility that the studied supply methods have the same effect on tooth growth CANNOT be ruled out. The mean and variance of length of tooth give different supply methods are presented the figure below.



Next, the dependency of the tooth growth on supplied dose level is examined. There are three dose levels included in the ToothGrowth data, 0.5, 1 and 2. In this study, they are compared against each other. The null hypothesis H0 is that the true difference in means is zero. The t-test results for the first group, dose 0.5 and 1 (Smaller dose - Lager dose) are provided below:

Welch Two Sample t-test
data: len by dose
t = -6.4766, df = 37.986, p-value = 1.268e-07
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
-11.983781 -6.276219
sample estimates:
mean in group 0.5 mean in group 1
10.605 19.735

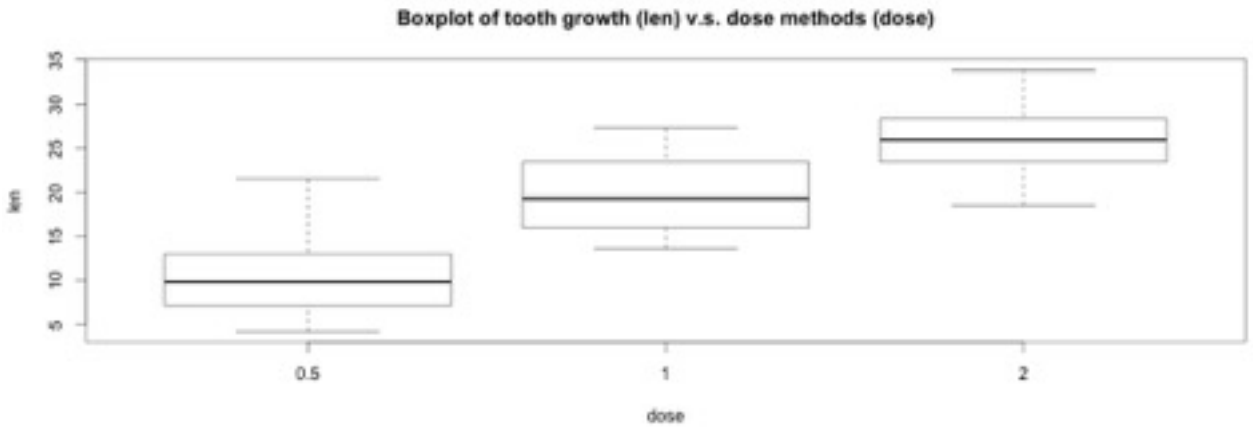
The t-test results for the second group, dose 0.5 and 2 (Smaller dose - Lager dose) are provided below:

Welch Two Sample t-test
data: len by dose
t = -11.799, df = 36.883, p-value = 4.398e-14
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
-18.15617 -12.83383
sample estimates:
mean in group 0.5 mean in group 2
10.605 26.100

The t-test results for the third group, dose 1 and 2 (Smaller dose - Lager dose) are provided below:
Welch Two Sample t-test

data: len by dose
t = -4.9005, df = 37.101, p-value = 1.906e-05
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
-8.996481 -3.733519
sample estimates:
mean in group 1 mean in group 2
19.735 26.100

The p-values from the above three groups are all smaller than 0.05. Therefore, the null hypothesis for the three study groups are all rejected with a 95 percent confidence. In addition, the calculated 95 percent confidence intervals are smaller than zero. This suggests that a higher dose level tends to increase the tooth growth. Similar trend can be observed in the box plot presented in row figure below.



In conclusion, this study suggests that supplement type has no effect on tooth growth and increasing the dose level tends to increased tooth growth. It is important to note that the data considered in the study are collected from random assignment of guinea pigs to different dose levels and supplement types. There might exit confounders that affect the above conclu

Appendix, R code

```
# ToothGrowth summary
summary(ToothGrowth)

# t-test for len and supp
t.test(len ~ supp, data = ToothGrowth)

# boxplot for len and supp
boxplot(len~supp,data=ToothGrowth, main="Boxplot of tooth growth (len) v.s. supply method
(supp)", xlab="supp", ylab="len")

# Reorgnize the data into three groups according to their dose levels
# The first group is 0.5 and 1, the second group is 0.5 and 2
# and the third group is 1 and 2.
x1 <- ToothGrowth[ToothGrowth$dose==0.5,1]
x2 <- ToothGrowth[ToothGrowth$dose==1,1]
x3 <- ToothGrowth[ToothGrowth$dose==2,1]
x_g1  <- cbind(x1,x2)
x_g2  <- cbind(x1,x3)
x_g3  <- cbind(x2,x3)

# t-test for len and three dose groups
t.test(x_g1[,1],x_g1[,2], paired=FALSE, var.equal=FALSE)
t.test(x_g2[,1],x_g2[,2], paired=FALSE, var.equal=FALSE)
t.test(x_g3[,1],x_g3[,2], paired=FALSE, var.equal=FALSE)

# boxplot for len and dose levels
boxplot(len~dose,data=ToothGrowth, main="Boxplot of tooth growth (len) v.s. dose methods
(dose)", xlab="dose", ylab="len")
```