Tooth Growth Basic Inferential Data Analysis

Kaushal Yadav

13 December 2018

Overview

The purpose of the this data analysis is to analyze the ToothGrowth data set by comparing the guinea tooth growth by supplement and dose. First, I will do exploratory data analysis on the data set. Then I will do the comparison with confidence intervals in order to make conclusions about the tooth growth.

Instruction

Analyze the ToothGrowth data in the R datasets package. Tasks

1- Load the ToothGrowth data and perform some basic exploratory data analyses 2- Provide a basic summary of the data. 3- Use confidence intervals and/or hypothesis tests to compare tooth growth by supp and dose. 4- State your conclusions and the assumptions needed for your conclusions.

Set-Up

Load required packages. Load required data: Dataset - The Effect of Vitamin C on Tooth Growth in Guinea Pigs.

```
ECHO=TRUE
library(ggplot2)
library(datasets)
data("ToothGrowth")
```

Exploring the Data

Description The response is the length of odontoblasts (teeth) in each of 10 guinea pigs at each of three dose levels of Vitamin C (0.5, 1, and 2 mg) with each of two delivery methods (orange juice or ascorbic acid).

```
str(ToothGrowth)
```

```
## 'data.frame':    60 obs. of  3 variables:
##  $ len : num  4.2 11.5 7.3 5.8 6.4 10 11.2 11.2 5.2 7 ...
##  $ supp: Factor w/ 2 levels "OJ","VC": 2 2 2 2 2 2 2 2 2 2 ...
##  $ dose: num  0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 ...
```

```
head(ToothGrowth)
```

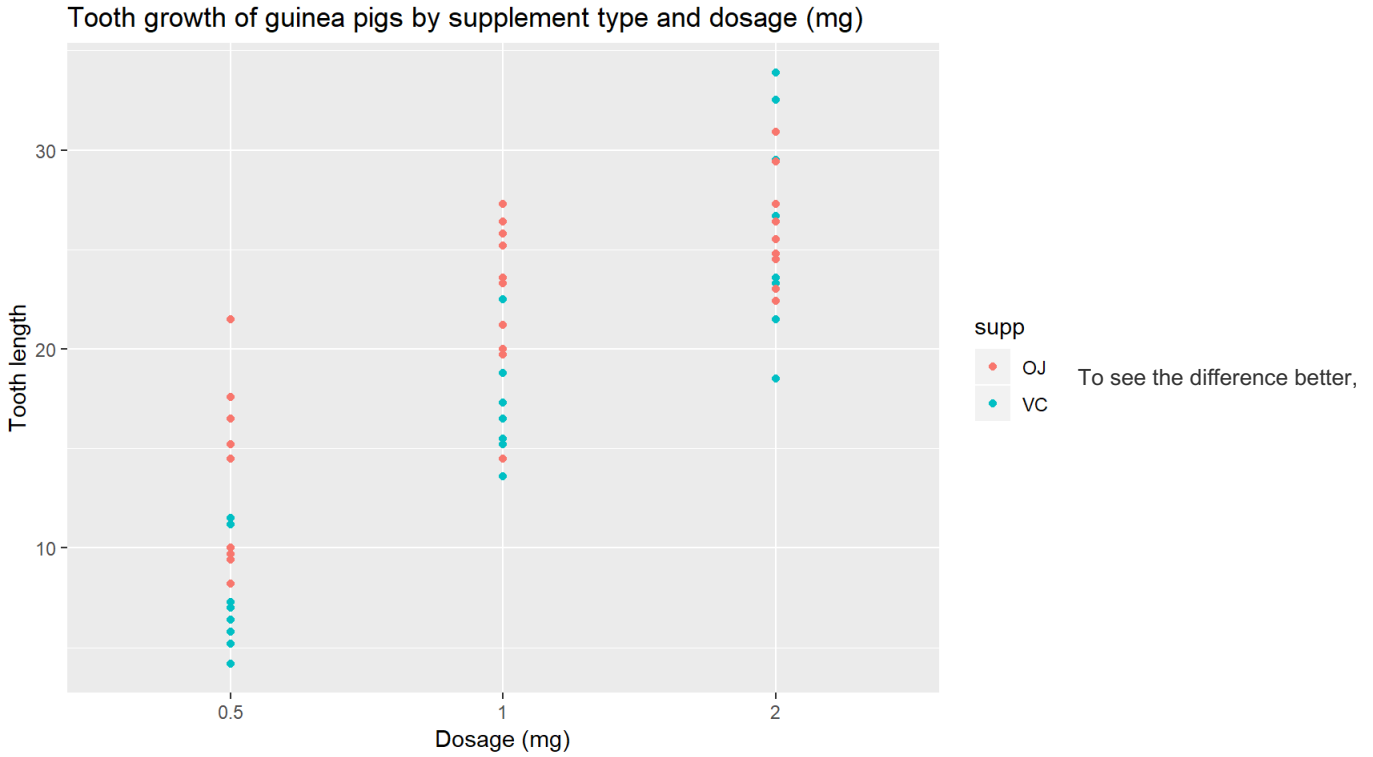
```
##    len supp dose
## 1  4.2   VC  0.5
## 2 11.5   VC  0.5
## 3  7.3   VC  0.5
## 4  5.8   VC  0.5
## 5  6.4   VC  0.5
## 6 10.0   VC  0.5
```

The data format can be improved on - and especially this will help us with the plotting: The dose variable has three levels. Therefore it makes more sense to re-format it to a factor, than keep in nummerical. So let's do that, summarize the data and make a quick plot (please note that the x-axis is now not gradually increasing, but is showing the three levels)

```
ToothGrowth$dose <- as.factor(ToothGrowth$dose)
summary(ToothGrowth)
```

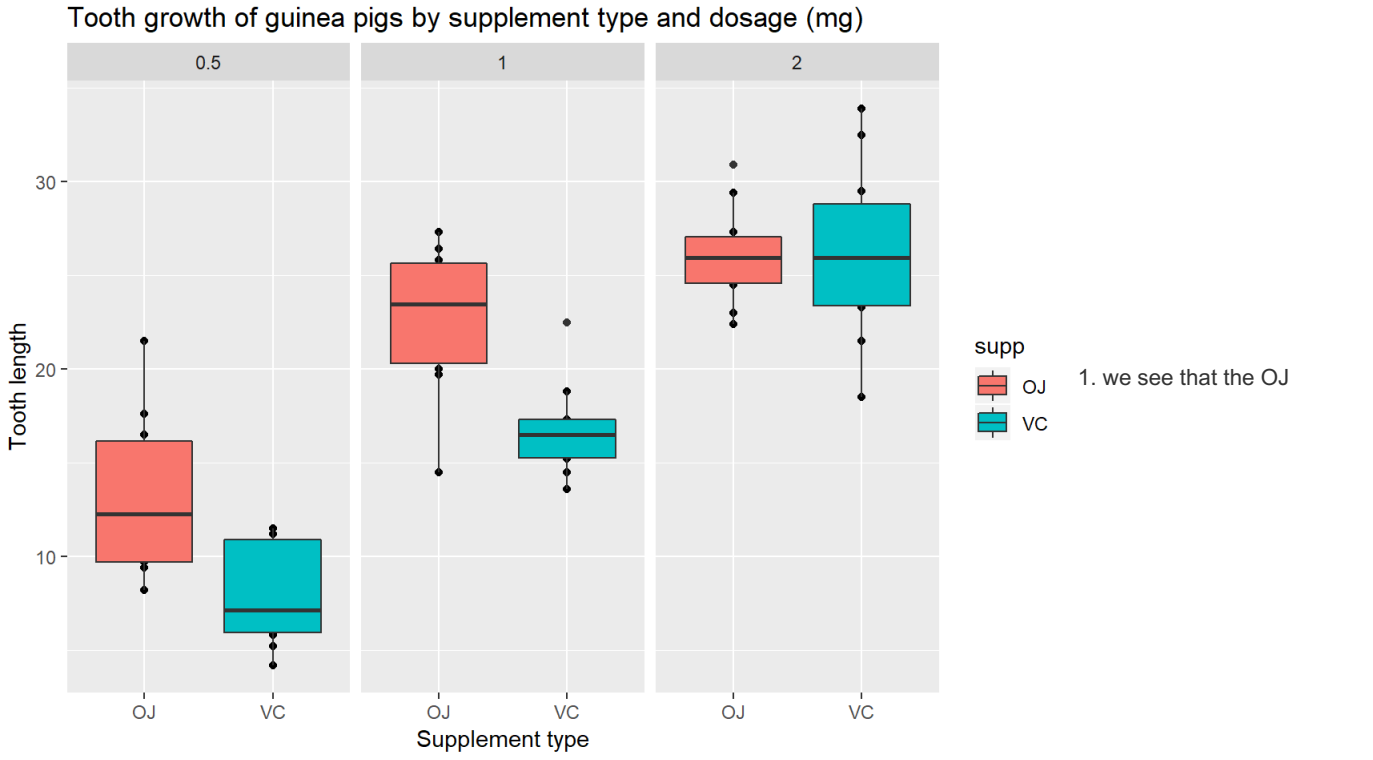
```
##       len        supp     dose
##  Min.   : 4.20   OJ:30   0.5:20
##  1st Qu.:13.07   VC:30   1  :20
##  Median :19.25           2  :20
##  Mean   :18.81
##  3rd Qu.:25.27
##  Max.   :33.90
```

```
qplot(dose ,len ,data = ToothGrowth,
      col = supp,
      main = "Tooth growth of guinea pigs by supplement type and dosage (mg)",
      xlab = "Dosage (mg)",
      ylab = "Tooth length")
```



To see the difference better, let's put the same data in a box-plot-style graph. (remark: to have the facets, it was a good idea to re-format the dose variable)

```
qplot(supp, len, data = ToothGrowth,
      facets = ~dose,
      main = "Tooth growth of guinea pigs by supplement type and dosage (mg)",
      xlab = "Supplement type",
      ylab = "Tooth length") +
        geom_boxplot(aes(fill = supp))
```



1. we see that the OJ generally is doing better in each dosage compared to VC 2. increasing the dosage (from 0.5, to 1, to 2) increased the length of the tooth, for both supplement types.

Comparing tooth growth by supp and dose

Hypothesis 1

Let H0: No difference in tooth growth given OJ or VC Ha: tooth growth is bigger when using OJ, than VC.

```
VC.length <- ToothGrowth$len[ToothGrowth$supp == "VC"]
OJ.length <- ToothGrowth$len[ToothGrowth$supp == "OJ"]
```

Student's t-Test

```
t.test(OJ.length, VC.length,
       alternative = "greater",
       paired = FALSE,
       var.equal = FALSE,
       conf.level = 0.95)
```

```
##
##  Welch Two Sample t-test
##
## data:  OJ.length and VC.length
## t = 1.9153, df = 55.309, p-value = 0.03032
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
##  0.4682687       Inf
## sample estimates:
## mean of x mean of y
##  20.66333  16.96333
```

The p-values of this comparison is p = 3%, lower than 5%. We reject the null hypothesis. So we conclude that the alternative hypothesis is true: OJ has a greater impact on tooth growth than VC.

Hypothesis 2

Let H0: No difference in growth given different doses Ha:Different growth given different doses

```
dose_0.5 <- ToothGrowth$len[ToothGrowth$dose == "0.5"]
dose_1   <- ToothGrowth$len[ToothGrowth$dose == "1"]
dose_2   <- ToothGrowth$len[ToothGrowth$dose == "2"]
```

Step 1: perform a t-test between dose_0.5 and dose_1

```
t.test(dose_0.5, dose_1,
       alternative = "less",
       paired = FALSE,
       var.equal = FALSE,
       conf.level = 0.95)
```

```
##
##  Welch Two Sample t-test
##
## data:  dose_0.5 and dose_1
## t = -6.4766, df = 37.986, p-value = 6.342e-08
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##       -Inf -6.753323
## sample estimates:
## mean of x mean of y
##    10.605    19.735
```

The p-value is very small (6.342e-8), therefore we can conclude that the null hypothesis can be rejected looking at dose_0.5 and dose_1.

Step 2: perform a t-test between dose_1 and dose_2:

```
t.test(dose_1, dose_2,
       alternative = "less",
       paired = FALSE,
       var.equal = FALSE,
       conf.level = 0.95)
```

```
##
##  Welch Two Sample t-test
##
## data:  dose_1 and dose_2
## t = -4.9005, df = 37.101, p-value = 9.532e-06
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##      -Inf -4.17387
## sample estimates:
## mean of x mean of y
##    19.735    26.100
```

Here too, the p-value is very small, therefore we can safely reject the null hypothesis. We can conclude that the higher the dosage gets, the bigger the tooth growth gets. Hence, we reject the null Hypothesis and accept the alternative hypothesis.

Conclusion

We can summarize that - there is (at least) a 95% confidence that by increasing the dosage from 0.5 to 1mg and from 1 to 2mg, increases the tooth length. - there is (at least) a 95% confidence that giving the supplement OJ (Orange Juice) increases the tooth length more significant than giving VC (Vitamin C)