Section 8.1

Definition: The **null hypothesis** H_0 is the statement that is under investigation or being tested. Usually the null hypothesis represents a statement of "no effect," "no difference," or, put another way, "things haven't changed."

Definition: The **alternate hypothesis** H_1 is the statement that you will adopt in the situation in which the evidence (data) is so strong that you reject H_0. A statistical test is designed to assess the strength of the evidence (data) against the null hypothesis.

Exercise 1. Suppose you want to test the claim that a population mean equals 30. (#12)
(a) State the null hypothesis.

(b) State the alternate hypothesis if you have no information regarding how the population mean might differ from 30.

(c) State the alternate hypothesis if you believe (based on experience or past studies) that the population mean may be greater than 30.

(d) State the alternate hypothesis if you believe (based on experience or past studies) that the population mean may not be as large as 30.

Class Exercise 1. *Consumer Reports* stated that the mean time for a Chrysler Concorde to go from 0 to 60 miles per hour is 8.7 seconds. (#18)
(a) If you want to set up a statistical test to challenge the claim of 8.7 seconds, what would you use for the null hypothesis? **Answer:** H_0**:** $\mu =$ **8.7 sec**
(b) The town of Leadville, Colorado, has an elevation over 10,000 feet. Suppose you wanted to test the claim that the average time to accelerate from 0 to 60 miles per hour is longer in Leadville (because of less oxygen). What would you use for the alternate hypothesis? **Answer:** H_1**:** $\mu >$ **8.7 sec**
(c) Suppose you made an engine modification and you think the average time to accelerate from 0 to 60 miles per hour is reduced. What would you use for the alternate hypothesis? **Answer:** H_1**:** $\mu <$ **8.7 sec**

Types of Statistical Tests

Definition: A test is a **left-tailed test** if H_1 states that the parameter is less than the value claimed in H_0.

Definition: A test is a **right-tailed test** if H_1 states the parameter is greater than the value claimed in H_0.

Definition: A test is a **two-tailed test** if H_1 states the parameter is different from (or not equal to) the value claimed in H_0.

Hypothesis Testing Terminology

Definition: Assuming H_0 is true, the probability that the test statistic will take on values as extreme as or more extreme than the observed test statistic (computed from sample data) is called the ***P*-value** of the test. The smaller the P-value computed from sample data, the stronger the evidence against H_0.

Definition: The **level of significance α** is the probability of rejecting H_0 when it is true. This is the probability of a type I error.

Notation: The *probability of making a type II error* is denoted by the Greek letter β.

Definition: The quantity $1 - \beta$ is called the **power of a test** and represents the probability of rejecting H_0 when it is, in fact, false.

Procedure

If P-value $\leq \alpha$, we reject the null hypothesis and say the data are statistically significant at the level α.
If P-value $> \alpha$, we do not reject the null hypothesis.

Exercise 2. It is known that the number of pizza slices the average college student in America eats per week is 10. Let's suppose we wanted to determine if the average student at De Anza eats more pizza than the average American college student. In order to do this, we take a random sample of 100 students. For the students in the sample, the average number of pizza slices is 10.2. At the 0.10 significance level, does the average De Anza College student eat more pizza than the average American student? (Let's suppose we know that the standard deviation for the number of pizza slices for De Anza College students is 5.)

We first establish the population parameter.

Let $\mu =$

(a) What is the null hypothesis?

H_0:

(b) What is the alternative hypothesis?

H_1:

Remark: The reason why the alternative hypothesis contains a $>$ sign as opposed to a $\neq$ sign is because the question specifically asked "more pizza" as opposed to a "different amount of pizza".

(c) What is the p-value?

In words, the p-value is the probability of obtaining a sample mean **as big or bigger than** 10.2 if the null hypothesis is true.

Let X =

Let's suppose

By the Central Limit Theorem,

(d) What is the conclusion?

There is to suggest that the average De Anza College student eats more pizza than the average college student.

Remark: Even though the **sample mean** is bigger than 10 that does not mean that the population mean is automatically bigger than 10.

You should use the following template for doing a hypothesis test:
Presentation Style:
Let μ =

H_0:

H_1:

Let X =

Let's suppose H_0 is true.

The p-value =

The p-value is

Initial Conclusion: Since the p-value ? α, we H_o.

Final Conclusion:

Exercise 3. Using the template on the previous page, present the hypothesis test for De Anza College students and pizza example.

Let $\mu =$

H_0:

H_1:

Let $X =$

Let's suppose

By the Central Limit Theorem for Means,

There is to suggest that the average De Anza College student eats more pizza than the average college student.

Exercise 4. The health of the bear population in Yellowstone National Park is monitored by periodic measurements taken from anesthetized bears. A sample of 54 bears has a mean weight of 182.9 lb. Assuming that σ is known to be 121.8 lb, use a 0.05 significance level to test the claim that the population mean of all such bear weights is greater than 150 lb.

Class Exercise 2. Gentle Ben is a Morgan horse at a Colorado dude ranch. Over the past 8 weeks, a veterinarian took the following glucose readings from this horse (in mg/100 ml).

93 88 82 105 99 110 84 89

The sample mean is $\bar{x} \approx 93.8$. Let x be a random variable representing glucose readings taken from Gentle Ben. We may assume that x has a normal distribution, and we know from past experience that $\sigma = 12.5$. The mean glucose level for horses should be $\mu = 85$ mg/100 ml (Reference: *Merck Veterinary Manual*). Do these data indicate Gentle Ben has an overall average glucose level higher than 85? Use $\alpha = 0.05$. (#20) **Answer: p-value = 0.0233**

Class Exercise 3. The price-to-earnings (P/E) ratio is an important tool in financial work. A random sample of 14 large U.S. banks (J.P. Morgan, Bank of America, and others) gave the following P/E ratios: 24, 16, 22, 14, 12, 13, 17, 22, 15, 19, 23, 13, 11, 18. The sample mean is $\bar{x} \approx 17.1$. Generally speaking, a low P/E ratio indicates a "value" or bargain stock. A recent copy of *The Wall Street Journal* indicated that P/E ratio of the entire S&P 500 stock index is $\mu = 19$. Let x be a random variable representing the P/E ratio of all large U.S. bank stocks. We assume that x has a normal distribution and $\sigma = 4.5$. Do these data indicate that the P/E ratio of all U.S. bank stocks is less than 19? Use $\alpha = 0.05$. (#22) **Answer: p-value = 0.0571**

Homework

C problems

Section 8.1: 11-23 ODD

B problems

Section 8.1: 1-9 ODD