Chapter 10 – Hypothesis Tests Regarding a Parameter

OUTLINE

Putting It Together

In Chapter 9, we mentioned there are two types of inferential statistics:

(1) estimation
(2) hypothesis testing

We have already discussed procedures for estimating the population proportion and the population mean.

We now focus our attention on hypothesis testing. Hypothesis testing is used to test statements regarding a characteristic of one or more populations. In this chapter, we will test hypotheses regarding a single population parameter, including the population proportion and the population mean.

Section 10.1
The Language of Hypothesis Testing

Objectives

❶ Determine the Null and Alternative Hypotheses

❷ Explain Type I and Type II Errors

❸ State Conclusions to Hypothesis Tests

INTRODUCTION, PAGE 2

Answer the following after watching the video.

1) After determining that the first five tosses are all tails is unlikely, what are the two possible conclusions that can be drawn?

Objective 1: Determine the Null and Alternative Hypotheses

OBJECTIVE 1, PAGE 1

Answer the following (2 – 8) after watching the video.

2) What is a hypothesis?

3) Why do we test statements about a population parameter using sample data?

4) State the definition of hypothesis testing.

OBJECTIVE 1, PAGE 1 (CONTINUED)

5) List the 3 steps in hypothesis testing.

6) State the definition of the null hypothesis.

7) State the definition of the alternative hypothesis.

8) List the three ways to set up the null and alternative hypotheses.

Two-tailed test

Left-tailed test

Right-tailed test

OBJECTIVE 1, PAGE 3

9) What type of tests are referred to as one-tailed tests?

10) What determines the structure of the alternative hypothesis (two-tailed, left-tailed, or right-tailed?)

OBJECTIVE 1, PAGE 4

Example 1 ***Forming Hypotheses***

For each situation, determine the null and alternative hypotheses. State whether the test is two-tailed, left-tailed, or right-tailed.

A) The Medco pharmaceutical company has just developed a new antibiotic for children. Two percent of children taking competing antibiotics experience headaches as a side effect. A researcher for the Food and Drug Administration wants to know if the percentage of children taking the new antibiotic and experiencing headaches as a side effect is more than 2%.

B) The Blue Book value of a used three-year-old Chevy Corvette Z06 is $56,130. Grant wonders if the mean price of a used three-year-old Chevy Corvette Z06 in the Miami metropolitan area is different from $56,130.

C) The standard deviation of the contents in a 64-ounce bottle of detergent using an old filling machine is 0.23 ounce. The manufacturer wants to know if a new filling machine has less variability.

Objective 2: Explain Type I and Type II Errors

OBJECTIVE 2, PAGE 1

11) What type of error is called a Type I error?

12) What type of error is called a Type II error?

OBJECTIVE 2, PAGE 2

Answer the following after watching the video.

13) In a jury trial, what are the null and alternative hypotheses?

14) What jury decision is associated with rejecting the null hypothesis?

15) What jury decision is associated with failing to reject the null hypothesis?

15) Is the null hypothesis ever declared “true”?

16) In a jury trial, what decision is equivalent to making a Type I error?

17) In a jury trial, what decision is equivalent to making a Type II error?

OBJECTIVE 2, PAGE 2 (CONTINUED)

18) Sketch the chart that illustrates the four outcomes from hypothesis testing.

OBJECTIVE 2, PAGE 3

Example 2 ***Type I and Type II Errors***

The Medco pharmaceutical company has just developed a new antibiotic. Two percent of children taking competing antibiotics experience headaches as a side effect. A researcher for the Food and Drug Administration wishes to know if the percentage of children taking the new antibiotic who experience a headache as a side effect is more than 2%.
The researcher conducts a hypothesis test with H0: $p = 0.02$ and H1: $p > 0.02$.

Explain what it would mean to make a (A) Type I error and (B) Type II error.

OBJECTIVE 2, PAGE 5

19) What symbols do we use to denote the probability of making a Type I error and the probability of making a Type II error?

OBJECTIVE 2, PAGE 6

20) What does the level of significance represent?

21) What does the choice of the level of significance depend on?

22) Why is the level of significance not always set at $\alpha=0.01$?

Objective 3: State Conclusions to Hypothesis Tests

OBJECTIVE 3, PAGE 1

It is important to recognize that we never accept the null hypothesis. Sample evidence can never prove the null hypothesis to be true. By not rejecting the null hypothesis, we are saying that the evidence indicates that the null hypothesis could be true or that the sample evidence is consistent with the statement in the null hypothesis.

OBJECTIVE 3, PAGE 2

Example 3 ***Stating the Conclusion***

The Medco pharmaceutical company has just developed a new antibiotic. Two percent of children taking competing antibiotics experience a headache as a side effect. A researcher for the Food and Drug Administration believes that the proportion of children taking the new antibiotic who experience a headache as a side effect is more than 0.02. So the null hypothesis is $H_0 : p = 0.02$ and the alternative hypothesis is $H_1 : p > 0.02$.

A) Suppose the sample evidence indicates that the null hypothesis is rejected. State the conclusion.

B) Suppose the sample evidence indicates that the null hypothesis is not rejected. State the conclusion.

Section 10.2
Hypothesis Tests for a Population Proportion

Objectives

❶ Explain the Logic of Hypothesis Testing

❷ Test Hypotheses about a Population Proportion

❸ Test Hypotheses about a Population Proportion Using the Binomial Probability Distribution

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Objective 1: Explain the Logic of Hypothesis Testing

OBJECTIVE 1, PAGE 1

The applet on page 2 will help you to determine what would be convincing evidence that the population proportion of registered voters who are in favor of a certain policy is greater than 50%.

OBJECTIVE 1, PAGE 2

Answer the following after using the Political Poll applet.

1) What is the center of the distribution when you simulate 1000 samples of 500 registered voters?

2) As the sample proportion increases from 52% to 54% to 56%, what happens to the proportion of surveys that resulted in a sample proportion that was greater than or equal to the given sample proportion?

3) Explain how you determined whether the proportion of voters in favor of this policy is greater than 0.5.

OBJECTIVE 1, PAGE 6

4) Give the definition of what it means for a result to be statistically significant.

OBJECTIVE 1, PAGE 7

Note: The sample distribution of $\hat{p}$ is approximately normal, with mean $\mu_{\hat{p}} = p$ and standard deviation $\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}}$, provided that the following requirements are satisfied:

The sample is a simple random sample.

$np(1-p) \geq 10$

The sampled values are independent of each other $(n \leq 0.05N)$.

OBJECTIVE 1, PAGE 8

A criterion for testing hypotheses is to determine how likely the observed sample proportion is under the assumption that the statement in the null hypothesis is true.

For example, for the scenario in Part (C) of the Logic of Hypothesis Testing Activity on page 2, the probability of obtaining a sample proportion of 0.52 or higher from a population whose proportion is assumed to be p = 0.5 is 0.1855.

OBJECTIVE 1, PAGE 9

The likelihood of obtaining a sample statistic can be obtained either through simulation or through the use of the normal model. Both approaches give similar results.

OBJECTIVE 1, PAGE 10

5) Give the definition of a *P*-value.

6) Explain how to determine whether the null hypothesis should be rejected using the *P*-value approach.

OBJECTIVE 1, PAGE 11

Figure 4 illustrates that obtaining a sample proportion of 0.54 or higher from a population whose proportion is 0.5 is unlikely. Therefore, we reject the null hypothesis that p=0.5 and conclude that p>0.5. We do not know what the population proportion of registered voters who are in favor of the policy is, but we have evidence to say that it is greater than 0.5 (a majority).

Objective 2: Test Hypotheses about a Population Proportion

OBJECTIVE 2, PAGE 1

7) What are the three conditions that must be satisfied before testing a hypothesis regarding a population proportion, *p*?

8) State the five steps for testing a hypothesis about a population proportion, *p*.

Step 1

Step 2

Step 3 (By Hand)

Step 3 (Using Technology)

Step 4

Step 5

OBJECTIVE 2, PAGE 2

Example 1 ***Testing a Hypothesis about a Population Proportion: Left-Tailed Test***

The two major college entrance exams that a majority of colleges accept for student admission are the SAT and ACT. ACT looked at historical records and established 22 as the minimum ACT math score for a student to be considered prepared for college mathematics. (Note: "Being prepared" means that there is a 75% probability of successfully completing College Algebra in college.) An official with the Illinois State Department of Education wonders whether less than half of the students in her state are prepared for College Algebra. She obtains a simple random sample of 500 records of students who have taken the ACT and finds that 219 are prepared for college mathematics (that is, scored at least 22 on the ACT math test). Does this represent significant evidence that less than half of Illinois students are prepared for college mathematics upon graduation from a high school? Use the $\alpha = 0.05$ level of significance. Data from ACT High School Profile Report.

OBJECTIVE 2, PAGE 4

Example 2 ***Testing a Hypothesis about a Population Proportion: Two-Tailed Test***

When asked the following question, "Which do you think is more important—protecting the right of Americans to own guns or controlling gun ownership?", 46% of Americans said that protecting the right to own guns is more important. The Pew Research Center surveyed 1267 randomly selected Americans with at least a bachelor's degree and found that 559 believed that protecting the right to own guns is more important. Does this result suggest that the proportion of Americans with at least a bachelor's degree feel differently than the general American population when it comes to gun control? Use the $\alpha = 0.1$ level of significance.

<u>OBJECTIVE 2, PAGE 6</u>

9) Explain how to make a decision about the null hypothesis when performing a two-tailed test using confidence intervals.

<u>OBJECTIVE 2, PAGE 7</u>

Example 3 ***Testing a Hypothesis Using a Confidence Interval***

A 2009 study by Princeton Survey Research Associates International found that 34% of teenagers text while driving. A recent study conducted by AT&T found that 515 of 1200 randomly selected teens had texted while driving. Do the results of this study suggest that the proportion of teens who text while driving has changed since 2009? Use a 95% confidence interval to answer the question.

Objective 3: Test Hypotheses about a Population Proportion Using the Binomial Probability Distribution

OBJECTIVE 3, PAGE 1

For the sampling distribution of $\hat{p}$ to be approximately normal, we require that $np(1-p)$ be at least 10. If this requirement is not satisfied we use the binomial probability formula to determine the *P*-value.

OBJECTIVE 3, PAGE 2

Example 4 ***Hypothesis Test for a Population Proportion: Small Sample Size***

According to the U.S. Department of Agriculture, 48.9% of males aged 20 to 39 years consume the recommended daily requirement of calcium. After an aggressive “Got Milk” advertising campaign, the USDA conducts a survey of 35 randomly selected males aged 20 to 39 and finds that 21 of them consume the recommended daily allowance (RDA) of calcium. At the $\alpha = 0.10$ level of significance, is there evidence to conclude that the percentage of males aged 20 to 39 who consume the RDA of calcium has increased?

Section 10.2A
Hypothesis Tests on a Population Proportion with Simulation

Objectives

❶ Explain the Logic of the Simulation Method

❷ Test Hypotheses about a Population Proportion Using the Simulation Method

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Objective 1: Explain the Logic of the Simulation Method

OBJECTIVE 1, PAGE 1

1) Give the definition of what it means for a result to be statistically significant.

OBJECTIVE 1, PAGE 3

To determine if sample results are statistically significant, we build a model that generates data randomly under the assumption the statement in the null hypothesis is true. Call this model the **null model**. Then compare the results of the randomly generated data from the null model to those observed to see if the observed results are unusual.

OBJECTIVE 1, PAGE 4

Repeating the simulation could lead to different results because of the randomness of the process.

OBJECTIVE 1, PAGE 5

If we repeat the process of simulation many, many times, we will be able to build a null model and use it to determine how often results such as those observed occur in the random process.

OBJECTIVE 1, PAGE 6

2) Give the definition of a *P*-value.

OBJECTIVE 1, PAGE 7

In the ESP study, we used the number of heads observed, 24, as the **test statistic**. We then determined the proportion of times we observed 24 or more heads in many repetitions using the null model.
Instead of using the number of heads as the test statistic, we could have used the sample proportion, $\hat{p} = \frac{24}{40} = 0.6,$ as the test statistic. We would then determine the proportion of times we observed a proportion of heads of 0.6 or higher in many repetitions using the null model.

OBJECTIVE 1, PAGE 10

Answer the following after watching the video.

3) What is the variable of interest in this study?

4) Why does it make sense to analyze this problem using proportions?

5) State the null and alternative hypotheses for this problem.

6) What is the sample proportion for this problem?

We are trying to determine how likely is it to obtain a sample proportion of 0.367 or lower from a population whose proportion is 0.42.

OBJECTIVE 1, PAGE 10

Watch the video to see how to use the urn applet in StatCrunch to simulate the results.

7) List the two guidelines for determining whether to use the coin-flipping applet or the urn applet for simulation.

<u>OBJECTIVE 1, PAGE 11</u>

8) Explain how to determine whether the null hypothesis should be rejected using the *P*-value approach.

9) List the rule of thumb for determining whether the null hypothesis should be rejected.

Objective 2: Test Hypotheses about a Population Proportion Using the Simulation Method

<u>OBJECTIVE 2, PAGE 1</u>

10) State the five steps for testing a hypothesis about a population proportion using simulation.

Step 1

Step 2

Step 3

Step 4

Step 5

OBJECTIVE 2, PAGE 2

Example 1 ***Testing a Hypothesis about a Population Proportion: Left-Tailed Test***

The two major college entrance exams that a majority of colleges accept for student admission are the SAT and ACT. ACT looked at historical records and established 22 as the minimum ACT math score for a student to be considered prepared for college mathematics. (Note: "Being prepared" means that there is a 75% probability of successfully completing College Algebra in college.) An official with the Illinois State Department of Education wonders whether less than half of the students in her state are prepared for College Algebra. She obtains a simple random sample of 500 records of students who have taken the ACT and finds that 219 are prepared for college mathematics (that is, scored at least 22 on the ACT math test). Does this represent significant evidence that less than half of Illinois students are prepared for college mathematics upon graduation from a high school?

OBJECTIVE 2, PAGE 4

Example 2 ***Testing a Hypothesis about a Population Proportion: Two-Tailed Test***

When asked the following question, "Which do you think is more important—protecting the right of Americans to own guns or controlling gun ownership?", 46% of Americans said that protecting the right to own guns is more important. The Pew Research Center surveyed 1267 randomly selected Americans with at least a bachelor's degree and found that 559 believed that protecting the right to own guns is more important. Does this result suggest that the proportion of Americans with at least a bachelor's degree feel differently than the general American population when it comes to gun control?

Section 10.2B
Hypothesis Tests on a Population Proportion Using the Normal Model

Objectives

❶ Explain the Logic of Hypothesis Testing Using the Normal Model

❷ Test Hypotheses about a Population Proportion Using the Normal Model

❸ Test Hypotheses about a Population Proportion Using the Binomial Probability Distribution

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Objective 1: Explain the Logic of Hypothesis Testing Using the Normal Model

OBJECTIVE 1, PAGE 1

One of the examples presented in Section 10.2A dealt with congressional districts. Recall the scenario. Prior to redistricting, the proportion of registered Republicans in a congressional district was 0.42. After redistricting, a random sample of 60 voters resulted in 22 being Republican. The goal of the research was to determine if the proportion of voters in the district registered as Republican decreased after redistricting. The hypotheses to be tested were H_0: $p = 0.42$ versus H_1: $p < 0.42$, and the StatCrunch urn applet was used.

Watch the video to continue the discussion of the problem, then answer the following.

1) What is the shape of the sampling distribution of the sample proportions?

2) List the formulas for the mean and standard deviation of the sampling distribution of the sample proportion and use them to compute the theoretical mean and standard deviation. How close were they to the mean and standard deviation of the 5000 simulated sample proportions?

3) Verify that the normal model may be used to describe the sampling distribution of the sample proportion.

OBJECTIVE 1, PAGE 1 (CONTINUED)

OBJECTIVE 1, PAGE 1 (CONTINUED)

4) Use the normal model to determine the probability of observing 22 or fewer Republicans in a district whose population proportion is 0.42.

OBJECTIVE 1, PAGE 2

The sample distribution of $\hat{p}$ is approximately normal, with mean $\mu_{\hat{p}} = p$ and standard deviation $\sigma_{\hat{p}} = \sqrt{\frac{p(1-p)}{n}}$, provided that the following requirements are satisfied:

The sample is a simple random sample.

$np(1-p) \geq 10$

The sampled values are independent of each other $(n \leq 0.05N)$.

Rather than using simulation to approximate a *P*-value, we can use a normal model to determine the *P*-value for a hypothesis test about a population proportion.

Objective 2: Test Hypotheses about a Population Proportion Using the Normal Model

OBJECTIVE 2, PAGE 1

5) What are the three conditions that must be satisfied before testing a hypothesis regarding a population proportion, *p*?

<u>OBJECTIVE 2, PAGE 1 (CONTINUED)</u>

6) State the five steps for testing a hypothesis about a population proportion, *p*.

Step 1

Step 2

Step 3 (By Hand)

Step 3 (Using Technology)

Step 4

Step 5

OBJECTIVE 2, PAGE 2

Example 1 ***Testing a Hypothesis about a Population Proportion: Left-Tailed Test***

The two major college entrance exams that a majority of colleges accept for student admission are the SAT and ACT. ACT looked at historical records and established 22 as the minimum ACT math score for a student to be considered prepared for college mathematics. (Note: “Being prepared” means that there is a 75% probability of successfully completing College Algebra in college.) An official with the Illinois State Department of Education wonders whether less than half of the students in her state are prepared for College Algebra. She obtains a simple random sample of 500 records of students who have taken the ACT and finds that 219 are prepared for college mathematics (that is, scored at least 22 on the ACT math test). Does this represent significant evidence that less than half of Illinois students are prepared for college mathematics upon graduation from a high school? Use the $\alpha = 0.05$ level of significance. Data from ACT High School Profile Report.

<u>OBJECTIVE 2, PAGE 4</u>

Example 2 ***Testing a Hypothesis about a Population Proportion: Two-Tailed Test***

When asked the following question, "Which do you think is more important—protecting the right of Americans to own guns or controlling gun ownership?", 46% of Americans said that protecting the right to own guns is more important. The Pew Research Center surveyed 1267 randomly selected Americans with at least a bachelor's degree and found that 559 believed that protecting the right to own guns is more important. Does this result suggest that the proportion of Americans with at least a bachelor's degree feel differently than the general American population when it comes to gun control? Use the $\alpha = 0.1$ level of significance.

OBJECTIVE 2, PAGE 6

9) Explain how to make a decision about the null hypothesis when performing a two-tailed test using confidence intervals.

OBJECTIVE 2, PAGE 7

Example 3 ***Testing a Hypothesis Using a Confidence Interval***

A 2009 study by Princeton Survey Research Associates International found that 34% of teenagers text while driving. A recent study conducted by AT&T found that 515 of 1200 randomly selected teens had texted while driving. Do the results of this study suggest that the proportion of teens who text while driving has changed since 2009? Use a 95% confidence interval to answer the question.

Objective 3: Test Hypotheses about a Population Proportion Using the Binomial Probability Distribution

OBJECTIVE 3, PAGE 1

For the sampling distribution of $\hat{p}$ to be approximately normal, we require that $np(1-p)$ be at least 10. If this requirement is not satisfied we use the binomial probability formula to determine the *P*-value.

OBJECTIVE 3, PAGE 2

Example 4 ***Hypothesis Test for a Population Proportion: Small Sample Size***

According to the U.S. Department of Agriculture, 48.9% of males aged 20 to 39 years consume the recommended daily requirement of calcium. After an aggressive "Got Milk" advertising campaign, the USDA conducts a survey of 35 randomly selected males aged 20 to 39 and finds that 21 of them consume the recommended daily allowance (RDA) of calcium. At the $\alpha = 0.10$ level of significance, is there evidence to conclude that the percentage of males aged 20 to 39 who consume the RDA of calcium has increased?

Section 10.3
Hypothesis Tests for a Population Mean

Objectives

❶ Test Hypotheses about a Mean

❷ Explain the Difference between Statistical Significance and Practical Significance

Objective 1: Test Hypotheses about a Mean

OBJECTIVE 1, PAGE 1

Answer the following after watching the video that explains the procedure for testing hypotheses about a mean.

1) What are the three conditions that must be satisfied before testing a hypothesis regarding a population mean, μ?

2) State the five steps for testing a hypothesis about a population mean, μ.

Step 1

Step 2

OBJECTIVE 1, PAGE 1 (CONTINUED)

Step 3 (By Hand)

Step 3 (Using Technology)

Step 4

Step 5

OBJECTIVE 1, PAGE 2

3) What tool is used to determine if the sample is drawn from a population that is normally distributed?

4) What tool is used to determine if the sample contains outliers?

OBJECTIVE 1, PAGE 3

Example 1 ***Testing a Hypothesis about a Population Mean: Large Sample***

The mean height of American males is 69.5 inches. The heights of the 44 male U.S. presidents (Washington through Trump) have a mean of 70.84 inches and a standard deviation of 2.73 inches. Treating the 44 presidents as a simple random sample, determine whether there is evidence to suggest that U.S. presidents are taller than the average American male. Use the $\alpha = 0.05$ level of significance. (Note: Grover Cleveland was elected to two nonconsecutive terms, so technically there have been 45 presidents of the United States.)

OBJECTIVE 1, PAGE 5

Example 2 ***Testing a Hypothesis about a Population Mean: Small Sample***

The "fun size" of a Snickers bar is supposed to weigh 20 grams. Because the penalty for selling candy bars under their advertised weight is severe, the manufacturer calibrates the machine so that the mean weight is 20.1 grams. The quality control engineer at Mars, the Snickers manufacturer, is concerned about the calibration. He obtains a random sample of 11 candy bars, weighs them, and obtains the data in Table 1. Should the machine be shut down and calibrated? Because shutting down the plant is expensive, he decides to conduct the test at the $\alpha = 0.01$ level of significance.

Table 1

19.68	20.66	19.56
19.98	20.65	19.61
20.55	20.36	21.02
21.50	19.74	

Data from Michael Carlisle, student at Joliet Junior College

Objective 2: Explain the Difference between Statistical Significance and Practical Significance

OBJECTIVE 2, PAGE 1

5) What does practical significance refer to?

OBJECTIVE 2, PAGE 2

Example 3 ***Statistical versus Practical Significance***

According to the American Community Survey, the mean travel time to work in Collin County, Texas, is 27.6 minutes. The Department of Transportation reprogrammed all the traffic lights in Collin County in an attempt to reduce travel time. To determine whether there is evidence that travel time has decreased as a result of the reprogramming, the Department of Transportation obtains a random sample of 2500 commuters, records their travel time to work, and finds a sample mean of 27.3 minutes with a standard deviation of 8.5 minutes. Does this result suggest that travel time has decreased at the $\alpha = 0.05$ level of significance?

OBJECTIVE 2, PAGE 3

Large sample sizes can lead to results that are statistically significant, whereas the difference between the statistic and parameter in the null hypothesis is not enough to be considered practically significant.

Section 10.3A
Hypothesis Tests on a Population Mean Using Simulation and the Bootstrap

Objectives

❶ Test Hypotheses about a Population Mean Using the Simulation Method

❷ Test Hypotheses about a Population Mean Using the Bootstrap

INTRODUCTION, PAGE 1

1) In tests regarding the population mean, the null hypothesis will be H_0: $\mu = \mu_0$. What are the three possible alternative hypotheses?

The statement in the null hypothesis is assumed to be true and we are looking for evidence in support of the statement in the alternative hypothesis. Put another way, we want to know if a sample mean could come from a population whose mean is μ_0 and any difference between μ_0 and the sample mean is due to random chance. Or, is the sample mean from a population whose mean is different from (two-tailed), less than (left-tailed), or greater than (right-tailed) μ_0?

INTRODUCTION, PAGE 2

Means are computed from quantitative data, so coins and urns are not going to be useful in simulating outcomes to build a null model that could be used to conduct inference on the mean. There are two approaches that may be utilized in building the null model when testing claims about a population mean – the simulation method and the Bootstrap.

Objective 1: Test Hypotheses about a Population Mean Using the Simulation Method

OBJECTIVE 1, PAGE 1

1) In order to test hypotheses about a population mean, what are the requirements to use the simulation method to build the null model?

2) Explain how the simulation method is used to approximate the *P*-value.

OBJECTIVE 1, PAGE 2

Example 1 ***Testing a Hypothesis about a Population Mean Using Simulation***

Coors Field is home to the Colorado Rockies baseball team and is located in Denver, Colorado. Denver is approximately one mile above sea level where the air is thinner. Therefore, baseballs are thought to travel farther in this stadium. Does the evidence support this belief? In a random sample of 15 homeruns hit in Coors Field, the mean distance the ball traveled was 417.3 feet. Does this represent evidence to suggest that the ball travels farther in Coors Field than it does in the other Major League ballparks?

427	383	399	444	414
397	421	395	427	432
399	415	433	427	446

OBJECTIVE 1, PAGE 3

3) State the four steps for testing a hypothesis about a population mean using simulation.

Step 1

Step 2

Step 3

Step 4

OBJECTIVE 1, PAGE 4

Note that the *P*-value for the hypothesis test $H_0: \mu = 400.0$ feet versus $H_1: \mu > 400.0$ feet using Student's *t*-distribution is 0.0017, which is very close to the approximate *P*-value using simulation of 0.002 we obtained in Example 1.

Objective 2: Test Hypotheses about a Population Mean Using the Bootstrap

OBJECTIVE 2, PAGE 1

4) When using the bootstrap method, is the sampling done with replacement or without replacement?

5) In doing any hypothesis testing, we always generate the sampling distribution under the assumption the null hypothesis is true. When using bootstrapping to test hypotheses about a population mean, what first must be done to the sample data?

OBJECTIVE 2, PAGE 2

Example 2 ***Using the Bootstrap Method Testing a Hypothesis about a Population Mean: Small Sample***

The "fun size" of a Snickers bar is supposed to weigh 20 grams. Because the penalty for selling candy bars under their advertised weight is severe, the manufacturer calibrates the machine so that the mean weight is 20.1 grams. The quality control engineer at Mars, the Snickers manufacturer, is concerned about the calibration. He obtains a random sample of 11 candy bars, weighs them, and obtains the data in Table 1. Should the machine be shut down and calibrated?

Table 1

19.68	20.66	19.56	21.50
19.98	20.65	19.61	19.74
20.55	20.36	21.02	

Data from Michael Carlisle, student at Joliet Junior College

OBJECTIVE 2, PAGE 3

6) State the four steps for testing a hypothesis about a population mean using simulation.

Step 1

Step 2

Step 3

Step 4

OBJECTIVE 1, PAGE 4

Note that the *P*-value for the hypothesis in Example 2 using Student's *t*-distribution is 0.3226. This is fairly close to the approximate *P*-value using the Bootstrap method.

Section 10.4
Putting It Together: Which Procedure Do I Use?

Objective

❶ Determine the Appropriate Hypothesis Test to Perform

Objective 1: Determine the Appropriate Hypothesis Test to Perform

OBJECTIVE 1, PAGE 1

Answer the following after watching the video.

1) What is the type of the variable of interest when testing a population proportion, *p*?

2) List two of the conditions that must be met when testing a population proportion, *p*.

3) What is the type of the variable of interest when testing a population mean, μ?

4) Besides the facts that the sample must be obtained by simple random sampling or through a randomized experiment and that the sample size must be small relative to the size of the population, what other condition must be satisfied?

<u>OBJECTIVE 1, PAGE 1</u>

Flowchart for Determining Which Type of Test to Perform