Coursera - Statistical Inference - Course Project

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The Effect of Vitamin C on Tooth Growth in Guinea Pigs

Data Overview

The R dataset "ToothGrowth" reports the length of odontoblasts (cells responsible for tooth growth) in response to dosing of vitamin C (ascorbic acid) in 60 guinea pigs.

The dataset has 60 rows and 3 columns. Each row is the data for one animal.

```
data("ToothGrowth")
dim(ToothGrowth)
```

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

Half of the animals received orange juice (OJ) and the other half received pure ascorbic acid powder (VC). Dose levels were split in 3 groups of the same size that each received one of three dose levels of vitamin C (0.5, 1, and 2 mg/day). It is assumed that grouping was performed in a **randomized** fashion without selection and the data points are **independent** from each other.

Tooth.Length	Delivery.Vehicle	Dose
Min. : 4.20	OJ:30	0.5:20
1st Qu.:13.07	VC:30	1 :20
Median :19.25	NA	2 :20
Mean :18.81	NA	NA
3rd Qu.:25.27	NA	NA
Max. :33.90	NA	NA

Effect of Delivery Vehicle on Tooth Growth

The mean tooth growth for the orange juice group (ojs) is higher than for the vehicle control group (vcs). The question is, whether this difference is significant (two sided test). The null hypothesis is that the two groups are not different from each other.

```
# Selecting animals by delivery vehicle
ojs <- ToothGrowth$len[which(ToothGrowth$supp == "OJ")]
vcs <- ToothGrowth$len[which(ToothGrowth$supp == "VC")]

# summary of each groups
mean(ojs)
```

```
## [1] 20.66333
```

```r
mean(vcs)
```

```
## [1] 16.96333
```

We assume that the data contains independent observations (not paired) and we don't know if the variance is similar. The test is performed at the standard 0.95 confidence interval.

```r
t.test(ojs, vcs, var.equal = FALSE, paired = FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  ojs and vcs
## 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
```

Based on the test we accept the null hypothesis and conclude there is no difference in tooth growth whether vitamin C is given as orange juice or in powder form. We can see this since the confidence interval passes by 0, additionally the p-value is higher than 0.05.

Effect of Dosing Level on Tooth Growth

We now want to investigate if the different doses of vitamin C lead to significantly different tooth growth. The null hypothesis is that they will not lead to different tooth growth.

```r
# Selecting animals by dosing regimen
low <- ToothGrowth$len[which(ToothGrowth$dose == "0.5")]
med <- ToothGrowth$len[which(ToothGrowth$dose == "1")]
high <- ToothGrowth$len[which(ToothGrowth$dose == "2")]

# summary of each group
mean(low)
```

```
## [1] 10.605
```

```r
mean(med)
```

```
## [1] 19.735
```

```r
mean(high)
```

```
## [1] 26.1
```

We see that the mean tooth growth is higher, the higher the dose. We will now compare the groups to see if the dose differences are significant. Or in other words, if higher doses lead to higher effect. We will use the same parameters and assumptions as outlined above.

```r
t.test(low, med, var.equal = FALSE, paired = FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  low and med
## 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
```

The very low p-value clearly indicates that the tooth growth for the medium dose and the low dose is significantly different and we have to reject the null hypothesis.

```r
t.test(med, high, var.equal = FALSE, paired = FALSE)
```

```
##
##  Welch Two Sample t-test
##
## data:  med and high
## 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
```

In the same way, the tooth growth is also significantly different between the med and the high dose. Since low is different from med and med is different from high, we don't have to test the difference of low and high, because their means are even further apart.

Overall Conclusions

Overall, we show based on the tooth growth data set that higher doses of vitamin C lead to more tooth growth, however it does not matter if the vitamin C is given as orange juice or as ascorbic acid powder.