Statistical_inference_2

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Using `ToothGrowth` data and compare odontoblasts growth by `supp` and `dose`

Basic summary

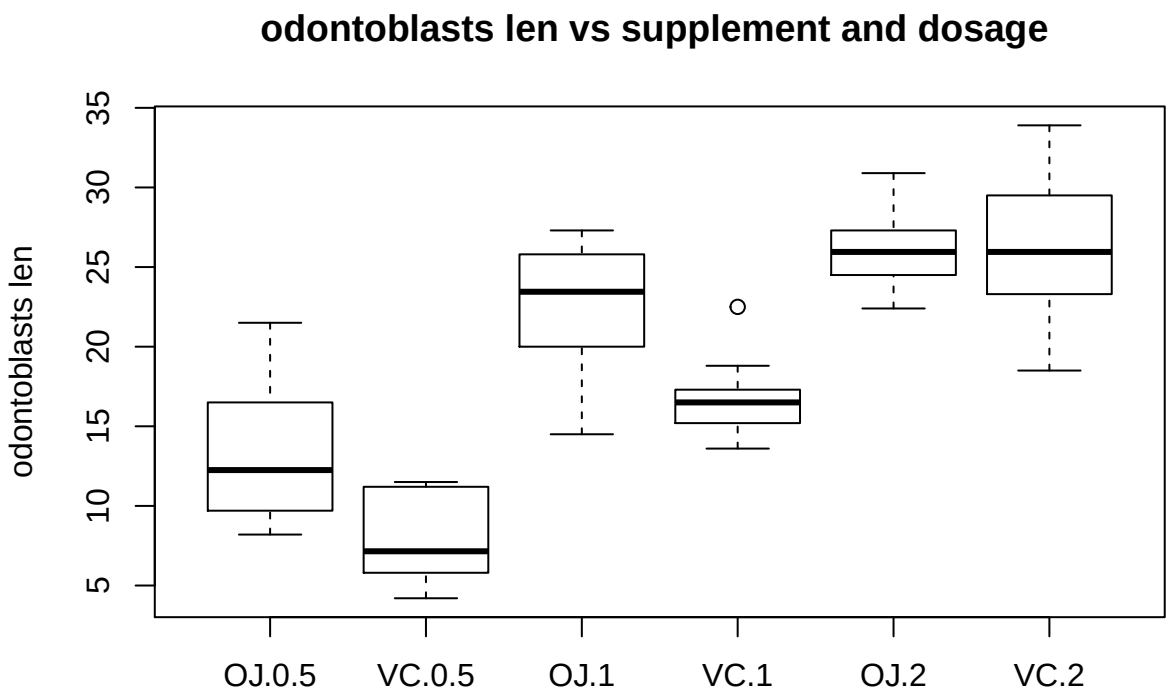
```
#Import data
data(ToothGrowth)
#Visualize data
head(ToothGrowth)
```

```
##    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
```

```
#change dose to factor
ToothGrowth$dose=factor(ToothGrowth$dose)
#Basic summary
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
```

```
#Plot visulaization
boxplot(len ~ supp + dose, data=ToothGrowth,ylab='odontoblasts len',main='odontoblasts len vs supplemen
```



Guess

- **Vitamine C could facilite the growth of odontoblasts.**
- **Low and medium dose (0.5 and 1 mg/day) of VC supplied with orange juice seems to favor the odontoblasts growth of guinea pigs compared with ascorbic acid.**
- **For high dose (2 mg/day), the effect of orange juice and ascorbic acid seems to be same.**

1. Effect of supplement and dosage

Assume that variance in each condition are the same. The Two-way ANOVA is adopted to see the effect of both supply and dosage.

The NULL hypothesis `H0`:

1.The population means of `len` in `OJ` and `VC` (`supp`) are the same.

2.The population means of `len` in `0.5`, `1` and `2` (`dose`) are the same.

3.There is no interaction between the two factors (`supp` and `dose`).

```
#Two-way ANOVA
two_way=aov(len ~ supp*dose,data=ToothGrowth)
summary(two_way)
```

```
##             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
```

Result reject all items in NULL hypothesis `H0` in the `95%` confidient intervals. Which indicate that:

1. The `supply` affects the odontoblasts growth (`P-value = 0.000231`)
2. The `dose` affects the odontoblasts growth (`P-value < 2e-16`)
3. There is interaction between `OJ` and `VC` (`P-value = 0.021860`), which means that the supply may affect the Vitamine C functioning on the pig.

We will further test effect within each group using the `Two-way ANOVA Tukey post-hoc test` to test the mean value between differnt groups.

2. Effect on the odontoblasts growth

All the NULL hypothesis `H0` is the mean value is same.

```
#Two-way ANOVA
TukeyHSD(two_way)
```

```
##   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
```

- In the `$supp` test, the NULL hypothesis `H0` is rejected (`adj P-value < 0.0002312`), indicating the effects for the `VC` and `OJ` is statistically different, with mean value of odontoblasts length 3.7 longer in OJ treatment.
- In the `$dose` test, the NULL hypothesis `H0` is rejected in all the dosase comparement (`adj P-value = 2.7e-06 or 0`), indicating the positive effect of Vitamine C on the growth of odontoblasts, and the effect is most obvious between dosage `1` and `0.5`
- In the `$supp:dose` test, only in following gropus no significant difference is found (95% confidence interval):

1. `VC:1-OJ:0.5` (`adj P-value = 0.2640208`)
2. `OJ:2-OJ:1` (`adj P-value = 0.3187361`)
3. `VC:2-OJ:1` (`adj P-value = 0.2936430`)
4. `VC:2-OJ:2` (`adj P-value = 1`)

The effect of Vitamine C tend to be satured for the growth of odontoblasts at dosage of 2 mg/day. All the guesses have been proved.