

Practice Assignment: ANOVA

- 1) We want to see if there is a difference in the mean number of sleep hours per night between freshmen, sophomores, juniors, and seniors.¹ Assume all assumptions of ANOVA are satisfied.

Part A: How many groups do we have?

Answer: Four

Part B: Define what each parameter of interest represents. Make sure to use words and symbols.

$$\mu_1 =$$

$$\mu_2 =$$

$$\mu_3 =$$

$$\mu_4 =$$

Answer:

μ_1 = mean amount of sleep hours per night for freshmen

μ_2 = mean amount of sleep hours per night for sophomores

μ_3 = mean amount of sleep hours per night for juniors

μ_4 = mean amount of sleep hours per night for seniors

Part C: State the null and alternative hypotheses.

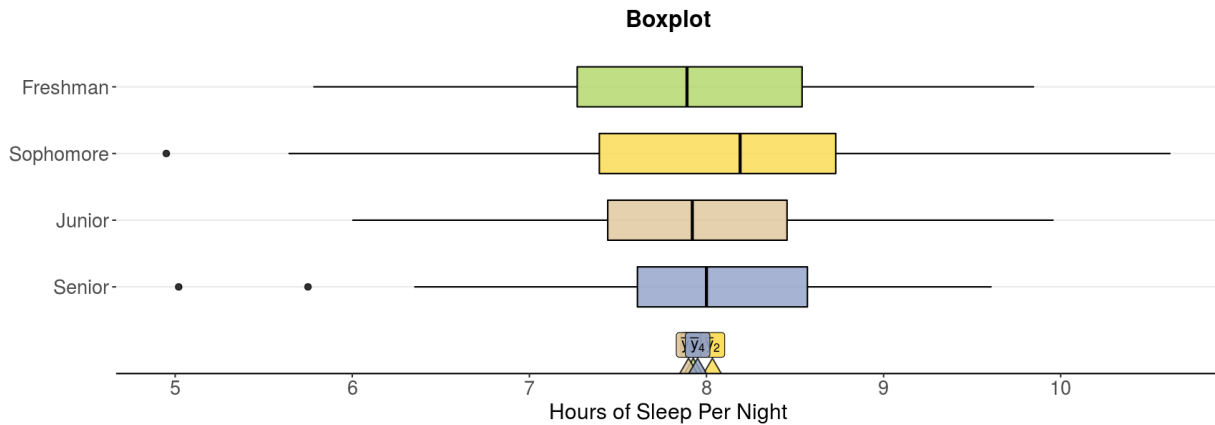
Answer:

$$H_0: \mu_1 = \mu_2 = \mu_3 = \mu_4$$

H_A : At least two group means are different.

- 2) Look at the following boxplots and sample means. Do you see any differences or similarities in sleep hours between the class years? Explain.

¹ Onyper, S. V., Thacher, P. V., Gilbert, J. W., & Gradess, S. G. (2012). Class start times, sleep, and academic performance in college: A path analysis. *Chronobiology International*, 29(3), 318–335.



Answer: The sample means are all around eight hours per night. The boxes for freshmen and sophomores have slightly larger widths than the boxes for juniors and seniors, which means their sleep hours vary more.

3) The following is the output for the ANOVA for the scenario in Questions 1 and 2.

ANOVA Table:

Source	df	Sum of Squares	Mean Square	F Statistic	P-value
Group	3	0.7708	0.2569	0.2736	0.8444
Error	249	233.8	0.939		
Total	252	234.5708			

Part A: State the F-statistic and P-value.

Answer: F-statistic = 0.2736, P-value = 0.8444

Part B: Based on your answer to Part A, what is your decision for the test? Use a significance level of 5%.

- Reject the null hypothesis.
- Fail to reject the null hypothesis.
- Accept the null hypothesis.

Answer: b

Part C: Interpret your results from Part B in the context of the problem.

Answer: There is not convincing evidence that there is a difference in the mean number of sleep hours per night for freshmen, sophomores, juniors, and seniors.

- 4) Does the container ramen comes in contribute to people's perceptions of the taste? Three independent samples of ramen in different containers (a cup, a pack, and a bowl) were taken. Each ramen sample was rated on a scale from 0–5, where 5 was the best-tasting ramen. We want to test to see if there is a difference in the mean ramen rating between ramen in cups, packs, and bowls.^{2 3} Assume all assumptions of ANOVA are satisfied.

Part A: How many groups do we have?

Answer: Three

Part B: Define what each parameter represents. Make sure to use words and symbols.

Answer:

μ_1 = mean ramen rating for ramen that come in a cup

μ_2 = mean ramen rating for ramen that come in a pack

μ_3 = mean ramen rating for ramen that come in a bowl

Part C: State the null and alternative hypotheses.

$$H_0: \mu_1 = \mu_2 = \mu_3$$

H_A : At least two group means are different.

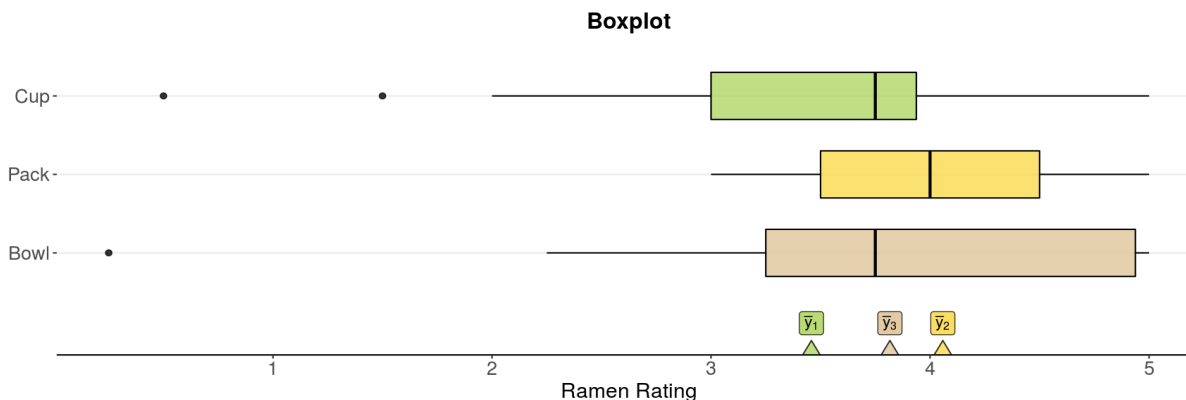
- 5) Look at the following boxplots and sample means. Do you see any differences or similarities in the ramen ratings for the three types of containers? Explain.

² *Ramen ratings*. (2019, June 3). GitHub.

<https://github.com/rfordatascience/tidytuesday/tree/master/data/2019/2019-06-04>

³ Lienesch, H. (2021, January 18). *The Big List*. The Ramen Rater.

<https://www.theramenrater.com/resources-2/the-list/>



Answer: The sample mean rating for the cup is less than the sample means for the pack and the bowl. The bowl ratings are more spread out. The sample mean for the pack is the highest.

6) The following is the output for the ANOVA for the scenario in Questions 4 and 5.

ANOVA Table:

Source	df	Sum of Squares	Mean Square	F Statistic	P-value
Group	2	5.468	2.734	3.2	0.0456
Error	87	74.34	0.8545		
Total	89	79.808			

Part A: State the F-statistic and P-value.

Answer: F-statistic = 3.2, P-value = 0.0456

Part B: Based on your answer from Part A, what is your decision for the test? Use a significance level of 5%.

- a) Reject the null hypothesis.
- b) Fail to reject the null hypothesis.
- c) Accept the null hypothesis.

Answer: a

Part C: Interpret your results from Part B in the context of the problem.

Answer: There is convincing evidence that at least two of the population mean ramen ratings differ.

Part D: Suppose your friend interpreted the results as, “All three types of ramen packaging have significantly different ratings.” Would this be the correct interpretation based on the ANOVA results? Explain.

Answer: No, the ANOVA only tells us that at least two groups are different; it does not tell us which groups are different.

7) In the previous in-class activity (14.A), we looked at the ANOVA table for the average number of alcoholic drinks consumed per week for the groups who identified as Morning Larks, Night Owls, and Neither. We got the following results:

Source	df	Sum of Squares	Mean Square	F-Statistic	P-value
Group	2	73.04	36.52	2.198	0.11
Error	250	4154.00	16.62		
Total	252	4227.00			

Suppose we wanted to see if there was a difference between the average number of alcoholic drinks per week among the groups Morning Larks, Night Owls, and Neither group. Use $\alpha = 0.05$. Assume all assumptions of ANOVA are satisfied.

Part A: Write the null and alternative hypotheses.

Answer:

$$H_0: \mu_1 = \mu_2 = \mu_3$$

H_a : At least two group means are different.

Part B: Define what each parameter represents. Make sure to use words and symbols.

Answer:

μ_1 = mean number of alcoholic drinks per week for Morning Larks

μ_2 = mean number of alcoholic drinks per week for Night Owls

μ_3 = mean number of alcoholic drinks per week for those who are Neither morning larks nor night owls

Part C: Interpret the results from the ANOVA table in the context of the problem.

Answer: Fail to reject the null; there is not convincing evidence that there is a difference in the average number of alcoholic drinks per week between the groups Morning Larks, Night Owls, and Neither.