ToothGrowth

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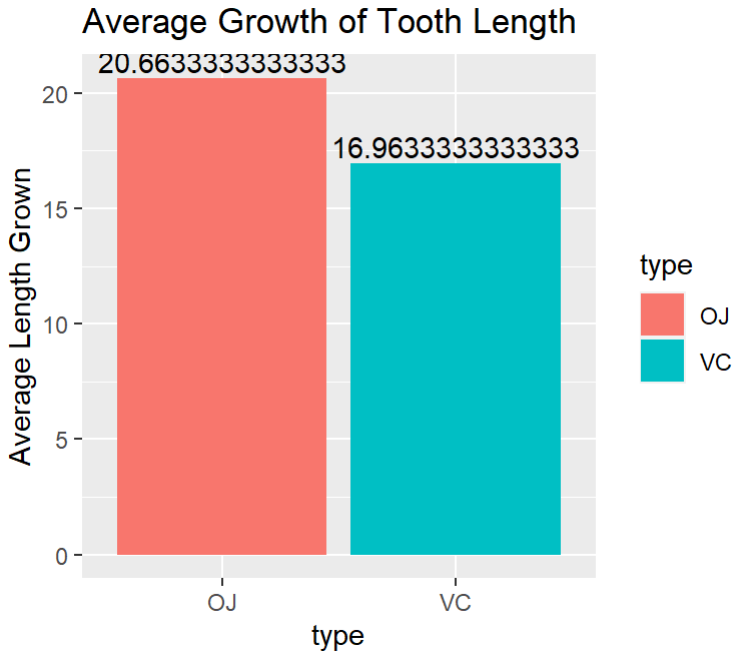
AVERAGE LENGTH GROWTH

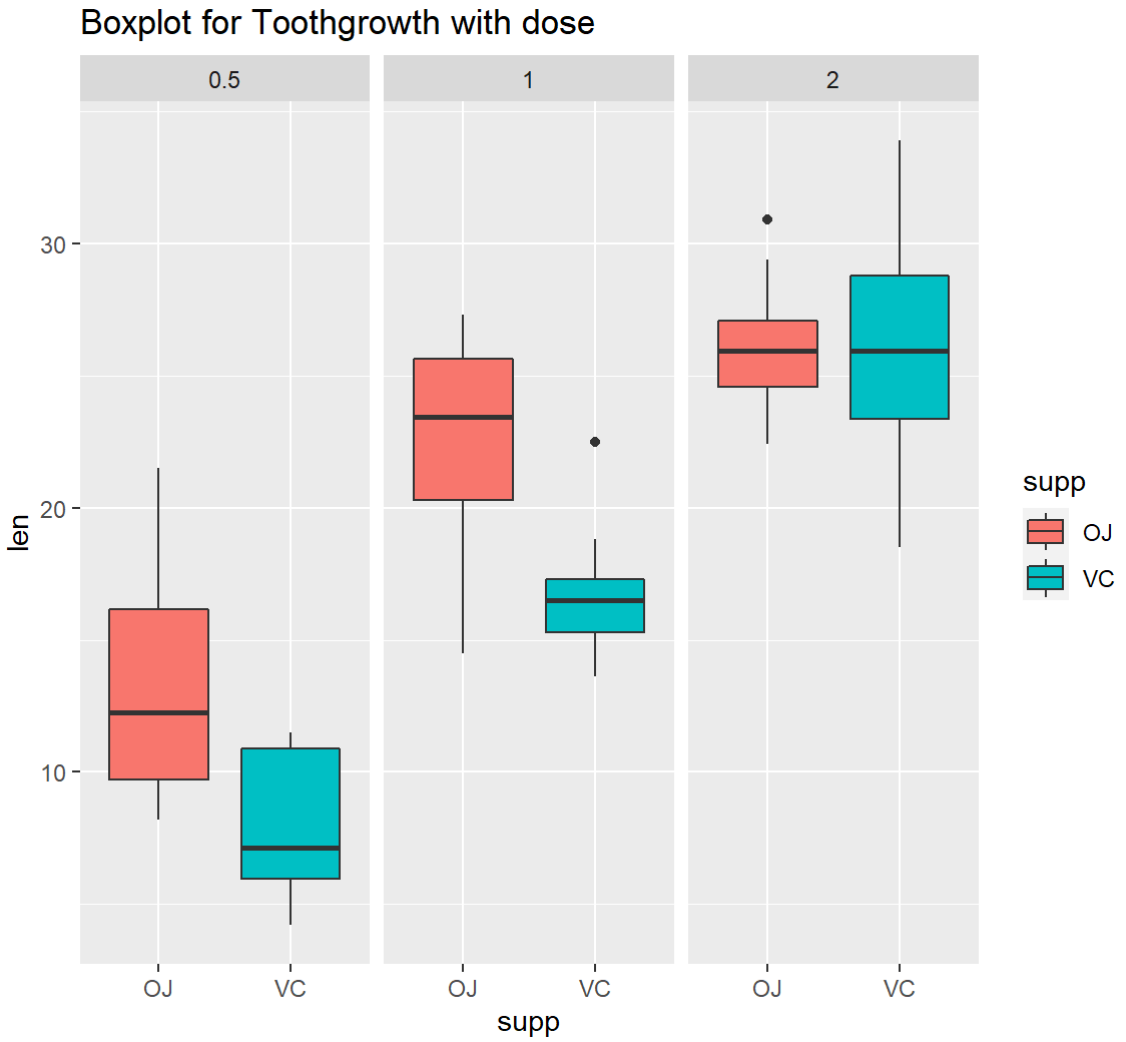
Lets see Average Length Growth first

```
library(ggplot2)
toothgrowth <- ToothGrowth
mean.len <- with(toothgrowth,tapply(len, supp, mean))
type <- c("OJ","VC")
avg.data <- data.frame(avg=mean.len,type=type)
gd <- ggplot(avg.data,aes(x=type,y=avg)) + geom_bar(aes(fill=type),stat = 'identity') +
ylab("Average Length Grown")+ geom_text(aes(label=avg), position=
position_dodge(width=0.9), vjust=-0.25) + ggtitle("Average Growth of Tooth Length")
gd
```



Mean of the Teeth Growth per type

```
ggplot(ToothGrowth,aes(x=supp,y=len)) + geom_boxplot(aes(fill=supp)) + facet_grid(.~dose) +
  ggtitle("Boxplot for Toothgrowth with dose ")
```



So the Box Plot shows that as concentration of dose increases Tooth Growth also increases.

Hypothesis

There are two features in this dataset on which Hypothesis Testing can be performed: 1) Hypothesis Test on “supp” i.e supplement type 2) Hypothesis Test on the “dose”

Hypothesis Test on “supp”

Let our Null Hypothesis be that there is no difference in toothgrowth due to supplement type.

Null: Toothgrowth due to “OJ” = Toothgrowth due to “VC”

Alternative: Toothgrowth due to “OJ” > Toothgrowth due to “VC”

```
oj.data <- subset(ToothGrowth,supp=="OJ")
vc.data <- subset(ToothGrowth,supp=="VC")
t.test(x=oj.data$len,y=vc.data$len,alternative='greater',var.equal=FALSE,paired=FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  oj.data$len and vc.data$len
## 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
```

So, the p-value is 0.03 which is less than alpha=0.05 (Type I error rate) so we reject the null hypothesis, which means that supplement type “OJ” gives better Toothgrowth than the supplement type “VC”. ## Hypothesis Test on Dosage **Null Hypothesis:** Toothgrowth does not change with the concentration of dose

Alternative Hypothesis: Toothgrowth due to “OJ” > Toothgrowth increases with concentration of dose

```
dose1 <- subset(ToothGrowth,dose=="0.5")
dose2 <- subset(ToothGrowth,dose=="1")
dose3 <- subset(ToothGrowth,dose=="2")
```

First dose of 0.5mg+1mg

```
t.test(x=dose1$len,y=dose2$len,alternative="less",paired=FALSE,var.equal=FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  dose1$len and dose2$len
## 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
```

So p-value is 6.342e-08 which is very less than alpha=0.05 so we reject the null hypothesis,this means that growth for dose of 0.5mg is less than that for dose of 1mg.

First for dose of 1mg+2mg

```
t.test(x=dose2$len,y=dose3$len,alternative="less",paired=FALSE,var.equal=FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  dose2$len and dose3$len
## 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
```

The p-value is 9.532e-06 again it is very less than alpha=0.05 so we reject the null hypothesis,this means growth for dose of 1mg is less than that for 2mg.

Assumptions taken in consideration and conclusions

1)Variance between supplement types and dose is not equal.

2)The Data is non-paired i.e experiments are done on different subjects for each supp and dose.

3)The variables are independent and identically distributed.

4)Supplement type “OJ” gives better Toothgrowth than the supplement type “VC”.

5)Toothgrowth increases as the concentation increases.