Week 2 Participation

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Exercise

Research Question:

- Does vitamin C (dose) or the delivery method (supplement: orange juice or ascorbic acid) affect tooth growth in guinea pigs?
- Variables len: Length of odontoblasts (tooth growth) supp: Supplement type (VC = Ascorbic Acid, OJ = Orange Juice) dose: Dose levels of vitamin C (0.5 mg, 1 mg, 2 mg)

```
?ToothGrowth
attach(ToothGrowth)
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
```

```
Tooth.aov <- aov(len ~ supp * dose, data = ToothGrowth)
summary(Tooth.aov)
```

```
##             Df Sum Sq Mean Sq F value   Pr(>F)
## supp         1  205.4   205.4  12.317 0.000894 ***
## dose         1 2224.3  2224.3 133.415  < 2e-16 ***
## supp:dose    1   88.9    88.9   5.333 0.024631 *
## Residuals   56  933.6    16.7
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The ANOVA results provide three main pieces of information:

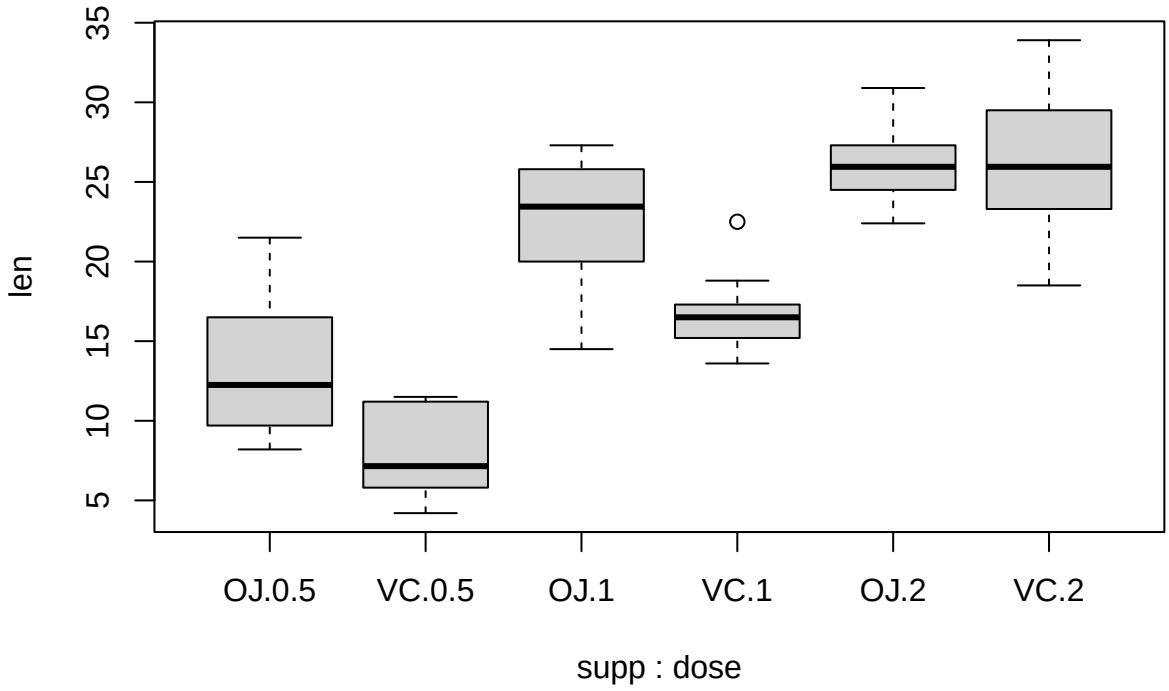
- Main Effect of Supplement (supp): $F(1, 56) = 12.317$, $p = 0.000894$ The supplement type (Orange Juice or Ascorbic Acid) has a significant effect on tooth growth.
- Main Effect of Dose (dose): $F(1, 56) = 133.415$, $p < 2e\text{-}16$ The dose of vitamin C has a highly significant effect on tooth growth.

- Interaction Effect (supp * dose): F(1, 56) = 5.333, p = 0.024631 There is a significant interaction between the supplement type and the dose level. This suggests that the effect of the supplement on tooth growth depends on the dose of vitamin C.

```r
# Assumptions
shapiro.test(Tooth.aov$residuals)
```

```
##
##  Shapiro-Wilk normality test
##
## data:  Tooth.aov$residuals
## W = 0.98162, p-value = 0.5008
```

```r
boxplot(len ~ supp * dose, data = ToothGrowth)
```




```r
leveneTest(len ~ supp * as.factor(dose), data = ToothGrowth)
```

```
## Levene's Test for Homogeneity of Variance (center = median)
##       Df F value Pr(>F)
## group  5  1.7086 0.1484
##       54
```

Normality (Shapiro-Wilk Test):

- p-value = 0.5008: The p-value is greater than 0.05, so we do not reject the null hypothesis of normality. The residuals are normally distributed.

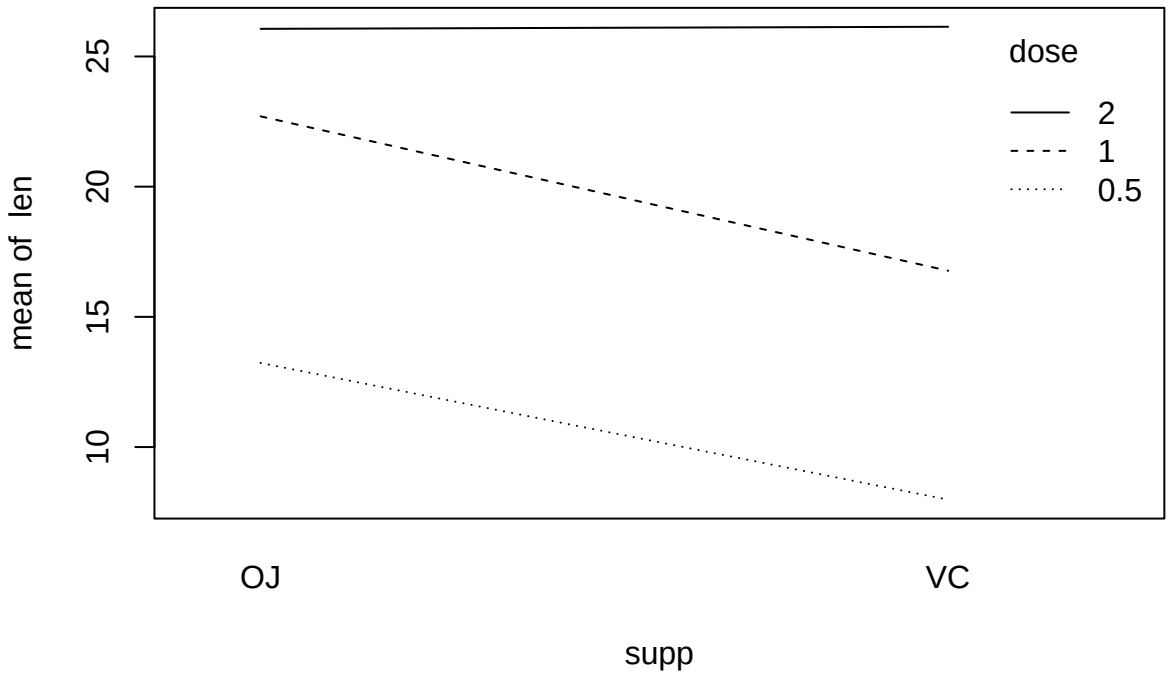
Homogeneity of Variance (Levene's Test):

- p-value = 0.1484: The p-value is greater than 0.05, indicating that the variances are equal across the groups, satisfying the homogeneity of variance assumption.

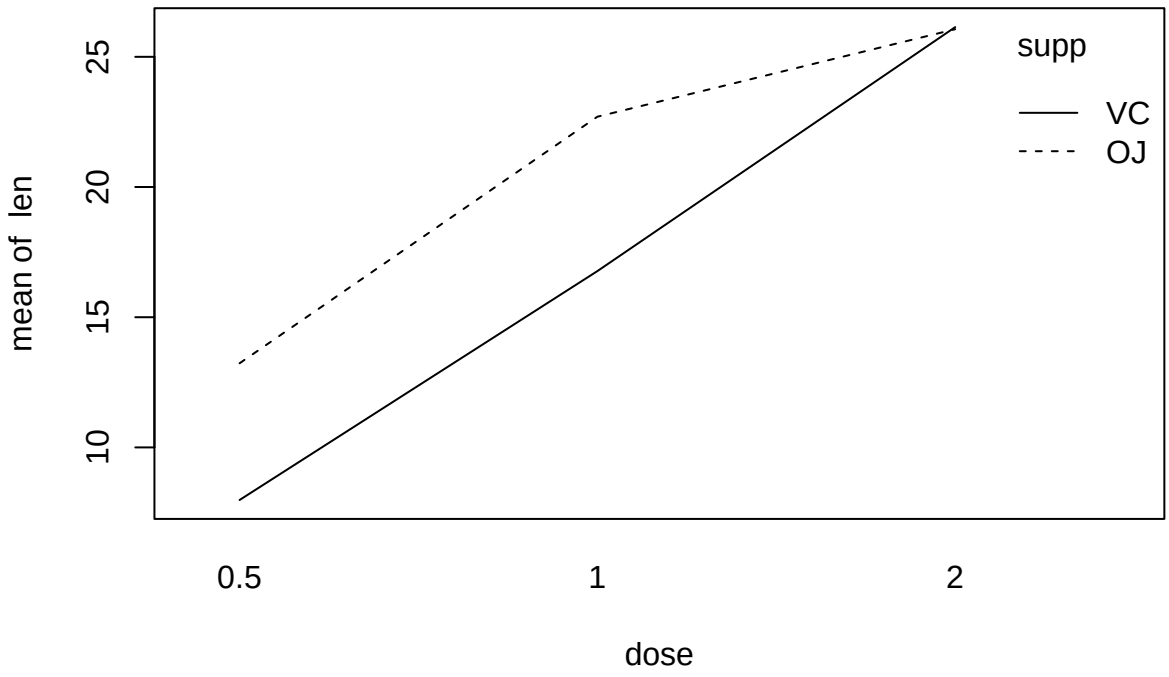
Interpretation of the Box-plot:

- OJ consistently results in higher tooth growth compared to VC, regardless of the dose.
- Dose levels significantly impact tooth growth, with higher doses leading to greater tooth growth in both supplement groups.
- The difference between OJ and VC becomes more pronounced at the higher dose levels, particularly at 2 mg/day, where OJ shows a much larger effect on tooth growth than VC.
- This box-plot reinforces the findings from the ANOVA and interaction plots, showing that both the dose and supplement type significantly affect tooth growth, with a notable interaction between these factors.

```
# Interaction Plots
interaction.plot(supp, trace.factor = dose, len)
```



```r
interaction.plot(dose, trace.factor = supp, len)
```



Interpretation of the Interaction Plots:

- supp vs. dose: This plot shows how the supplement type (OJ or VC) affects tooth growth at each dose level. Orange Juice (OJ) consistently results in higher tooth growth than Ascorbic Acid (VC) at all dose levels. The lines are not parallel, which indicates a potential interaction effect between supplement type and dose. The gap between the OJ and VC lines widens as the dose increases, suggesting that the effect of the supplement becomes more pronounced at higher doses. At the highest dose (2 mg), OJ leads to significantly greater tooth growth compared to VC, while at the lowest dose (0.5 mg), the difference is less pronounced.
- dose vs. supp: This plot shows how the dose levels (0.5, 1, and 2 mg/day) affect tooth growth for each supplement. Both, OJ and VC show an increasing trend in tooth growth as the dose of vitamin C increases. However, the OJ line increases more steeply than the VC line, indicating that the increase in tooth growth with dose is more pronounced for OJ than for VC. Again, the non-parallel lines indicate that the effect of dose on tooth growth is different depending on the supplement type. The steeper slope for OJ suggests that OJ has a stronger effect on tooth growth as the dose increases, compared to VC.

Answer to Research Question:

- Yes, both the dose of vitamin C and the delivery method (supplement type: orange juice or ascorbic acid) significantly affect tooth growth in guinea pigs.

- The dose of vitamin C has a highly significant effect on tooth growth, as indicated by the ANOVA result with a p-value $< 2e\text{-}16$.
- The type of supplement (OJ vs. VC) also has a significant effect on tooth growth ($p = 0.000894$).
- There is a significant interaction effect between dose and supplement type ($p = 0.024631$). This means the effect of the supplement type on tooth growth depends on the dose of vitamin C.
- The interaction plots show that at lower doses (0.5 mg/day), the difference between OJ and VC is smaller, but as the dose increases (to 2 mg/day), OJ results in significantly more tooth growth compared to VC.

Conclusion:

- Both vitamin C dose and the delivery method (supplement type) affect tooth growth in guinea pigs. Higher doses of vitamin C lead to greater tooth growth, and orange juice is more effective than ascorbic acid in promoting tooth growth, especially at higher doses.