

## 7.H: Hypothesis Testing (Homework + Practice)

### 9.2 Null and Alternative Hypotheses

45. Some of the following statements refer to the null hypothesis, some to the alternate hypothesis.

State the null hypothesis,  $H_0$ , and the alternative hypothesis,  $H_a$ , in terms of the appropriate parameter ( $\mu$  or  $p$ ).

- The mean number of years Americans work before retiring is 34.
- At most 60% of Americans vote in presidential elections.
- The mean starting salary for San Jose State University graduates is at least \$100,000 per year.
- Twenty-nine percent of high school seniors get drunk each month.
- Fewer than 5% of adults ride the bus to work in Los Angeles.
- The mean number of cars a person owns in her lifetime is not more than ten.
- About half of Americans prefer to live away from cities, given the choice.
- Europeans have a mean paid vacation each year of six weeks.
- The chance of developing breast cancer is under 11% for women.
- Private universities' mean tuition cost is more than \$20,000 per year.

46. Over the past few decades, public health officials have examined the link between weight concerns and teen girls' smoking. Researchers surveyed a group of 273 randomly selected teen girls living in Massachusetts (between 12 and 15 years old). After four years the girls were surveyed again. Sixty-three said they smoked to stay thin. Is there good evidence that more than thirty percent of the teen girls smoke to stay thin? The alternative hypothesis is:

- $p < 0.30$
- $p \leq 0.30$
- $p \geq 0.30$
- $p > 0.30$

47. A statistics instructor believes that fewer than 20% of Evergreen Valley College (EVC) students attended the opening night midnight showing of the latest Harry Potter movie. She surveys 84 of her students and finds that 11 attended the midnight showing. An appropriate alternative hypothesis is:

- $p = 0.20$
- $p > 0.20$
- $p < 0.20$
- $p \leq 0.20$

48. Previously, an organization reported that teenagers spent 4.5 hours per week, on average, on the phone. The organization thinks that, currently, the mean is higher. Fifteen randomly chosen teenagers were asked how many hours per week they spend on the phone. The sample mean was 4.75 hours with a sample standard deviation of 2.0. Conduct a hypothesis test. The null and alternative hypotheses are:

- $H_0: \bar{x} = 4.5, H_a: \bar{x} > 4.5$
- $H_0: \mu \geq 4.5, H_a: \mu < 4.5$
- $H_0: \mu = 4.75, H_a: \mu > 4.75$
- $H_0: \mu = 4.5, H_a: \mu > 4.5$

### 9.3 Outcomes and the Type I and Type II Errors

49. State the Type I and Type II errors in complete sentences given the following statements.

- The mean number of years Americans work before retiring is 34.
- At most 60% of Americans vote in presidential elections.
- The mean starting salary for San Jose State University graduates is at least \$100,000 per year.
- Twenty-nine percent of high school seniors get drunk each month.
- Fewer than 5% of adults ride the bus to work in Los Angeles.
- The mean number of cars a person owns in his or her lifetime is not more than ten.
- About half of Americans prefer to live away from cities, given the choice.
- Europeans have a mean paid vacation each year of six weeks.
- The chance of developing breast cancer is under 11% for women.
- Private universities mean tuition cost is more than \$20,000 per year.

50. For statements a-j in [Exercise 9.109](#), answer the following in complete sentences.

- a. State a consequence of committing a Type I error.
- b. State a consequence of committing a Type II error.

51. When a new drug is created, the pharmaceutical company must subject it to testing before receiving the necessary permission from the Food and Drug Administration (FDA) to market the drug. Suppose the null hypothesis is “the drug is unsafe.” What is the Type II Error?

- a. To conclude the drug is safe when in, fact, it is unsafe.
- b. Not to conclude the drug is safe when, in fact, it is safe.
- c. To conclude the drug is safe when, in fact, it is safe.
- d. Not to conclude the drug is unsafe when, in fact, it is unsafe.

52. A statistics instructor believes that fewer than 20% of Evergreen Valley College (EVC) students attended the opening midnight showing of the latest Harry Potter movie. She surveys 84 of her students and finds that 11 of them attended the midnight showing. The Type I error is to conclude that the percent of EVC students who attended is \_\_\_\_\_.

- a. at least 20%, when in fact, it is less than 20%.
- b. 20%, when in fact, it is 20%.
- c. less than 20%, when in fact, it is at least 20%.
- d. less than 20%, when in fact, it is less than 20%.

53. It is believed that Lake Tahoe Community College (LTCC) Intermediate Algebra students get less than seven hours of sleep per night, on average. A survey of 22 LTCC Intermediate Algebra students generated a mean of 7.24 hours with a standard deviation of 1.93 hours. At a level of significance of 5%, do LTCC Intermediate Algebra students get less than seven hours of sleep per night, on average?

The Type II error is not to reject that the mean number of hours of sleep LTCC students get per night is at least seven when, in fact, the mean number of hours

- a. is more than seven hours.
- b. is at most seven hours.
- c. is at least seven hours.
- d. is less than seven hours.

54. Previously, an organization reported that teenagers spent 4.5 hours per week, on average, on the phone. The organization thinks that, currently, the mean is higher. Fifteen randomly chosen teenagers were asked how many hours per week they spend on the phone. The sample mean was 4.75 hours with a sample standard deviation of 2.0. Conduct a hypothesis test, the Type I error is:

- a. to conclude that the current mean hours per week is higher than 4.5, when in fact, it is higher
- b. to conclude that the current mean hours per week is higher than 4.5, when in fact, it is the same
- c. to conclude that the mean hours per week currently is 4.5, when in fact, it is higher
- d. to conclude that the mean hours per week currently is no higher than 4.5, when in fact, it is not higher

#### 9.4 Distribution Needed for Hypothesis Testing

55. It is believed that Lake Tahoe Community College (LTCC) Intermediate Algebra students get less than seven hours of sleep per night, on average. A survey of 22 LTCC Intermediate Algebra students generated a mean of 7.24 hours with a standard deviation of 1.93 hours. At a level of significance of 5%, do LTCC Intermediate Algebra students get less than seven hours of sleep per night, on average? The distribution to be used for this test is  $X - \bar{X} - \sim$  \_\_\_\_\_

- a.  $N(7.24, 1.9322\sqrt{22})$
- b.  $N(7.24, 1.93)N(7.24, 1.93)$
- c.  $t_{22}$
- d.  $t_{21}$

#### 9.5 Full Hypothesis Test Examples

56. A particular brand of tires claims that its deluxe tire averages at least 50,000 miles before it needs to be replaced. From past studies of this tire, the standard deviation is known to be 8,000. A survey of owners of that tire design is conducted. From the 28 tires surveyed, the mean lifespan was 46,500 miles with a standard deviation of 9,800 miles. Using  $\alpha = 0.05$ , is the data highly inconsistent with the claim?

57. From generation to generation, the mean age when smokers first start to smoke varies. However, the standard deviation of that age remains constant of around 2.1 years. A survey of 40 smokers of this generation was done to see if the mean starting age is at

least 19. The sample mean was 18.1 with a sample standard deviation of 1.3. Do the data support the claim at the 5% level?

58. The cost of a daily newspaper varies from city to city. However, the variation among prices remains steady with a standard deviation of 20¢. A study was done to test the claim that the mean cost of a daily newspaper is \$1.00. Twelve costs yield a mean cost of 95¢ with a standard deviation of 18¢. Do the data support the claim at the 1% level?

59. An article in the *San Jose Mercury News* stated that students in the California state university system take 4.5 years, on average, to finish their undergraduate degrees. Suppose you believe that the mean time is longer. You conduct a survey of 49 students and obtain a sample mean of 5.1 with a sample standard deviation of 1.2. Do the data support your claim at the 1% level?

60. The mean number of sick days an employee takes per year is believed to be about ten. Members of a personnel department do not believe this figure. They randomly survey eight employees. The number of sick days they took for the past year are as follows: 12; 4; 15; 3; 11; 8; 6; 8. Let  $x$  = the number of sick days they took for the past year. Should the personnel team believe that the mean number is ten?

61. In 1955, *Life Magazine* reported that the 25 year-old mother of three worked, on average, an 80 hour week. Recently, many groups have been studying whether or not the women's movement has, in fact, resulted in an increase in the average work week for women (combining employment and at-home work). Suppose a study was done to determine if the mean work week has increased. 81 women were surveyed with the following results. The sample mean was 83; the sample standard deviation was ten. Does it appear that the mean work week has increased for women at the 5% level?

62. Your statistics instructor claims that 60 percent of the students who take her Elementary Statistics class go through life feeling more enriched. For some reason that she can't quite figure out, most people don't believe her. You decide to check this out on your own. You randomly survey 64 of her past Elementary Statistics students and find that 34 feel more enriched as a result of her class. Now, what do you think?

63. A Nissan Motor Corporation advertisement read, "The average man's I.Q. is 107. The average brown trout's I.Q. is 4. So why can't man catch brown trout?" Suppose you believe that the brown trout's mean I.Q. is greater than four. You catch 12 brown trout. A fish psychologist determines the I.Q.s as follows: 5; 4; 7; 3; 6; 4; 5; 3; 6; 3; 8; 5. Conduct a hypothesis test of your belief.

64. Refer to [Exercise 9.119](#). Conduct a hypothesis test to see if your decision and conclusion would change if your belief were that the brown trout's mean I.Q. is **not** four.

65. According to an article in *Newsweek*, the natural ratio of girls to boys is 100:105. In China, the birth ratio is 100: 114 (46.7% girls). Suppose you don't believe the reported figures of the percent of girls born in China. You conduct a study. In this study, you count the number of girls and boys born in 150 randomly chosen recent births. There are 60 girls and 90 boys born of the 150. Based on your study, do you believe that the percent of girls born in China is 46.7%?

66. A poll done for *Newsweek* found that 13% of Americans have seen or sensed the presence of an angel. A contingent doubts that the percent is really that high. It conducts its own survey. Out of 76 Americans surveyed, only two had seen or sensed the presence of an angel. As a result of the contingent's survey, would you agree with the *Newsweek* poll? In complete sentences, also give three reasons why the two polls might give different results.

67. The mean work week for engineers in a start-up company is believed to be about 60 hours. A newly hired engineer hopes that it's shorter. She asks ten engineering friends in start-ups for the lengths of their mean work weeks. Based on the results that follow, should she count on the mean work week to be shorter than 60 hours?

Data (length of mean work week): 70; 45; 55; 60; 65; 55; 55; 60; 50; 55.

68. Sixty-eight percent of online courses taught at community colleges nationwide were taught by full-time faculty. To test if 68% also represents California's percent for full-time faculty teaching the online classes, Long Beach City College (LBCC) in California, was randomly selected for comparison. In the same year, 34 of the 44 online courses LBCC offered were taught by full-time faculty. Conduct a hypothesis test to determine if 68% represents California. NOTE: For more accurate results, use more California community colleges and this past year's data.

69. According to an article in *Bloomberg Businessweek*, New York City's most recent adult smoking rate is 14%. Suppose that a survey is conducted to determine this year's rate. Nine out of 70 randomly chosen N.Y. City residents reply that they smoke. Conduct a hypothesis test to determine if the rate is still 14% or if it has decreased.

70. The mean age of De Anza College students in a previous term was 26.6 years old. An instructor thinks the mean age for online students is older than 26.6. She randomly surveys 56 online students and finds that the sample mean is 29.4 with a standard deviation of 2.1. Conduct a hypothesis test.

71. Registered nurses earned an average annual salary of \$69,110. For that same year, a survey was conducted of 41 California registered nurses to determine if the annual salary is higher than \$69,110 for California nurses. The sample average was \$71,121 with a sample standard deviation of \$7,489. Conduct a hypothesis test.

72. La Leche League International reports that the mean age of weaning a child from breastfeeding is age four to five worldwide. In America, most nursing mothers wean their children much earlier. Suppose a random survey is conducted of 21 U.S. mothers who recently weaned their children. The mean weaning age was nine months ( $3/4$  year) with a standard deviation of 4 months. Conduct a hypothesis test to determine if the mean weaning age in the U.S. is less than four years old.

73. Over the past few decades, public health officials have examined the link between weight concerns and teen girls' smoking. Researchers surveyed a group of 273 randomly selected teen girls living in Massachusetts (between 12 and 15 years old). After four years the girls were surveyed again. Sixty-three said they smoked to stay thin. Is there good evidence that more than thirty percent of the teen girls smoke to stay thin?

After conducting the test, your decision and conclusion are

74. A statistics instructor believes that fewer than 20% of Evergreen Valley College (EVC) students attended the opening night midnight showing of the latest Harry Potter movie. She surveys 84 of her students and finds that 11 of them attended the midnight showing.

At a 1% level of significance, an appropriate conclusion is:

- There is insufficient evidence to conclude that the percent of EVC students who attended the midnight showing of Harry Potter is less than 20%.
- There is sufficient evidence to conclude that the percent of EVC students who attended the midnight showing of Harry Potter is more than 20%.
- There is sufficient evidence to conclude that the percent of EVC students who attended the midnight showing of Harry Potter is less than 20%.
- There is insufficient evidence to conclude that the percent of EVC students who attended the midnight showing of Harry Potter is at least 20%.

75. Previously, an organization reported that teenagers spent 4.5 hours per week, on average, on the phone. The organization thinks that, currently, the mean is higher. Fifteen randomly chosen teenagers were asked how many hours per week they spend on the phone. The sample mean was 4.75 hours with a sample standard deviation of 2.0. Conduct a hypothesis test.

At a significance level of  $\alpha = 0.05$ , what is the correct conclusion?

- There is enough evidence to conclude that the mean number of hours is more than 4.75
- There is enough evidence to conclude that the mean number of hours is more than 4.5
- There is not enough evidence to conclude that the mean number of hours is more than 4.5
- There is not enough evidence to conclude that the mean number of hours is more than 4.75

*Instructions: For the following ten exercises,*

*Hypothesis testing: For the following ten exercises, answer each question.*

- State the null and alternate hypothesis.
- State the  $p$ -value.
- State  $\alpha$ .
- What is your decision?
- Write a conclusion.
- Answer any other questions asked in the problem.

76. According to the Center for Disease Control website, in 2011 at least 18% of high school students have smoked a cigarette. An Introduction to Statistics class in Davies County, KY conducted a hypothesis test at the local high school (a medium sized—approximately 1,200 students—small city demographic) to determine if the local high school's percentage was lower. One hundred fifty students were chosen at random and surveyed. Of the 150 students surveyed, 82 have smoked. Use a significance level of 0.05 and using appropriate statistical evidence, conduct a hypothesis test and state the conclusions.

77. A recent survey in the *N.Y. Times Almanac* indicated that 48.8% of families own stock. A broker wanted to determine if this survey could be valid. He surveyed a random sample of 250 families and found that 142 owned some type of stock. At the 0.05 significance level, can the survey be considered to be accurate?

78. Driver error can be listed as the cause of approximately 54% of all fatal auto accidents, according to the American Automobile Association. Thirty randomly selected fatal accidents are examined, and it is determined that 14 were caused by driver error. Using  $\alpha = 0.05$ , is the AAA proportion accurate?

79. The US Department of Energy reported that 51.7% of homes were heated by natural gas. A random sample of 221 homes in Kentucky found that 115 were heated by natural gas. Does the evidence support the claim for Kentucky at the  $\alpha = 0.05$  level in Kentucky? Are the results applicable across the country? Why?

**80.** For Americans using library services, the American Library Association claims that at most 67% of patrons borrow books. The library director in Owensboro, Kentucky feels this is not true, so she asked a local college statistic class to conduct a survey. The class randomly selected 100 patrons and found that 82 borrowed books. Did the class demonstrate that the percentage was higher in Owensboro, KY? Use  $\alpha = 0.01$  level of significance. What is the possible proportion of patrons that do borrow books from the Owensboro Library?

**81.** The Weather Underground reported that the mean amount of summer rainfall for the northeastern US is at least 11.52 inches. Ten cities in the northeast are randomly selected and the mean rainfall amount is calculated to be 7.42 inches with a standard deviation of 1.3 inches. At the  $\alpha = 0.05$  level, can it be concluded that the mean rainfall was below the reported average? What if  $\alpha = 0.01$ ? Assume the amount of summer rainfall follows a normal distribution.

**82.** A survey in the *N.Y. Times Almanac* finds the mean commute time (one way) is 25.4 minutes for the 15 largest US cities. The Austin, TX chamber of commerce feels that Austin's commute time is less and wants to publicize this fact. The mean for 25 randomly selected commuters is 22.1 minutes with a standard deviation of 5.3 minutes. At the  $\alpha = 0.10$  level, is the Austin, TX commute significantly less than the mean commute time for the 15 largest US cities?

**83.** A report by the Gallup Poll found that a woman visits her doctor, on average, at most 5.8 times each year. A random sample of 20 women results in these yearly visit totals

3; 2; 1; 3; 7; 2; 9; 4; 6; 6; 8; 0; 5; 6; 4; 2; 1; 3; 4; 1

At the  $\alpha = 0.05$  level can it be concluded that the sample mean is higher than 5.8 visits per year?

**84.** According to the *N.Y. Times Almanac* the mean family size in the U.S. is 3.18. A sample of a college math class resulted in the following family sizes:

5; 4; 5; 4; 4; 3; 6; 4; 3; 3; 5; 5; 6; 3; 3; 2; 7; 4; 5; 2; 2; 3; 2

At  $\alpha = 0.05$  level, is the class' mean family size greater than the national average? Does the Almanac result remain valid? Why?

**85.** The student academic group on a college campus claims that freshman students study at least 2.5 hours per day, on average. One Introduction to Statistics class was skeptical. The class took a random sample of 30 freshman students and found a mean study time of 137 minutes with a standard deviation of 45 minutes. At  $\alpha = 0.01$  level, is the student academic group's claim correct?

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