Chapter 8: Problem Set

Numbers with an asterisk* have solutions in the back of the book.

Foundations of Hypothesis Testing (8.1)

1.* For each scenario, (a) state the claim, the null hypothesis, and the alternate hypotheses in symbolic form. (b) Define what μ or p represents in these statements. (c) Determine which hypothesis supports the claim. And (d) whether the actual test would be left-tailed, right-tailed, or two-tailed.

   (a) The good people at *Fizzy Pop* claim that the mean volume of fluid in all 12 ounce cans of soda is 12 ounces.

   (b) A group of scientists claim that the mean daily flow rate of oil from the damaged Deep Horizon well is more than 40,000 barrels per day.

   (c) I claim that most people have a strong dislike for statistics.

2. For each scenario, (a) state the claim, the null hypothesis, and the alternate hypotheses in symbolic form. (b) Define what μ or p represents in these statements. (c) Determine which hypothesis supports the claim. And (d) whether the actual test would be left-tailed, right-tailed, or two-tailed.

   (a) The folks at the Better Business Bureau claim that the mean volume in all 12 ounce cans of *Fizzy Pop* is less than 12 ounces.

   (b) The good people at British Petroleum claim that the mean daily flow rate of oil from the damaged Deep Horizon well was about 25,000 barrels per day.

   (c) The American Mathematical Association claims that more than 40% of all people like statistics.

3.* Using a significance level of $\alpha = 0.10$, find the critical z values for each of the following alternative hypotheses. Sketch the normal curve and the rejection region.

   (A) $H_1 : p < .75$ (B) $H_1 : p > .75$ (C) $H_1 : p \neq .75$

4. Using a significance level of $\alpha = 0.05$, find the critical z values for each of the following alternative hypotheses. Sketch the normal curve and the rejection region.

   (A) $H_1 : p < .50$ (B) $H_1 : p > .50$ (C) $H_1 : p \neq .50$

5.* Given the alternate hypotheses (H_1) and test statistics ($z_{\hat{p}}$), determine the P-value of the test statistic.

   (a) $H_1 : p < .95$, and $z_{\hat{p}} = -1.95$

   (b) $H_1 : p \neq .23$, and $z_{\hat{p}} = 2.01$

6. Given the alternate hypotheses (H_1) and test statistics ($z_{\hat{p}}$), determine the P-value of the test statistic.

   (a) $H_1 : p > .23$, and $z_{\hat{p}} = 2.01$

   (b) $H_1 : p \neq .23$, and $z_{\hat{p}} = -2.65$

7.* Write an accurate concluding statement for the following hypothesis tests.

(a) You claim that the mean volume of all *12 ounce* cans of Fizzy Pop is less than 12 ounces. After analyzing the data and performing a hypothesis test, you reject the null hypothesis.

(b) Fizzy Pop claims that most *12 ounce* cans of Fizzy Pop contain more than 12 ounces. After analyzing the data and performing a hypothesis test, you fail to reject the null hypothesis.

(c) You claim that the average speed of cars going down a certain stretch of highway is 72 mph. After analyzing the data and performing a hypothesis test, you reject the null hypothesis.

8. Write an accurate concluding statement for the following hypothesis tests.

(a) You claim that the mean volume of all *12 ounce* cans of Fizzy Pop is less than 12 ounces. After analyzing the data and performing a hypothesis test, you fail to reject the null hypothesis.

(b) Fizzy Pop claims that most *12 ounce* cans of Fizzy Pop contain more than 12 ounces. After analyzing the data and performing a hypothesis test, you reject the null hypothesis.

(c) You claim that the average speed of cars going down a certain stretch of highway is 72 mph. After analyzing the data and performing a hypothesis test, you fail to reject the null hypothesis.

9.* You perform a hypothesis test on the claim that the mean gas mileage of the Toyota Prius is greater than 43 miles per gallon (mpg). Describe what results when a Type I and Type II error is made.

10. You perform a hypothesis test on the claim that the mean volume of all 12 ounce cans of Fizzy Pop is less than 12 ounces. Describe what results when a Type I and Type II error is made.

Hypothesis Tests About a Proportion (8.2)

11.* **Corn:** In a random sample of 80 ears of corn, farmer Carl finds that 6 of them have worms (7.5%). Conduct the following hypothesis tests and finish with an understandable concluding statement.

(a) Carl claims that less than 15% of his corn has worms. Test his claim at the 0.05 significance level.

(b) Carl claims that less than 15% of his corn has worms. Test his claim at the 0.01 significance level.

(c) Why was it that you could make apparently contradictory statements in parts (a) and (b)?

12. **Pinworm:** In Sludge County, a sample of 50 randomly selected citizens were tested for pinworm. Of these, 10 tested positive (20%). The CDC reports that the U.S. average pinworm infection rate is 12%. Conduct the following hypothesis tests and finish with an understandable concluding statement.

(a) Test the claim that Sludge County has a pinworm infection rate that is greater than the national average. Use a 0.05 significance level.

(b) Test the claim that Sludge County has a pinworm infection rate that is greater than the national average. Use a 0.01 significance level.

(c) Why was it that you could make apparently contradictory statements in parts (a) and (b)?

13.* **Speeding:** On a certain stretch of West Street, I claim that most cars are going more than 5 miles per hour over the speed limit. The speed limit is posted at 25 mph and in a random sample of 50 cars, 29 of them are traveling faster than 30 mph. Test my claim at the 0.10 significance level.

14. **Binge Drinking:** Binge drinking is defined by the U.S. Department of Health and Human Services as *the consumption of 5 or more drinks in a row for men and 4 or more for women.* In a recent study of 1200 college students 564 of them reported to have engaged in binge drinking in the past two weeks.

    (a) The report concluded that half of all college students binge drink. Test this claim at the 0.01 significance level.

    (b) At the 0.05 significance level, test the claim that less than half of all college students are binge drinkers.

    (c) How can you get two apparently contradictory results.

15.* **Spam:** Larry claims that more than a quarter of all his email is spam. In a random sample of 40 of his emails, 12 of them are spam. Test his claim at the 0.01 significance level.

16. **Teenage Tobacco Use:** In a random sample of 2000 teenagers, 18% used tobacco of some form. The managers of an anti-tobacco campaign want to claim that less than 20% of all teenagers use tobacco.

    (a) Test this claim at the 0.05 significance level.

    (b) Would your conclusion change at the 0.01 significance level?

Hypothesis Tests About a Mean (σ unknown) (8.3)

17.* **Sleep:** Suppose you perform a study about the hours of sleep that college students get. You know that for all people, the average is about 7 hours. You randomly select 50 college students and survey them on their sleep habits. From this sample, the mean number of hours of sleep is found to be 6.2 hours with a standard deviation of 0.75 hours. In the previous chapter we calculated a 99% confidence interval for the mean number of hours of sleep to college students as $5.9 < \mu < 6.5$. As such, it certainly seems reasonable that we can claim that college students get less sleep than the average for all people of 7 hours. Test this claim at the 0.01 significance level.

18. **Salmon:** Assume that the weights of spawning Chinook Salmon in the Columbia River are normally distributed. You randomly catch and weigh 20 such salmon. The mean weight from your sample is 25.2 pounds with a standard deviation of 4.5 pounds.

    (a) Test the claim that the mean weight of Columbia River salmon is greater than 23 pounds. Use a 0.10 significance level.

    (b) Test the same claim at the 0.05 significance level.

    (c) Test the same claim at the 0.01 significance level.

19.* **Assembly Time:** In a sample of 40 grown-ups, the mean assembly time for a boxed swing set was 1.78 hours with a standard deviation of 0.75 hours. The makers of this swing set claim the average assembly time is less than 2 hours.

(a) Test their claim at the 0.01 significance level.

(b) Test their claim at the 0.05 significance level.

(c) How can these two near-contradictory conclusions co-exist for the same data?

20. **AM -vs- PM Height:** We want to test the claim that people are taller in the morning than at night. In a sample of 30 adults, the mean difference between morning height and evening height was 0.72 cm (people were taller in the morning) with a standard deviation of 0.35 cm. Set up and test this claim at the 0.01 significance level and write a meaningful conclusion.

21.* **Math SAT:** Last year, the national mean SAT score in mathematics was 515. In a random sample of 50 students who said they did not prepare for the SAT, the mean was 508, with a standard deviation of 35. Test the claim that there is no difference in mean scores between those that did not prepare and the national average. Use a 0.05 significance level.

22. **Real Fruit Juice:** A 32 ounce can of a popular fruit drink claims to contain 20% *real fruit juice*. Since this is a 32 ounce can, they are actually claiming that the can contains 6.4 ounces of *real fruit juice*. The consumer protection agency samples 60 such cans of this fruit drink. Of these, the mean volume of fruit juice is 6.32 ounces with a standard deviation of 0.21 ounces. Test the claim that the mean amount of real fruit juice in all 32 ounce cans is 6.4 ounces. Test the claim at the 0.01 significance level.

23.* **Similar Tests: Facebook Friends** Suppose you look at the number of Facebook friends for college students. You want to test the following claims. (1) The average number of Facebook friends for college student users is greater than 254. (2) Most college student Facebook users have more than 254 Facebook friends. How does the set-up differ for these two nearly equivalent claims? Would you expect both claims to be true if one of them is found to be true?

24. **Similar Tests: Assembly Time** You manufacture boxed swing-sets and want to convince customers that it takes less than 2 hours to assemble one. You have a sample of adults assemble the swing-sets and time them. About 78% of the adults get done in just under 2 hours but the other 22% take much more than 2 hours. You are considering two claims to test.

- Claim 1: Most adults can complete the assembly in less than 2 hours.
- Claim 2: The mean time of completion is less than 2 hours.

Which claim is better and which would you most likely be able to support with your data and why?

Hypothesis Tests About a Mean (σ known) (8.4)

25.* **Math SAT:** The SAT tests were originally designed to have a mean of 500 and a standard deviation of 100. The mean math SAT score last year was 515 but the standard deviation was not reported. You read in an article for an SAT prep course that states in a sample of 76 students, the mean math score was 534, but they did not disclose the standard deviation.

(a) Assume the population standard deviation (σ) for all prep course students is 100 and test the claim that the mean score for prep course students is above the national average of 515. Use a 0.05 significance level.

(b) Assume now that we don't know σ but we do know the sample standard deviation (s) for the 76 prep course students was 100 and test the claim that the mean score for prep course students is above the national average of 515. Use a 0.05 significance level.

(c) Compare your two different answers. Why do they disagree?

26. **Salmon:** Assume that the weights of spawning Chinook Salmon in the Columbia River are normally distributed with a population standard deviation (σ) of 4.5 pounds. You randomly catch and weigh 20 such salmon. The mean weight from your sample is 25.2 pounds. We did this problem earlier in this problem set while assuming that the **sample standard deviation** was 4.5 pounds. We now assume the **population standard deviation** is 4.5 pounds.

(a) Test the claim that the mean weight of Columbia River salmon is greater than 23 pounds. Use a 0.10 significance level.

(b) Test the same claim at the 0.05 significance level.

(c) Test the same claim at the 0.01 significance level.

(d) We did similar tests in problem # 18 only we did not know the population standard deviation. How do the results from that problem compare to the results obtained in this problem?