JHU Statistical Inference - course project

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Contents

Overview

This report describes the outcome of my search in R and the course material to submit a solution to the course project as described above.

2: Basic Inferential Data Analysis Instructions

Now in the second portion of the project, we're going to analyze the ToothGrowth data in the R datasets package. Load the ToothGrowth data and perform some basic exploratory data analyses

```
#Load data
library(datasets)
data(ToothGrowth)

#Explore a bit
dim(ToothGrowth)     #Size of the dataset
str(ToothGrowth)     #Structure of the data
summary(ToothGrowth) #Basic summary of the dataset
head(ToothGrowth)    #First rows
tail(ToothGrowth)    #Last rows

#Statistics
for (i in 1:dim(ToothGrowth)[2]) { TG_mean[i] <- mean(ToothGrowth[,i])}
TG_mean
TG_var <- c(var(ToothGrowth[,1]), 1, var(ToothGrowth[,3]))
TG_var
TG_sd = sqrt(TG_var)
TG_sd
```

Provide a basic summary of the data.

A basic summary of the data consists of the structure and its contents.

```
str(ToothGrowth)                          #Structure of the data
```

```
## '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 ...
```

```
summary(ToothGrowth)                      #Basic summary of the dataset
```

```
##       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
```

Since ToothGrowth contains data on measured ToothLength on different cases, it's nice to know how the cases have been organised.

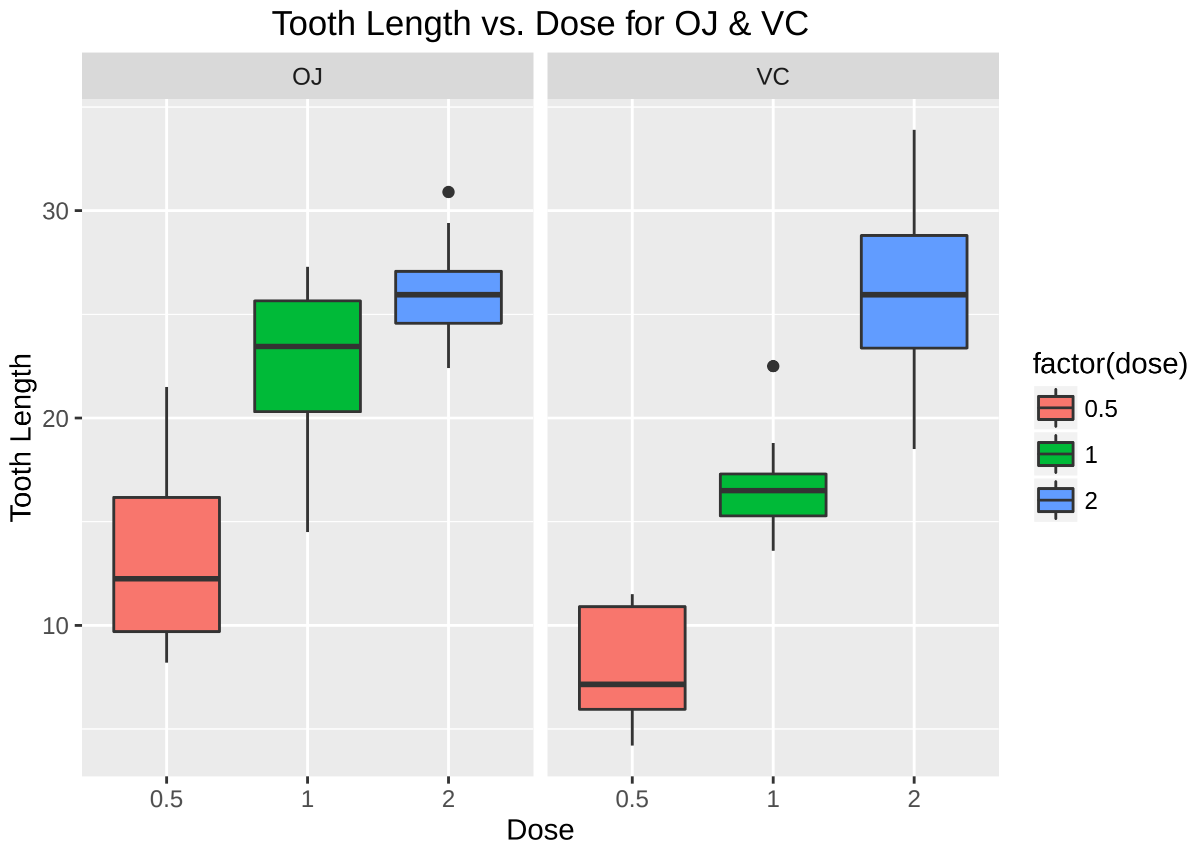
```
table(ToothGrowth$supp,ToothGrowth$dose)  #Len is the dependent variable, so let's check the structure
```

```
##     
##      0.5  1  2
##   OJ  10 10 10
##   VC  10 10 10
```

Use confidence intervals and/or hypothesis tests to compare tooth growth by supp and dose.

Let's plot the data first, explaining ToothLength by the two variables Supp and Dose.

```
#Boxplot graph of the tooth length vs the dose
library(ggplot2)
ggplot(ToothGrowth, aes(x = factor(dose), y = len, fill = factor(dose)))+
      geom_boxplot()+
      facet_grid(.~supp)+
      labs(title = "Tooth Length vs. Dose for OJ & VC",
      x = "Dose", y = "Tooth Length")
```



The Box plot suggests that
- for supp OJ there's a non-linear relationship between ToothLength and the doubling of the dose (decreasing merits);
- for supp VC there seems to be a linear relationship betweeen ToothLength and the doubling of te dose;
- OJ seems to support ToothGrowth better than VC with dose smaller than 2.

Let's focus on the last one.

Effect of supp VC and OJ on ToothLength given dose x

We need to test for each dose wether there's a difference in effect between the two supplements. Given the Boxplot we should assume different variance between the two experiments.

So we need a two-sided t-test on wether the difference of the means equals zero or not.

Dose 0.5

```
#Test dose 0.5
dose05 <- ToothGrowth[ToothGrowth$dose == 0.5, ]
t.test(len ~ supp, paired=FALSE, var.equal=FALSE, data=dose05)
```

```
##
##  Welch Two Sample t-test
##
## data:  len by supp
```

```
## t = 3.1697, df = 14.969, p-value = 0.006359
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  1.719057 8.780943
## sample estimates:
## mean in group OJ mean in group VC
##            13.23             7.98
```

We have a 95% confidence interval that does not contain 0, telling us to believe that supp. OJ performs statistically significantly better than supp. VC with dose 0.50.

Dose 1.0

```r
#Test dose 1.0
dose10 <- ToothGrowth[ToothGrowth$dose == 1.0, ]
t.test(len ~ supp, paired=FALSE, var.equal=FALSE, data=dose10)
```

```
##
##  Welch Two Sample t-test
##
## data:  len by supp
## t = 4.0328, df = 15.358, p-value = 0.001038
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  2.802148 9.057852
## sample estimates:
## mean in group OJ mean in group VC
##            22.70            16.77
```

We have a 95% confidence interval that does not contain 0, telling us to believe that supp. OJ performs statistically significantly better than supp. VC with dose 1.0.

Dose 2.0

```r
#Test dose 2.0
dose20 <- ToothGrowth[ToothGrowth$dose == 2.0, ]
t.test(len ~ supp, paired=FALSE, var.equal=FALSE, data=dose20)
```

```
##
##  Welch Two Sample t-test
##
## data:  len by supp
## t = -0.046136, df = 14.04, p-value = 0.9639
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -3.79807  3.63807
## sample estimates:
## mean in group OJ mean in group VC
##            26.06            26.14
```

Now we have a 95% confidence interval that does contain 0, telling us to believe that supp. OJ and supp. VC perform statistically equally with dose 2.0.

Effect of doubling the dose on ToothLength given supp y

We need to test for each supplement wether there's a difference in effect in doubling the dose. Given the Boxplot we should assume different variance between the two experiments.

So we need a two-sided t-test on wether the difference of the means equals zero or not.

Supp OJ

```
#Create subsets of the data
OJ05 <- ToothGrowth[ToothGrowth$supp == 'OJ' & ToothGrowth$dose == 0.5, ]
OJ10 <- ToothGrowth[ToothGrowth$supp == 'OJ' & ToothGrowth$dose == 1.0, ]
OJ20 <- ToothGrowth[ToothGrowth$supp == 'OJ' & ToothGrowth$dose == 2.0, ]

t.test(OJ05$len, OJ10$len, paired=FALSE, var.equal=FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  OJ05$len and OJ10$len
## t = -5.0486, df = 17.698, p-value = 8.785e-05
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -13.415634  -5.524366
## sample estimates:
## mean of x mean of y
##     13.23     22.70
```

```
t.test(OJ10$len, OJ20$len, paired=FALSE, var.equal=FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  OJ10$len and OJ20$len
## t = -2.2478, df = 15.842, p-value = 0.0392
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -6.5314425 -0.1885575
## sample estimates:
## mean of x mean of y
##     22.70     26.06
```

We have 95% confidence intervals that do not contain 0, telling us to believe that doubling the dose with supp. OJ performs statistically significantly better starting with dose 0.50 up to dose 2.0.

Supp VC

```
#Create subsets of the data
VC05 <- ToothGrowth[ToothGrowth$supp == 'VC' & ToothGrowth$dose == 0.5, ]
VC10 <- ToothGrowth[ToothGrowth$supp == 'VC' & ToothGrowth$dose == 1.0, ]
VC20 <- ToothGrowth[ToothGrowth$supp == 'VC' & ToothGrowth$dose == 2.0, ]

t.test(VC05$len, VC10$len, paired=FALSE, var.equal=FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  VC05$len and VC10$len
## t = -7.4634, df = 17.862, p-value = 6.811e-07
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -11.265712  -6.314288
## sample estimates:
## mean of x mean of y
##      7.98     16.77
```

```r
t.test(VC10$len, VC20$len, paired=FALSE, var.equal=FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  VC10$len and VC20$len
## t = -5.4698, df = 13.6, p-value = 9.156e-05
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -13.054267  -5.685733
## sample estimates:
## mean of x mean of y
##     16.77     26.14
```

We have 95% confidence intervals that do not contain 0, telling us to believe that doubling the dose with supp. VC performs statistically significantly better starting with dose 0.50 up to dose 2.0.

Conclusions and Assumptions

Conclusions

- Pigs given the OJ supplement at 0.5 and 1.0 dosages have significantly faster tooth growth than guinea pigs given VC at the same doses;
- Pigs given OJ or VC at a dose of 2.0 do not have significantly different tooth growth;
- Doubling supplement dosage significantly increases tooth growth (proven untill dose 2.0).

Assumptions

- The variances between the sample popluations are not equal;
- The sample data is not paired;
- The sample population distribution is mound shaped and not skewed.