Statistical Inference 2

Ajith Masthan

May 17, 2020

Statistical Inference Part-2

Overview

ToothGrowth data is loaded and some basic exploratory data analyses is peformed Basic Summarixations of the data is done Confidence intervals and/or hypothesis tests are used to compare tooth growth by supp and dose. The finally few conclusions are made along with assumptions needed for those conclusions.

Data Import

```
# Libraries
library(ggplot2)
library(datasets)
library(gridExtra)
library(GGally)
```

```
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg   ggplot2
```

```
# Vitamin C effect on Tooth Growth in Guinea Pigs
data(ToothGrowth)
toothGrowth <- ToothGrowth
toothGrowth$dose <- as.factor(toothGrowth$dose)
```

Summaries

```
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: Factor w/ 3 levels "0.5","1","2": 1 1 1 1 1 1 1 1 1 1 ...
```

```
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
```

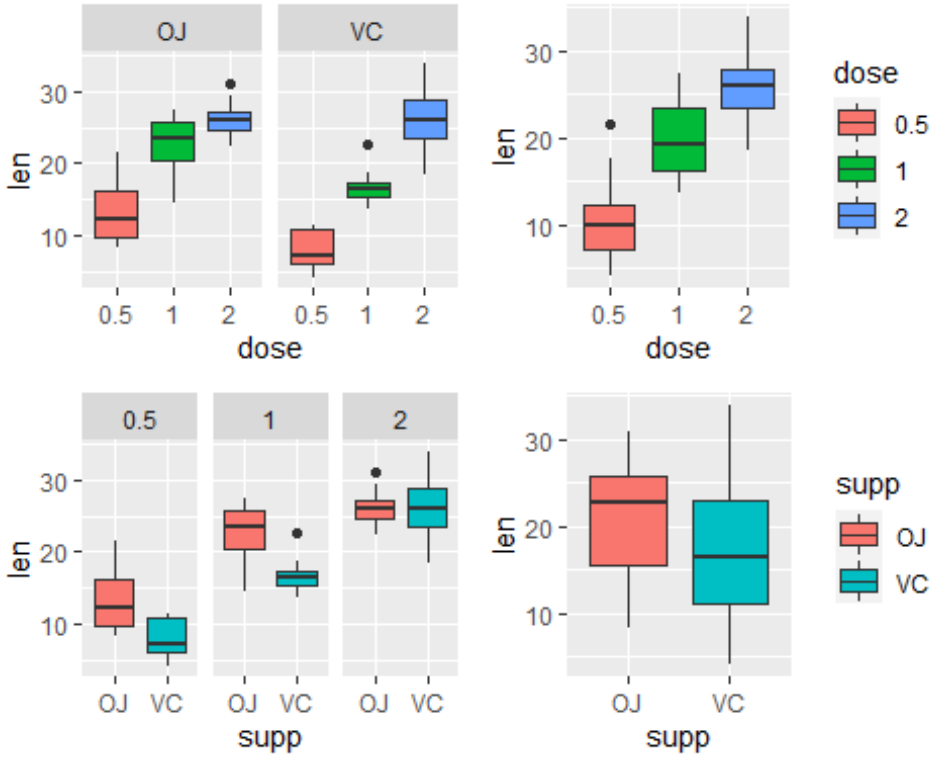
```
head(toothGrowth)
```

```
##    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
```

```
table(toothGrowth$supp, toothGrowth$dose)
```

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



Analysis of Variance (ANOVA)

```
anova.out <- aov(len ~ supp * dose, data=toothGrowth)
summary(anova.out)
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)
## supp         1  205.4   205.4  15.572 0.000231 ***
## dose         2 2426.4  1213.2  92.000  < 2e-16 ***
## supp:dose    2  108.3    54.2   4.107 0.021860 *
## Residuals   54  712.1    13.2
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

Observation: There is a relationship between the length (len) and dosage (dose) ($F(1,54)=15.572; p<0.01$) length(len) and supplement type (supp) ($F(2,54)=92; p<0.01$). Combination of supplement type (supp) and dosage (dose) compared to the length (len) ($F(2,54)=4.107; p<0.05$).

```
TukeyHSD(anova.out)
```

```
##   Tukey multiple comparisons of means
##     95% family-wise confidence level
##
## Fit: aov(formula = len ~ supp * dose, data = toothGrowth)
```

```
##
## $supp
##       diff       lwr       upr     p adj
## VC-OJ -3.7 -5.579828 -1.820172 0.0002312
##
## $dose
##         diff       lwr       upr   p adj
## 1-0.5  9.130  6.362488 11.897512 0.0e+00
## 2-0.5 15.495 12.727488 18.262512 0.0e+00
## 2-1    6.365  3.597488  9.132512 2.7e-06
##
## $`supp:dose`
##                 diff        lwr        upr     p adj
## VC:0.5-OJ:0.5 -5.25 -10.048124 -0.4518762 0.0242521
## OJ:1-OJ:0.5    9.47   4.671876 14.2681238 0.0000046
## VC:1-OJ:0.5    3.54  -1.258124  8.3381238 0.2640208
## OJ:2-OJ:0.5   12.83   8.031876 17.6281238 0.0000000
## VC:2-OJ:0.5   12.91   8.111876 17.7081238 0.0000000
## OJ:1-VC:0.5   14.72   9.921876 19.5181238 0.0000000
## VC:1-VC:0.5    8.79   3.991876 13.5881238 0.0000210
## OJ:2-VC:0.5   18.08  13.281876 22.8781238 0.0000000
## VC:2-VC:0.5   18.16  13.361876 22.9581238 0.0000000
## VC:1-OJ:1     -5.93 -10.728124 -1.1318762 0.0073930
## OJ:2-OJ:1      3.36  -1.438124  8.1581238 0.3187361
## VC:2-OJ:1      3.44  -1.358124  8.2381238 0.2936430
## OJ:2-VC:1      9.29   4.491876 14.0881238 0.0000069
## VC:2-VC:1      9.37   4.571876 14.1681238 0.0000058
## VC:2-OJ:2      0.08  -4.718124  4.8781238 1.0000000
```

Observation : There are significant differences between each of the groups in supp and dose Only the interactions between VC:0.5-OJ:0.5; VC:1-OJ:0.5; OJ:2-OJ:1; VC:2-OJ:1 and VC:2-OJ:2 are not significant

```
confint(anova.out)
```

```
##                   2.5 %    97.5 %
## (Intercept)  10.9276907 15.532309
## suppVC       -8.5059571 -1.994043
## dose1         6.2140429 12.725957
## dose2         9.5740429 16.085957
## suppVC:dose1 -5.2846186  3.924619
## suppVC:dose2  0.7253814  9.934619
```

```
print(model.tables(anova.out,"means"),digits=3)
```

```
## Tables of means
## Grand mean
##
## 18.81333
##
##  supp
## supp
##    OJ    VC
## 20.66 16.96
##
##  dose
## dose
```

```
##   0.5     1     2
## 10.60 19.73 26.10
##
##  supp:dose
##     dose
## supp 0.5   1     2
##   OJ 13.23 22.70 26.06
##   VC  7.98 16.77 26.14
```

Conclusions

Supplement and the dosage have clear individual effects on the length of teeth in guinea pigs. More the means on average longer teeth. Supplement type has a clear influence but OJ has a greater avarage teethgrowth in combination with dosages 0.5 and 1 then for the VC supplement. While teeth length for the VC supplement vs the OJ in combiantion with dosage 2 has no significant effect (almost same mean & same confidence interval)

These conclusions are based on the assumptions of the facts that

- The guinea pigs are repesentative for the population of guinea pigs,
- The dosage and supplement were randomly assigned and
- The distribution of the means is normal.