Effect of vitamin C dose and supplement type on Guinea pig tooth length

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Overiew

We will analyze the `ToothGrowth` data from R datasets, which contains the results of an experiment investigating the effect of vitamin C dose level and supplement type on Guinea pig tooth length.

`ToothGrowth` contains 60 observations of 3 variables:

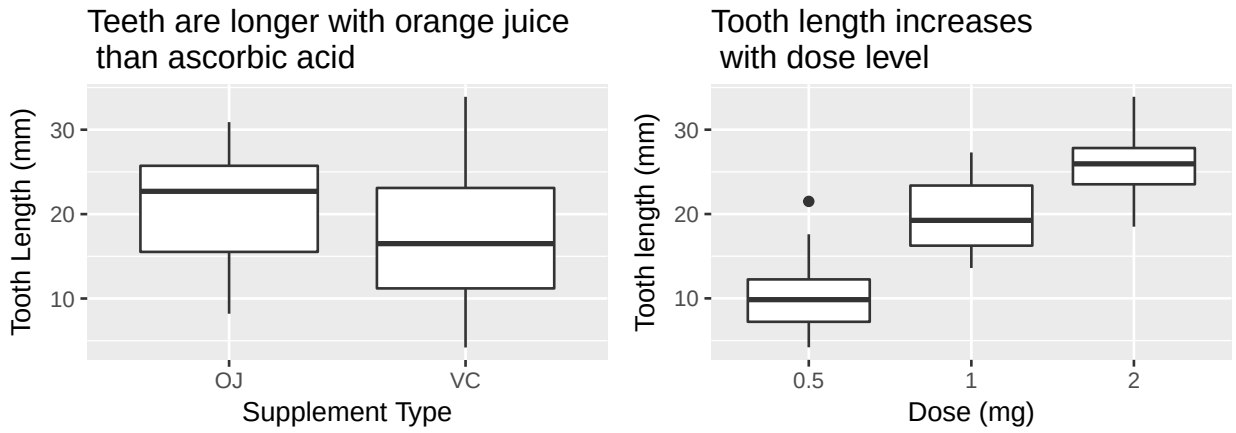
- `len`: Tooth length (in millimeters)
- `supp`: Supplement type (VC or OJ)
- `dose`: Dose in milligrams/day

The Guinea pigs were randomly assigned to six groups of 10 depending on the dose level (0.5, 1, or 2) and supplement type (orange juice or ascorbic acid).

```
##      supp
## dose  OJ VC
##   0.5 10 10
##   1   10 10
##   2   10 10
```

Exploratory Data Analysis

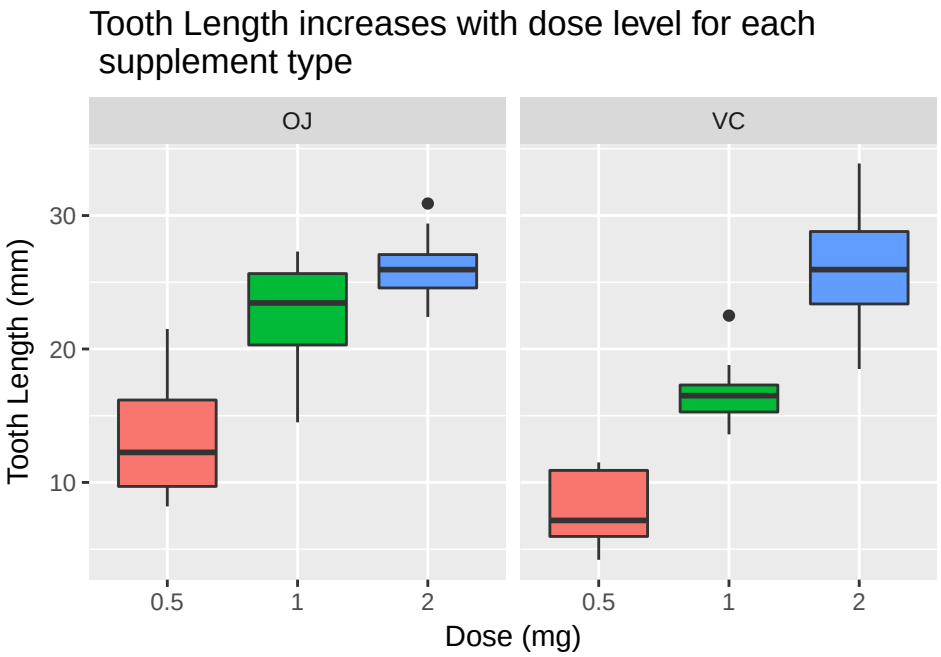
Let's investigate how tooth length varies with supplement type and dose level.



We can drill down to each treatment group and compare the sample means:

```
##      supp
## dose     OJ    VC
##   0.5 13.23  7.98
##   1   22.70 16.77
##   2   26.06 26.14
```

We can also graph a boxplot of the distribution of tooth lengths within each treatment group:



Statistical tests

Each treatment group has much fewer than 30 observations, so cannot use the results of the Central Limit Theorem for our statistical test. Instead, we assume:

1. Each Guinea pig was randomly and independently assigned to one of the treatment groups.
2. The distribution of tooth lengths by group is approximately normal.

Then, the appropriate tests of our hypotheses are t-tests with unequal variances.

Supplement type

First, we use a null hypothesis that mean tooth length does not vary with supplement type. Here are the results:

```
##   estimate estimate1 estimate2 statistic    p.value parameter   conf.low
## 1      3.7  20.66333  16.96333  1.915268 0.06063451  55.30943 -0.1710156
##   conf.high                 method alternative
## 1  7.571016 Welch Two Sample t-test   two.sided
```

With a confidence interval of (-0.171, 7.571) and a p-value of 0.061, we cannot reject the null hypothesis that mean tooth length does not vary with supplement type.

Dose level

Next we explore how much tooth length varies with dose level. While there are more sophisticated methods, we will perform 3 t-tests, one for each pairing of dose levels.

```
##     null_hypothesis                  method estimate estimate1 estimate2
## 1   μ2mg - μ1mg = 0 Welch Two Sample t-test    6.365    26.100    19.735
```

```
## 2 μ2mg - μ0.5mg = 0 Welch Two Sample t-test   15.495    26.100    10.605
## 3 μ1mg - μ0.5mg = 0 Welch Two Sample t-test    9.130    19.735    10.605
##   statistic      p.value parameter  conf.low conf.high
## 1  4.900484 1.906430e-05  37.10109  3.733519  8.996481
## 2 11.799046 4.397525e-14  36.88259 12.833833 18.156167
## 3  6.476648 1.268301e-07  37.98641  6.276219 11.983781
```

With p-values less than 0.5, we can conclude tooth length varies with dose level for each pairing of dose level. For example, with the first test we are able to reject the null hypothesis that mean tooth length for dose level 2 mg is equal to mean tooth length for dose level 1 mg.