Project Part 2

Statistical Inference: Data Analysis on Tooth Growth Data Set

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Description of Tooth Growth Data Set:

The response is the length of odontoblasts in each of 10 guinea pigs at each of three dose levels of Vitamin C (0.5, 1, and 2 mg) with each of two delivery methods.
No. of Observation: 60
Variable in data: 3 (len, sup, dose)
Format of Data: (num, factor, factor)
Delivery Methods: Orange Juice, Ascorbic Acid
Dose Levels of Vitamin C: 0.5, 1, and 2 mg

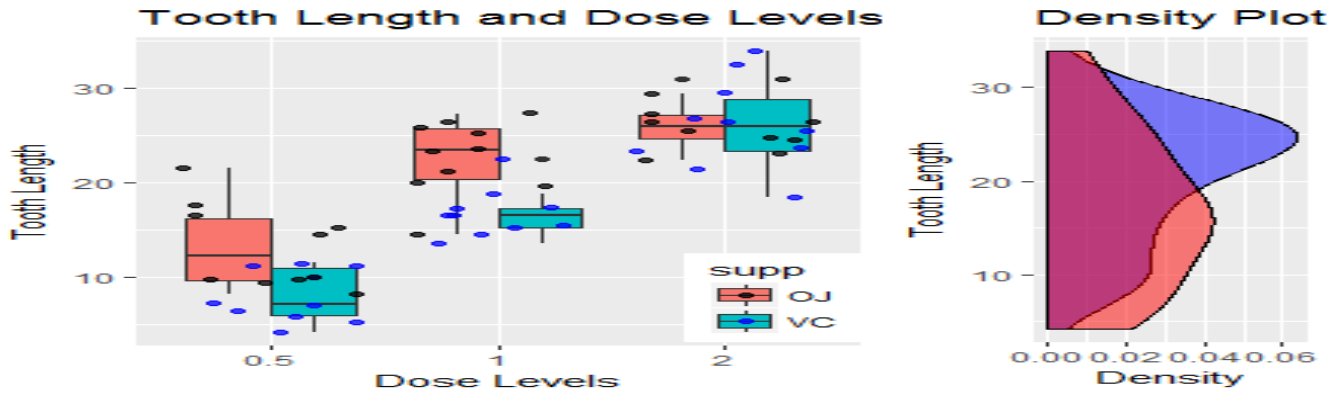
```
install.packages("gridExtra")
library(ggplot2)
library(grid)
library(datasets)
library(gridExtra)
```

```
data(ToothGrowth)
attach(ToothGrowth)
ToothGrowth$dose <- factor(ToothGrowth$dose)
str(ToothGrowth)
```

Exploratory Tooth Growth Data Analysis:

Here to compare between tooth lengths with respect to dose levels and delivery methods using scatterplot and box plot. Using plotting feature of the R- plotting marginal density of tooth lengths.

```
set.seed(123)
scatter <- ggplot(ToothGrowth,aes(dose,len)) + geom_boxplot(aes(fill=supp)) +
geom_jitter(alpha=I(3/4),aes(color=supp)) + scale_color_manual(values=c("black","blue")) +
theme(legend.position=c(1,0.3),legend.justification=c(1,1)) +labs(title="Tooth Length and Dose Levels",x="Dose
Levels",y="Tooth Length")
plot_right <- ggplot(ToothGrowth,aes(len,fill=supp)) + geom_density(alpha=.5) +coord_flip()
+scale_fill_manual(values=c("blue","red")) + theme(legend.position="none") +labs(title="Density
Plot",y="Density",x="Tooth Length")
grid.arrange(scatter, plot_right, ncol=2, nrow=1, widths=c(4, 2))
```



Data Summary:

Summary Statistics for all the variables- summary (ToothGrowth)

Statistics	len	supp	dose
Min	4.2	OJ:30	0.5:20
1st Quartile	13.07	VC:30	1:20
Median	19.25		2:20
Mean	18.81		
3rd Quartile	25.27		
Max	33.9		

Splitting the cases between different Dose Levels and Delivery Methods.

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

	0.5	1	2
OJ	10	10	10
VC	10	10	10

Hypothesis Testing Using Confidence Intervals:

Using Supplement Delivery Method as A Factor:

Analyzing the data for correlation between the Delivery Method and change in Tooth Growth, assuming unequal variances between the two groups.
Null Hypothesis: There is no correlation between the Delivery Method and Tooth Length.

```
t.test(len ~ supp, paired = F, var.equal = F, data = ToothGrowth)
t-stats-report:- data:  len by supp
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 in group OJ      mean in group VC
20.66333                  16.96333
```

Here, the 95% confidence interval is [-0.1710156, 7.5710156], which contains zero and the p-value is 0.06063, which is greater than 0.05. Hence, we cannot reject the NULL Hypothesis.
We conclude that: There is no correlation between the Delivery Method and Tooth Length.

Using Supplement Dosage Level as A Factor:

Analyzing the data for correlation between the Dose Level and change in Tooth Growth, assuming unequal variances between the two groups. Here the NULL Hypothesis for the following three t-tests is that, there is no correlation between the Dose Level and Tooth Length.

```
Dose_05_10 <- subset(ToothGrowth, dose %in% c(0.5, 1.0))
Dose_05_20 <- subset(ToothGrowth, dose %in% c(0.5, 2.0))
Dose_10_20 <- subset(ToothGrowth, dose %in% c(1.0, 2.0))
t.test(len ~ dose, paired = F, var.equal = F, data = Dose1_05_10)
t-stats-report:- data:  len by dose
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 in group 0.5 and mean in group 1: 10.60     19.735
```

Here, the 95% confidence interval is [-11.983781, -6.276219], which does not contain zero and the p-value is 1.268e-07, which is less than 0.05. Hence, we can safely reject the NULL Hypothesis.

```
t.test(len ~ dose, paired = F, var.equal = F, data = Dose_05_20)
t-stats-report:- data:  len by dose
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 in group 0.5           mean in group 2
10.605                        26.100
```

Here, the 95% confidence interval is [-18.15617, -12.83383], which does not contain zero and the p-value is 4.398e-14, which is less than 0.05. Hence, we can safely reject the NULL Hypothesis.

```
t.test(len ~ dose, paired = F, var.equal = F, data = Dose_10_20)
t-stats-report:- data:  len by dose
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 in group 1          mean in group 2
19.735                      26.100
```

Here, the 95% confidence interval is [-8.996481, -3.733519], which does not contain zero and the p-value is 1.906e-05, which is less than 0.05. Hence, we can safely reject the NULL Hypothesis.From these three t-tests, we conclude that, There is significant correlation between the Dose Level andTooth Length.

Using Supplement Delivery Method as A Factor Within Dose Levels:

Analyzing the data for correlation between the Delivery Method and change in Tooth Growth within each Dose Level, assuming unequal variances between the two groups. Here the NULL Hypothesis for the following three t-tests is that, there is no correlation between the Delivery Method and Tooth Length for the given Dose Level.

```
Dose_05 <- subset(ToothGrowth, dose %in% c(0.5))
Dose_20 <- subset(ToothGrowth, dose %in% c(2.0))
Dose_10 <- subset(ToothGrowth, dose %in% c(1.0))
t.test(len ~ supp, paired = F, var.equal = F, data = Dose_05)
t-stats-report:- data:  len by supp
t = 3.1697, df = 14.969, p-value = 0.006359
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:[1.719057, 8.780943]
sample estimates: mean in group OJ mean in group VC 13.23  7.98
```

Here, the 95% confidence interval is [1.719057, 8.780943], which does not contain zero and the p-value is 0.006359, which is less than 0.05. Hence, we can safely reject the NULL Hypothesis.

```
t.test(len ~ supp, paired = F, var.equal = F, data = Dose_10)
t-stats-report:- data:  len by supp
t = 4.0328, df = 15.358, p-value = 0.001038
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:[2.802148, 9.057852]
sample estimates: mean in group OJ mean in group VC: 22.70 16.77
```

Here, the 95% confidence interval is [2.802148, 9.057852], which does not contain zero and the p-value is 0.001038, which is less than 0.05. Hence, we can safely reject the NULL Hypothesis.

```
t.test(len ~ supp, paired = F, var.equal = F, data = Dose_20)
t-stats-report:- data:  len by supp
t = -0.0461, df = 14.04, p-value = 0.9639
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:[-3.79807,  3.63807]
sample estimates:
mean in group OJ mean in group VC: 26.06   26.14
```

Here, the 95% confidence interval is [-3.79807, 3.63807], which contains zero and the p-value is 0.9639, which is greater than 0.05. Hence, we cannot reject the NULL Hypothesis.

Discussion and Conclusion:

For the t-tests, the variances are assumed to be different for the two groups being compared. This assumption is less strong than the case in which the variances are assumed to be equal. Here we are considering that the given sample is representative of the entire population of guinea pigs so that we can generalize our results on entire population.

- Here from the t-test report we can conclude that supplement delivery method has no overall significant impact on tooth length.
- Orange juice increases tooth length faster than ascorbic acid for 0.5 and 1.0 dose level.
- There is no significant difference in the increase of tooth length by both supplement delivery methods for 2.0 dose level.
- Increase in Supplement Dose Levels leads to overall increase in Tooth Length.