Statistical Inference Course Project - Part 2: Basic Inferential Data Analysis Instructions

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Overview

Analyze the ToothGrowth data in the R datasets package ToothGrowth {dataset } Provide : The Effect of Vitamin C on Tooth Growth in Guinea Pigs

Description

The response is the length of odontoblasts (cells responsible for tooth growth) in 60 guinea pigs. Each animal received one of three dose levels of vitamin C (0.5, 1, and 2 mg/day) by one of two delivery methods, orange juice or ascorbic acid (a form of vitamin C and coded as VC).

A data frame with 60 observations on 3 variables.

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

Data Analyzes

This part includes the data loading, and initial data analyzes.

Load required libraries.

```r
library(ggplot2)
library(datasets)
library(UsingR)
```

```
## Loading required package: MASS

## Loading required package: HistData

## Loading required package: Hmisc

## Loading required package: lattice

## Loading required package: survival

## Loading required package: Formula

##
## Attaching package: 'Hmisc'

## The following objects are masked from 'package:base':
##
##     format.pval, units

##
## Attaching package: 'UsingR'

## The following object is masked from 'package:survival':
##
##     cancer
```

```r
library(kableExtra)
```

A preliminary review of the data.

```r
dim(ToothGrowth)
```

```
## [1] 60  3
```

```r
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
```

Check how much samples we have for each test.

```r
table(ToothGrowth$supp)
```

```
##
## OJ VC
## 30 30
```

```r
table(ToothGrowth$dose)
```

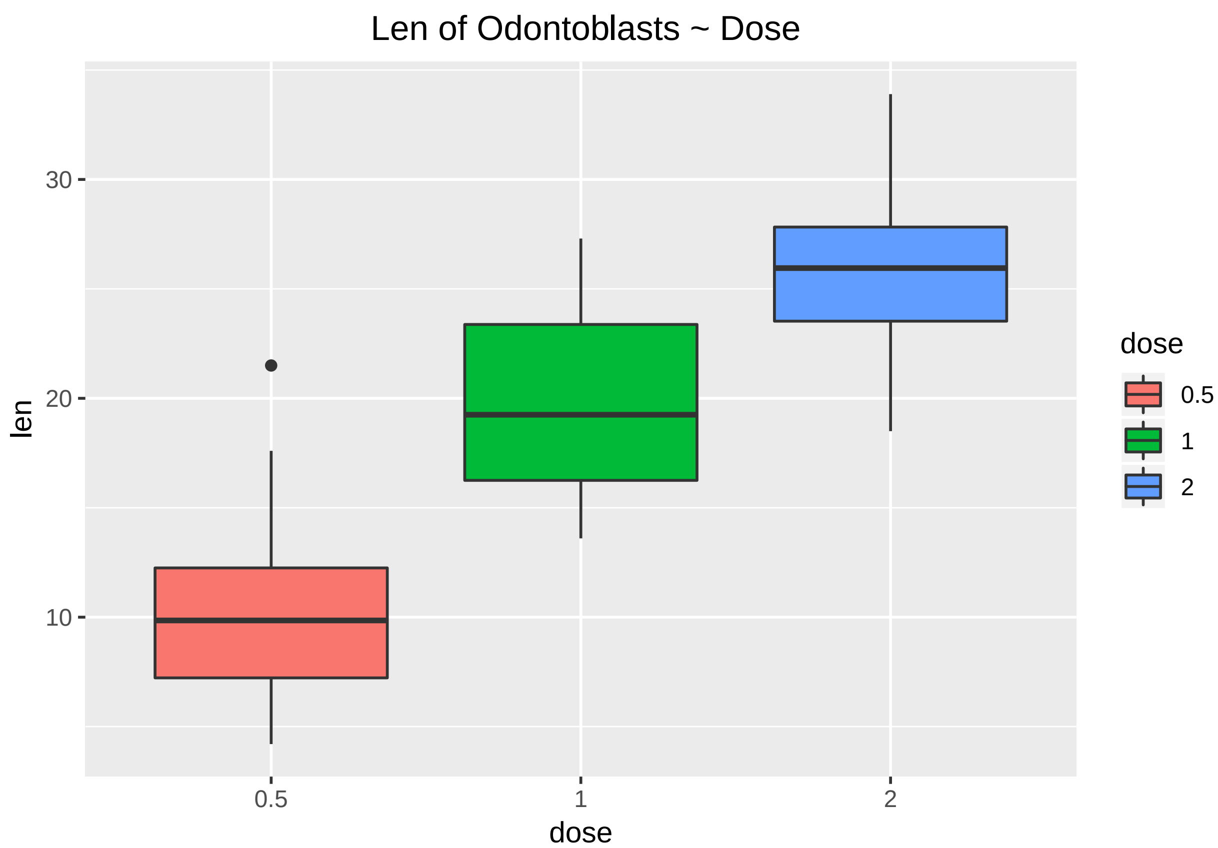
```
##
## 0.5   1   2
##  20  20  20
```

The methods of providing the Vitamins and the amount is equally split along the 60 guinea pigs Half of the guinea pigs got the Vitamin via orange juice and half via ascorbic acid.

Plot some basic graph to get some view of the data

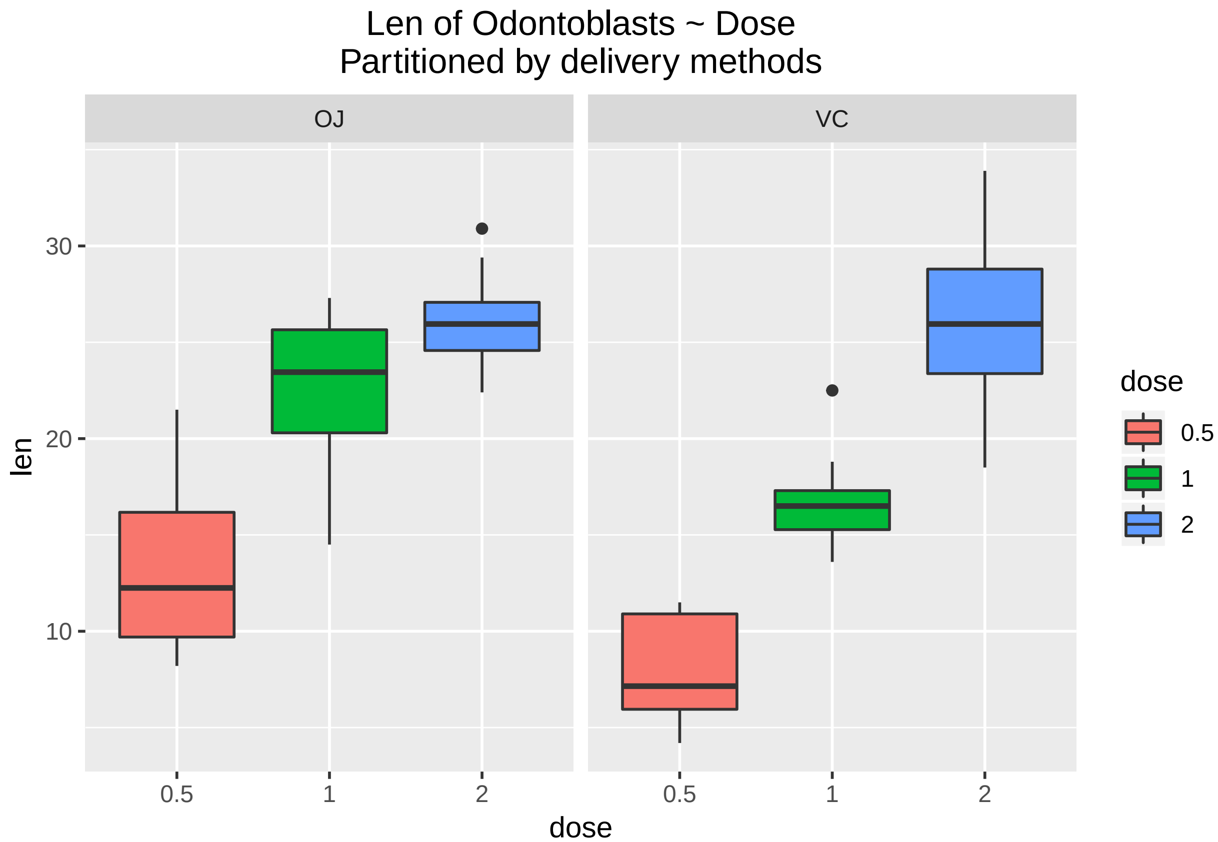
Plot the ratio len ~dose

```r
ToothGrowth$dose<-as.factor(ToothGrowth$dose)
theme_update(plot.title = element_text(hjust = 0.5))
ggplot(ToothGrowth, aes(x=dose, y=len, group=(dose))) +
   geom_boxplot(aes(fill=dose)) +   ggtitle(" Len of Odontoblasts ~ Dose")
```



plot the ratio len ~ dose , and split according to the delivery method.

```
ggplot(ToothGrowth, aes(x=dose, y=len, group=(dose))) +geom_boxplot(aes(fill=dose)) +
  ggtitle(" Len of Odontoblasts ~ Dose \n Partitioned by delivery methods ")   + facet_grid(. ~ supp)
```



Hypothesis and Confidence Interval

This section contains several Hypothesis checking and illustration of a confidence interval.

Hypothesis I Null hypothesis , The Supplement type (VC or OJ) doesn't impact the Tooth length

H0 -> Mean of Length for VC = Mean of Length for OJ H1 -> Mean of Length for VC != Mean of Length for OJ

```
t.test(ToothGrowth$len[ToothGrowth$supp=="OJ"],ToothGrowth$len[ToothGrowth$supp=="VC"],
       mu=0,var.equal = FALSE,alternative=c("two.sided"))
```

```
##
##  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
```

As it can be seen the p-value = 0.06063 > .005 and , we can see that 0 is in the confidence interval -0.1710156 7.5710156. So the Null Hypothesis can't be rejected, and we can assume that there is no difference between the two Supplement types when we measure their impact of the length of the tooth.

Hypothesis II Check the impact of the amount of Dose on Tooth's length. The Null Hypothesis is that increasing the Dose doesn't impact the length of the tooth.

Compare amount .5 and 1

```
res<-t.test(ToothGrowth$len[ToothGrowth$dose==.5],ToothGrowth$len[ToothGrowth$dose==1],mu=0,var.equal =
P_Values<-res$p.value
Conf_Intervals_Low<-res$conf.int[1]
Conf_Intervals_High<-res$conf.int[2]
res
```

```
##
##  Welch Two Sample t-test
##
## data:  ToothGrowth$len[ToothGrowth$dose == 0.5] and ToothGrowth$len[ToothGrowth$dose == 1]
## 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
```

Compare amount 1 and 2

```
res<-t.test(ToothGrowth$len[ToothGrowth$dose==1],ToothGrowth$len[ToothGrowth$dose==2],
       mu=0,var.equal = FALSE,alternative=c("two.sided"))
P_Values<-c(P_Values,res$p.value)
Conf_Intervals_Low<-c(Conf_Intervals_Low,res$conf.int[1])
Conf_Intervals_High<-c(Conf_Intervals_High,res$conf.int[2])
res
```

```
##
##  Welch Two Sample t-test
##
## data:  ToothGrowth$len[ToothGrowth$dose == 1] and ToothGrowth$len[ToothGrowth$dose == 2]
## 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
```

Compare amount 0.5 and 2

```
res<-t.test(ToothGrowth$len[ToothGrowth$dose==.5],ToothGrowth$len[ToothGrowth$dose==2],mu=0,var.equal =
P_Values<-c(P_Values,res$p.value)
Conf_Intervals_Low<-c(Conf_Intervals_Low,res$conf.int[1])
Conf_Intervals_High<-c(Conf_Intervals_High,res$conf.int[2])
res
```

```
##
##  Welch Two Sample t-test
##
## data:  ToothGrowth$len[ToothGrowth$dose == 0.5] and ToothGrowth$len[ToothGrowth$dose == 2]
## 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
```

Present the results in a table.

```r
Dose_Comparison_Values<-c("0.5<->1.0","1.0<->2.0","0.5<->2")
df<-data.frame(Dose_Comparison_Values)
df<-(cbind(df,P_Values))
df<-(cbind(df,Conf_Intervals_Low))
df<-(cbind(df,Conf_Intervals_High))

kable(df) %>%
  kable_styling(bootstrap_options = "striped", full_width = F, position = "left")
```

Dose_Comparison_Values	P_Values	Conf_Intervals_Low	Conf_Intervals_High
0.5<->1.0	1.00e-07	-11.983781	-6.276219
1.0<->2.0	1.91e-05	-8.996481	-3.733519
0.5<->2	0.00e+00	-18.156167	-12.833834

As it can be seen from the table the P_Values are very low (<..05) It means that we need to reject the Null Hypothesis. Increasing the dose impact the length of the teeth.

Conclusions

1.There is no clear and direct impact of the two Supplement type (VC or OJ), it means that we don't see any preferred method that impact the teeth length.
2. There is an impact of the Dose amount on the teeth length.