Tooth Growth Data Analysis.

Hsin-Yu Cheng
July 26, 2015

Introduction

The goal of the project is to explore and analyze the ToothGrowth data in the R. Also, to process hypothesis tests to compare tooth growth by supplement and dose.

ToothGrowth data is the effect of vitamin C on tooth growth in guinea pigs. It contains 60 observations and 3 variables:

1. len : tooth length of guinea pigs.
2. supp : supplement type (VC or OJ).
3. dose : dose in milligrams.

Load Packages

```
library(ggplot2)
library(dplyr)
library(tidyr)
knitr::opts_chunk$set(comment = NA, message = F, cache=TRUE)
```

Exploratory Data Analysis

Data Summary and Transformation

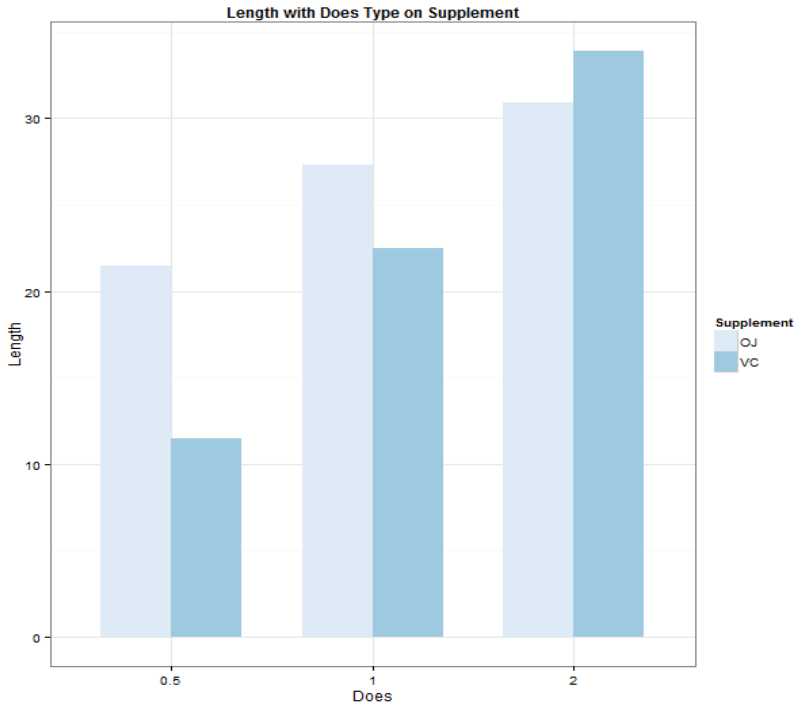
```
Tooth <- ToothGrowth %>%
  mutate(dose = as.factor(dose),
         supp = as.factor(supp)) %>%
  rename(length = len, Supplement = supp)

summary(Tooth)
```

```
     length      Supplement  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
```

- The does variable containa 3 different doeses, 0.5, 1, and 2 milligrams respectively.
- There are two type supplement. Orange juice(OJ) contains 30 sample size and ascorbic acid(VC) contains 30 sample size.

Descriptive Exploration

```
ggplot(Tooth, aes(x = dose, y = length, fill = Supplement)) +
  geom_bar(stat = "identity", position = "dodge", width=0.7) +
  theme_bw() +
  scale_fill_brewer() +
  ylab("Length") +
  xlab("Does") +
  ggtitle("Length with Does Type on Supplement") +
  theme(plot.title = element_text(lineheight=.8, face="bold", size = 12))
```



- As can be seen from the graph, it shows a positive trend with does on two supplement. When the does increases, the length also increases on the supplement of orange juice and ascorbic acid.
- In general, the length with orange juice supplement is higher than that with ascorbic acid supplement. However, with 2 milligrams, it shows opposite length result.
- In the following hypothesis, we will test the does achieves significate different effect on tooth length. Also, we will test whether supplement type would influence tooth lenght with the statistical difference.

Hypothesis Tests

T distribution is used for the hypothesis tests. We **assume** that guinea pigs were randomly assigned to one of the groups and they were sampled from a nearly normal population.

Tooth length with 3 doeses.

```
does <- Tooth %>%
  select(-Supplement) %>%
  mutate(dose = ifelse(dose == "0.5","dose_level1",
                       ifelse(dose == "1", "dose_level2","dose_level3"))) %>%
  spread(dose, length)

level1 <- does %>% select(dose_level1) %>% filter(!is.na(dose_level1))
level2 <- does %>% select(dose_level2) %>% filter(!is.na(dose_level2))
level3 <- does %>% select(dose_level3) %>% filter(!is.na(dose_level3))

dose_data <- cbind(level1, level2, level3)

t.test(dose_data$dose_level1 , dose_data$dose_level2, paired = FALSE)
t.test(dose_data$dose_level1 , dose_data$dose_level3, paired = FALSE)
t.test(dose_data$dose_level2 , dose_data$dose_level3, paired = FALSE)
```

- As can be seen from the t-test result (in Appendix, page 4) , the p values between dosese are all smaller than 0.05%, which means that they all achieve significate level and null hypothesis is rejected. The length means are significantly different between different dose with 0.5, 1, and 2 milligrams.

Tooth length with 2 supplement.

```
t.test(length ~ Supplement, Tooth, var.equal = FALSE)

    Welch Two Sample t-test

data:  length by Supplement
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
```

- As can be seen from the t-test result, the p value is 0.06, which is larger that 0.05. It does not achieve significant difference and the null hypothesis is not rejected. It means that the length mean show no significantly difference betwee orange juice and ascorbic acid.

Conclusions

The mean of tooth length are significantly different between 3 level dose, namely 0.5, 1, and 2 milligrams. However, it does not show difference when using orange juice and ascorbic acid.

Appendix

```
t.test(dose_data$dose_level1 , dose_data$dose_level2, paired = FALSE)
```

```
    Welch Two Sample t-test
data:  dose_data$dose_level1 and dose_data$dose_level2
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 of x mean of y
   10.605    19.735
```

```
t.test(dose_data$dose_level1 , dose_data$dose_level3, paired = FALSE)
```

```
    Welch Two Sample t-test
data:  dose_data$dose_level1 and dose_data$dose_level3
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 of x mean of y
   10.605    26.100
```

```
t.test(dose_data$dose_level2 , dose_data$dose_level3, paired = FALSE)
```

```
    Welch Two Sample t-test
data:  dose_data$dose_level2 and dose_data$dose_level3
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 of x mean of y
   19.735    26.100
```