

# Part 2 - Statistical Inference Project

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## Tooth Growth

### Overview

Explore the R datasets “ToothGrowth” data.

“ToothGrowth” captures the length of teeth in ten guinea pigs w/three dose levels of Vitamin C (0.5, 1 and 2 mg), delivered via orange juice or ascorbic acid.

```
library(dplyr)
```

```
##  
## Attaching package: 'dplyr'  
  
## The following objects are masked from 'package:stats':  
##  
##   filter, lag  
  
## The following objects are masked from 'package:base':  
##  
##   intersect, setdiff, setequal, union
```

```
library(knitr)
```

```
## Warning: package 'knitr' was built under R version 3.6.3
```

```
library(datasets)  
library(ggplot2)  
data("ToothGrowth")
```

### Data Dictionary

- [1] len numeric Tooth length
- [2] supp factor Supplement type (VC or OJ).
- [3] dose numeric Dose in milligrams.

```
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 ...
## $ dose: num 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 ...
```

```
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
```

```
summary(ToothGrowth)
```

```
## 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
```

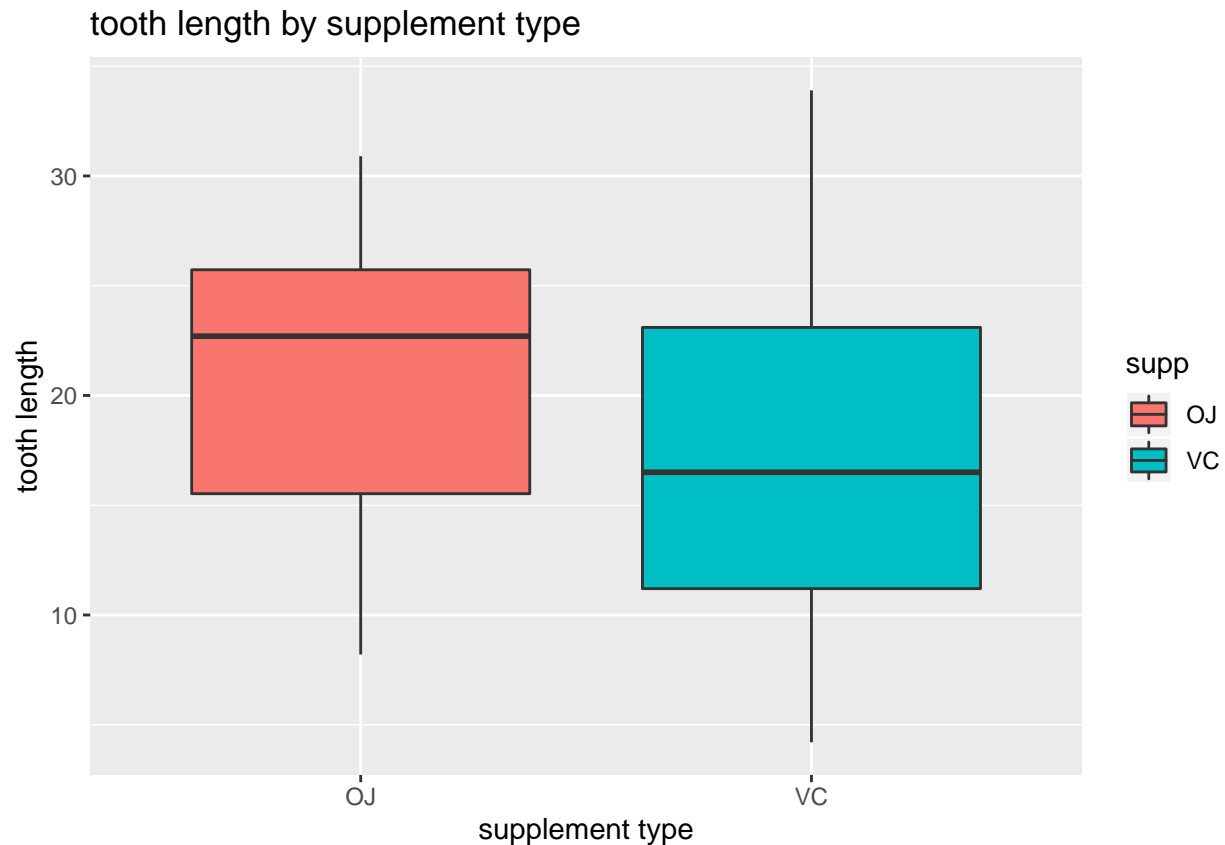
## Initial Analysis

Initial analysis indicates that longer tooth length correlates to higher vitamin C dosage.

```
summaryDataFrame <- ToothGrowth %>% group_by(supp, dose) %>% summarise(count = n(), mean=mean(len), med.
kable(summaryDataFrame ,digits = 3, align = 'c')
```

supp	dose	count	mean	median	standard deviation
OJ	0.5	10	13.23	12.25	4.460
OJ	1.0	10	22.70	23.45	3.911
OJ	2.0	10	26.06	25.95	2.655
VC	0.5	10	7.98	7.15	2.747
VC	1.0	10	16.77	16.50	2.515
VC	2.0	10	26.14	25.95	4.798

```
ggplot(data=ToothGrowth, aes(x=supp, y=len))+
  geom_boxplot(aes(fill=supp))+
  xlab("supplement type") +
  ylab("tooth length")+
  ggtitle("tooth length by supplement type ")
```



## Confidence Interval Testing

Employ t test to verify null hypotheses (both supply methods produce same results).

```
t.test(ToothGrowth$len[ToothGrowth$supp=="OJ"], ToothGrowth$len[ToothGrowth$supp=="VC"], paired=FALSE, v
```

```
##
## Welch Two Sample t-test
##
## data: ToothGrowth$len[ToothGrowth$supp == "OJ"] and ToothGrowth$len[ToothGrowth$supp == "VC"]
## 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 of x mean of y
## 20.66333 16.96333
```

Return p-value of 0.06063 which is not large enough to reject null hypothesis. Conclusion is that tooth length not caused by supply method.

Test increasing dose from 0.5 to 1.

```
t.test(ToothGrowth$len[ToothGrowth$dose==0.5], ToothGrowth$len[ToothGrowth$dose==1], paired=FALSE, var.equal=TRUE)

##
## Two Sample t-test
##
## data: ToothGrowth$len[ToothGrowth$dose == 0.5] and ToothGrowth$len[ToothGrowth$dose == 1]
## t = -6.4766, df = 38, p-value = 1.266e-07
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -11.983748 -6.276252
## sample estimates:
## mean of x mean of y
## 10.605 19.735
```

Dramatically lower p value (1.266e-07) implies dosage impacts mean.

```
t.test(ToothGrowth$len[ToothGrowth$dose==1], ToothGrowth$len[ToothGrowth$dose==2], paired=FALSE, var.equal=TRUE)

##
## Two Sample t-test
##
## data: ToothGrowth$len[ToothGrowth$dose == 1] and ToothGrowth$len[ToothGrowth$dose == 2]
## t = -4.9005, df = 38, p-value = 1.811e-05
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -8.994387 -3.735613
## sample estimates:
## mean of x mean of y
## 19.735 26.100
```

Which also yields a very low p value (1.811e-05) which implies that increased vitamin C dosage encourages tooth growth.

## Conclusion

Analysis using t-tests indicate that delivery methods do not impact tooth growth. Increased levels of vitamin C dosage encourages increased tooth growth.