HYPOTHESIS TESTING OF SINGLE MEAN AND SINGLE PROPORTION: HOMEWORK (MODIFIED R. BLOOM)*

Roberta Bloom

Based on Hypothesis Testing of Single Mean and Single Proportion: Homework[†] by

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Abstract

This module provides a homework of Hypothesis Testing of Single Mean and Single Proportion as a part of Collaborative Statistics collection (col10522) by Barbara Illowsky and Susan Dean. The original module has been revised by R. Bloom; some problems have been omitted.

Some exercises from the original version of this textbook have been removed in this revision of this section: #11,12,14,18-24,26,27. They are available at http://cnx.org/content/m17001/

Exercise 1 (Solution on p. 8.)

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

State the null hypothesis, H_{-} and the alternative hypothesis, H_{-} in terms of the appropriate the null hypothesis.

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

- a. Americans work an average of 34 years before retiring.
- **b.** At most 60% of Americans vote in presidential elections.
- c. The average starting salary for San Jose State University graduates is at least \$100,000 per year.
- d. 29% of high school seniors get drunk each month.
- e. Fewer than 5% of adults ride the bus to work in Los Angeles.
- f. The average number of cars a person owns in her lifetime is not more than 10.
- g. About half of Americans prefer to live away from cities, given the choice.
- **h.** Europeans have an average paid vacation each year of six weeks.
- i. The chance of developing breast cancer is under 11% for women.

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 $^{^{\}dagger}$ http://cnx.org/content/m17001/1.8/

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j. Private universities cost, on average, more than \$20,000 per year for tuition.

Exercise 2 (Solution on p. 8.)

For (a) - (j) above, state the Type I and Type II errors in complete sentences.

Exercise 3

For (a) - (j) above, in complete sentences:

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

NOTE: For each of the word problems, use a solution sheet to do the hypothesis test.

NOTE: If you are using a student-t distribution for a homework problem below, you may assume that the underlying population is normally distributed. (However, in general, a statistician would first need to verify that this assumption is reasonable before applying a t-test.)

Exercise 4

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 8000. A survey of owners of that tire design is conducted. From the 28 tires surveyed, the average lifespan was 46,500 miles with a standard deviation of 9800 miles. Do the data support the claim at the 5% level?

Exercise 5 (Solution on p. 8.)

From generation to generation, the average 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 average starting age is at least 19. The sample average was 18.1 with a sample standard deviation of 1.3. Do the data support the claim at the 5% level?

Exercise 6

The cost of a daily newspaper varies from city to city. However, the variation among prices remains steady with a standard deviation of 6c. A study was done to test the claim that the average cost of a daily newspaper is 35c. Twelve costs yield an average cost of 30c with a standard deviation of 4c. Do the data support the claim at the 1% level?

Exercise 7 (Solution on p. 8.)

An article in the **San Jose Mercury News** stated that students in the California state university system take an average of 4.5 years to finish their undergraduate degrees. Suppose you believe that the average 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?

Exercise 8

The average number of sick days an employee takes per year is believed to be about 10. Members of a personnel department do not believe this figure. They randomly survey 8 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 average number is about 10?

Exercise 9 (Solution on p. 8.)

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 average work week has increased. 81 women were surveyed with the following results. The sample average was 83 hours; the sample

standard deviation was 10 hours. Does it appear that the average work week has increased for women at the 5% level?

Exercise 10

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?

Exercise 11

Exercise 11 removed from textbook

Exercise 12

Exercise 12 removed from textbook

Exercise 13 (Solution on p. 8.)

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?

Exercise 14

Exercise 14 removed from textbook

Exercise 15 (Solution on p. 8.)

The average 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 a random sample of 10 engineers working in start-ups for the lengths of their average work weeks. Based on the results that follow, should she count on the average work week to be shorter than 60 hours?

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

Exercise 16

Use the "Lap time" data for Lap 4 (see Table of Contents) to test the claim that Terri finishes Lap 4 on average in less than 129 seconds. Use all twenty races given.

Exercise 17

Use the "Initial Public Offering" data (see Table of Contents) to test the claim that the average offer price was \$18 per share. Do not use all the data. Use your random number generator to randomly survey 15 prices.

Exercise 18

Exercise removed from textbook.

Exercise 19

Exercise removed from textbook

Exercise 20

Exercise removed from textbook

Exercise 21

Exercise removed from textbook

Exercise 22

Exercise removed from textbook

Exercise 23

Exercise removed from textbook

Exercise 24

Exercise removed from textbook

Exercise 25 (Solution on p. 9.)

Japanese Girls' Names, by Kumi Furuichi

It used to be very typical for Japanese girls' names to end with "ko." (The trend might have started around my grandmothers' generation and its peak might have been around my mother's generation.) "Ko" means "child" in Chinese character. Parents would name their daughters with "ko" attaching to other Chinese characters which have meanings that they want their daughters to become, such as Sachiko – a happy child, Yoshiko – a good child, Yasuko – a healthy child, and so on

However, I noticed recently that only two out of nine of my Japanese girlfriends at this school have names which end with "ko." More and more, parents seem to have become creative, modernized, and, sometimes, westernized in naming their children.

I have a feeling that, while 70 percent or more of my mother's generation would have names with "ko" at the end, the proportion has dropped among my peers. I wrote down all my Japanese friends', ex-classmates', co-workers, and acquaintances' names that I could remember. Below are the names. (Some are repeats.) Test to see if the proportion has dropped for this generation.

Ai, Akemi, Akiko, Ayumi, Chiaki, Chie, Eiko, Eri, Eriko, Fumiko, Harumi, Hitomi, Hiroko, Hiroko, Hidemi, Hisako, Hinako, Izumi, Izumi, Junko, Junko, Kana, Kanako, Kanayo, Kayo, Kayoko, Kazumi, Keiko, Keiko, Kei, Kumi, Kumiko, Kyoko, Kyoko, Madoka, Maho, Mai, Maiko, Maki, Miki, Miki, Mikiko, Mina, Minako, Miyako, Momoko, Nana, Naoko, Naoko, Naoko, Noriko, Rieko, Rika, Rika, Rumiko, Rei, Reiko, Reiko, Sachiko, Sachiko, Sachiyo, Saki, Sayaka, Sayoko, Sayuri, Seiko, Shiho, Shizuka, Sumiko, Takako, Takako, Tomoe, Tomoe, Tomoko, Touko, Yasuko, Yasuyo, Yoko, Yoko, Yoko, Yoshiko, Yoshiko, Yoshiko, Yuka, Yuki, Yuki, Yukiko, Yuko, Yuko.

Exercise 26

Exercise removed from textbook

Exercise 27

Exercise removed from textbook

Exercise 28

Toastmasters International cites a February 2001 report by Gallop Poll that 40% of Americans fear public speaking. A student believes that less than 40% of students at her school fear public speaking. She randomly surveys 361 schoolmates and finds that 135 report they fear public speaking. Conduct a hypothesis test to determine if the percent at her school is less than 40%. (Source: http://toastmasters.org/artisan/detail.asp?CategoryID=1&SubCategoryID=10&ArticleID=429&Page=1^1)

Exercise 29 (Solution on p. 9.)

In 2004, 68% 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), CA, was randomly selected for comparison. In 2004, 34 of the 44 online courses LBCC offered were taught by full-time faculty. Conduct a hypothesis test to determine if 68% represents CA. NOTE: For a true test, use more CA community colleges. (Sources: **Growing by Degrees** by Allen and Seaman; Amit Schitai, Director of Instructional Technology and Distance Learning, LBCC).

NOTE: For a true test, use more CA community colleges.

Exercise 30

According to an article in **The New York Times** (5/12/2004), 19.3% of New York City adults smoked in 2003. Suppose that a survey is conducted to determine this year's rate. Twelve out of 70 randomly chosen N.Y. City residents reply that they smoke. Conduct a hypothesis test to determine is the rate is still 19.3%.

 $^{^{1}} http://toastmasters.org/artisan/detail.asp? Category ID = 1 \& SubCategory ID = 10 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Page = 120 \& Article ID = 429 \& Article$

Exercise 31 (Solution on p. 9.)

The average age of De Anza College students in Winter 2006 term was 26.6 years old. An instructor thinks the average age for online students is older than 26.6. She randomly surveys 56 online students and finds that the sample average is 29.4 with a standard deviation of 2.1. Conduct a hypothesis test. (Source: http://research.fhda.edu/factbook/DAdemofs/Fact_sheet_da_2006w.pdf²)

Exercise 32

In 2004, registered nurses earned an average annual salary of \$52,330. A survey was conducted of 41 California nursed to determine if the annual salary is higher than \$52,330 for California nurses. The sample average was \$61,121 with a sample standard deviation of \$7,489. Conduct a hypothesis test. (Source: $http://stats.bls.gov/oco/ocos083.htm#earnings^3$)

Exercise 33 (Solution on p. 9.)

La Leche League International reports that the average age of weaning a child from breastfeeding is age 4 to 5 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 average weaning age was 9 months (3/4 year) with a standard deviation of 4 months. Conduct a hypothesis test to determine is the average weaning age in the U.S. is less than 4 years old. (Source: http://www.lalecheleague.org/Law/BAFeb01.html⁴)

1 Try these multiple choice questions.

Exercise 34 (Solution on p. 9.)

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 claim the drug is safe when in, fact, it is unsafe
- **B.** To claim the drug is unsafe when, in fact, it is safe.
- C. To claim the drug is safe when, in fact, it is safe.
- **D.** To claim the drug is unsafe when, in fact, it is unsafe

The next two questions refer to the following information: 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 (63) said they smoked to stay thin. Is there good evidence that more than thirty percent of the teen girls smoke to stay thin?

Exercise 35 (Solution on p. 9.)

The alternate hypothesis is

A. p < 0.30

B. p < 0.30

C. $p \ge 0.30$

D. p > 0.30

Exercise 36 (Solution on p. 9.)

After conducting the test, your decision and conclusion are

²http://research.fhda.edu/factbook/DAdemofs/Fact_sheet_da_2006w.pdf

³http://stats.bls.gov/oco/ocos083.htm#earnings

 $^{^4}$ http://www.lalecheleague.org/Law/BAFeb01.html

- **A.** Reject H_o : More than 30% of teen girls smoke to stay thin.
- **B.** Do not reject H_o : Less than 30% of teen girls smoke to stay thin.
- C. Do not reject H_o : At most 30% of teen girls smoke to stay thin.
- **D.** Reject H_o : Less than 30% of teen girls smoke to stay thin.

The next three questions refer to the following information: 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. For a random sample of 84 EVC students, 11 of the students in the sample attended the midnight showing.

Exercise 37 (Solution on p. 9.)

An appropriate alternative hypothesis is

- **A.** p = 0.20
- **B.** p > 0.20
- **C.** p < 0.20
- **D.** $p \le 0.20$

Exercise 38 (Solution on p. 9.)

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

- A. The percent of EVC students who attended the midnight showing of Harry Potter is at least 20%.
- B. The percent of EVC students who attended the midnight showing of Harry Potter is more
- C. The percent of EVC students who attended the midnight showing of Harry Potter is less than 20%.
- **D.** There is not enough information to make a decision.

Exercise 39 (Solution on p. 9.)

The Type I error is believing 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%.

The next two questions refer to the following information:

It is believed that Lake Tahoe Community College (LTCC) Intermediate Algebra students get less than 7 hours of sleep per night, on average. A survey of 22 LTCC Intermediate Algebra students generated an average 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 7 hours of sleep per night, on average?

Exercise 40 (Solution on p. 9.)

The distribution to be used for this test is \overline{X} ~

- **A.** $N\left(7.24, \frac{1.93}{\sqrt{22}}\right)$ **B.** $N\left(7.24, 1.93\right)$
- C. t_{22}
- **D.** t_{21}

Exercise 41 (Solution on p. 9.)

The Type II error is "I believe that the average number of hours of sleep LTCC students get per night

- **A.** is less than 7 hours when, in fact, it is at least 7 hours."
- **B.** is less than 7 hours when, in fact, it is less than 7 hours."
- C. is at least 7 hours when, in fact, it is at least 7 hours."
- **D.** is at least 7 hours when, in fact, it is less than 7 hours."

The next three questions refer to the following information: An organization in 1995 reported that teenagers spent an average of 4.5 hours per week on the telephone. The organization thinks that, in 2007, the average is higher. Fifteen (15) randomly chosen teenagers were asked how many hours per week they spend on the telephone. The sample mean was 4.75 hours with a sample standard deviation of 2.0.

Exercise 42 (Solution on p. 9.)

The null and alternate hypotheses are:

- **A.** $H_o: \overline{x} = 4.5, H_a: \overline{x} > 4.5$
- **B.** $H_o: \mu \geq 4.5 \ H_a: \mu < 4.5$
- C. $H_o: \mu = 4.75 \ H_{a:} \mu > 4.75$
- **D.** $H_o: \mu = 4.5 \ H_a: \mu > 4.5$

Exercise 43 (Solution on p. 9.)

At a significance level of a = 0.05, the correct conclusion is:

- **A.** The average in 2007 is higher than it was in 1995.
- **B.** The average in 1995 is higher than in 2007.
- C. The average is still about the same as it was in 1995.
- **D.** The test is inconclusive.

Exercise 44 (Solution on p. 9.)

The Type I error is:

- **A.** To conclude the average hours per week in 2007 is higher than in 1995, when in fact, it is higher.
- **B.** To conclude the average hours per week in 2007 is higher than in 1995, when in fact, it is the same.
- C. To conclude the average hours per week in 2007 is the same as in 1995, when in fact, it is higher.
- **D.** To conclude the average hours per week in 2007 is no higher than in 1995, when in fact, it is not higher.

Solutions to Exercises in this Module

Solution to Exercise (p. 1)

Complete solutions to all parts of this problem are available on the instructor's website for this class.

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\begin{array}{l} \mathbf{a.} \;\; H_o: \mu = 34 \; ; \; H_a: \mu \neq 34 \\ \mathbf{c.} \;\; H_o: \mu \geq 100,000 \; ; \; H_a: \mu < 100,000 \\ \mathbf{d.} \;\; H_o: p = 0.29 \; ; \; H_a: p \neq 0.29 \\ \mathbf{g.} \;\; H_o: p = 0.50 \; ; \; H_a: p \neq 0.50 \\ \mathbf{i.} \;\; H_o: p \geq 0.11 \; ; \; H_a: p < 0.11 \end{array}
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Solution to Exercise (p. 2)

Complete solutions to all parts of this problem are available on the instructor's website for this class.

- a. Type I error: We believe the average is not 34 years, when it really is 34 years. Type II error: We believe the average is 34 years, when it is not really 34 years.
- c. Type I error: We believe the average is less than \$100,000, when it really is at least \$100,000. Type II error: We believe the average is at least \$100,000, when it is really less than \$100,000.
- d. Type I error: We believe that the proportion of h.s. seniors who get drunk each month is not 29%, when it really is 29%. Type II error: We believe that 29% of h.s. seniors get drunk each month, when the proportion is really not 29%.
- i. Type I error: We believe the proportion is less than 11%, when it is really at least 11%. Type II error: WE believe the proportion is at least 11%, when it really is less than 11%.

Solution to Exercise (p. 2)

```
e. z=-2.71
f. 0.0034
h. Decision: Reject null; Conclusion: \mu<19
i. (17.449,18.757)
Solution to Exercise (p. 2)
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e. 3.5 **f.** 0.0005

h. Decision: Reject null; Conclusion: $\mu > 4.5$

i. (4.7553, 5.4447)

Solution to Exercise (p. 2)

e. 2.7

f. 0.0042

h. Decision: Reject Null

i. (80.789, 85.211)

Solution to Exercise (p. 3)

e. -1.64

f. 0.1000

h. Decision: Do not reject null

i. (0.3216, 0.4784)

Solution to Exercise (p. 3)

 $\mathbf{d}. t_9$

```
e. -1.33
  f. 0.1086
  h. Decision: Do not reject null
  i. (51.886, 62.114)
Solution to Exercise (p. 4)
  e. z = -2.99
  f. 0.0014
  h. Decision: Reject null; Conclusion: p < .70
  i. (0.4529, 0.6582)
Solution to Exercise (p. 4)
  e. 1.32
  f. 0.1873
  h. Decision: Do not reject null
  i. (0.65, 0.90)
Solution to Exercise (p. 5)
  e. 9.98
  f. 0.0000
  h. Decision: Reject null
  i. (28.8, 30.0)
Solution to Exercise (p. 5)
  e. -44.7
  f. 0.0000
  h. Decision: Reject null
  i. (0.60, 0.90) - in years
Solution to Exercise (p. 5)
Solution to Exercise (p. 5)
Solution to Exercise (p. 5)
Solution to Exercise (p. 6)
Solution to Exercise (p. 7)
Solution to Exercise (p. 7)
Solution to Exercise (p. 7)
В
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