

Review Exercises: Hypothesis Testing

1. In recent years airlines have been subjected to various forms of criticism. An executive of Airline X has taken a quick poll of 16 regular airplane passengers. Each passenger is asked to rate the airline he or she last flew on. The ratings were on a 7-point Likert scale where 1 = poor and 7 = very good. Of the 16 respondents, six last flew on Airline X and the remainder flew on other airlines. The ratings are shown below. Can the executive conclude from these data with 5% significance level that Airline X is more highly rated than the other airlines?

Ratings of Airlines

Airline X	Other Airlines
6	5
4	3
5	3
6	2
5	3
3	4
	3
	5
	3

2. Because of the rising costs of industrial accidents many chemical, mining, and manufacturing firms have instituted safety courses. Employees are encouraged to take these courses designed to heighten safety awareness. A company is trying to decide which one of two courses to institute. To help make a decision, eight employees take course 1 and another eight take course 2. Each employee writes a test, which is marked, out of a possible 25. The results are shown below. Do these data provide sufficient evidence at the 5% level of significance to conclude that the marks from course 2 are higher than those of course 1? Assume that the scores are normally distributed.

Safety Test Scores

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Course 1	Course 2
14	20
21	18
17	22
14	15
17	23
19	21
20	19
16	15

3. Each year the personnel department in a large corporation assesses the performance of all of its employees. Each employee is rated for various aspects of his or her job on a 7- point scale where 1 = very unsatisfactory and 7 = satisfactory. The president of the company believes that the assessment scores this year are lower than last year's. To examine the validity of this belief she draws a random sample of six employees' scores from last year and another six employees' scores this year. Do the data listed below allow the president to conclude at the 5% significance level that her belief is correct?

Employees Ratings Scores

<i>This Year</i>	<i>Last Year</i>
5	5
6	5
4	3
5	3
5	4
4	3

4. The following data represent the test scores of eight students on a statistics test before and after attending extra help sessions for the test:

Student	before	After
Abby	82	90
Brenda	75	86
Carmen	90	90
David	68	62
Edward	87	89
Frank	73	75
Gill	81	78
Heidi	92	98

Determine at the 5% significance level whether the extra help sessions have been effective.

5. 10 secretaries were selected at random from among the secretaries of a university. The typing speed (number of words per minute) was recorded for each secretary on two different brands of computer keyboards. The following results were obtained.

Computer Keyboard		
Secretary	Brand A	Brand B
Amy	72	74
Betty	80	86
Carol	68	72
Donna	74	70
Ellen	86	85
Faith	75	73
Gwen	78	72
Heather	69	65
Ingrid	76	79
Jody	65	64

Determine if these data provide enough evidence at the 5% significance level to infer that the brands differ with respect to typing speed.

6. Let π denote the proportion of Floridians who think that government environmental regulations are too strict
- Test $H_0: \pi = 0.5$ against a two-sided alternative using data from a telephone poll of 834 people conducted in June 1995 in which 26.6% said regulations were too strict.
 - Calculate the test statistic
 - Find the p-value and interpret
 - Using $\alpha = 0.01$, can you determine whether a majority or minority think that environmental regulations are too strict, or is it plausible that $\pi = 0.5$?

7. A contract for supplying rechargeable batteries specifies that not more than 10 per cent should need recharging before 100 hours of use. To test compliance with this requirement a potential purchaser takes a random sample of 25 from a large consignment and finds that 5 need recharging after being used for less than 100 hours.

- (i) What is the parameter of interest?
- (ii) Assess the strength of evidence that the batch is below specification.
Clearly state H_0 , H_a , test statistic, the decision rule, and the p-value.

8. Of 36 cars inspected during a safety campaign, 20 were found to be safe.

- (i) Test the hypothesis that no more than 10% of the cars in the population are unsafe.

9. A researcher wishes to determine if the number of viewers for 9 returning television shows has not changed since last year. The data are given in millions of viewers.

Last year	147	183	232	161	197	206	190	215	166
This year	137	176	200	163	193	201	180	203	158

- (i) Test at the 0.05 level of significance the claim that the number of viewers has not changed.
- (ii) Depending on your answer, would a television executive plan to air these programs for another year?

10. A Service company is concerned about the length of time that customers had to wait before receiving the help they requested. The company randomly selected 20 customers and recorded the wait time in minutes. The times are shown below.

Service Company Waiting Time

38	21	19	16	29	21	18	15	27	21
24	20	17	13	22	20	17	13	22	19

- (i) Check if the sample provides sufficient evidence to conclude that median service waiting time exceeds 15 minutes ? Use $\alpha = .05$.
11. Test the hypothesis that weight loss in a new diet program exceeds 20 pounds during the first month.
- Sample data : $n = 36$, $\bar{x} = 21$, $s^2 = 25$, $\alpha = 0.05$
12. A consumer rights group tests a representative sample of 18 connoisseur chocolate bars and finds that their average amount of cocoa is 16.28 grams, with a standard deviation of 115 milligrams. The manufacturer claims that these bars are made with 16.50 grams of cocoa. What do we conclude? (Note: Left Tail Test)
13. A local newspaper reports that in their city, 20% of all teenagers play soccer in a league. In a representative sample of a 110 teenagers from this city, 11 say they're in a soccer league. What do we think of the newspaper's info?
14. A random sample of 219 adult drug users contains 55 individuals who began smoking cigarettes at age 12 or younger. A second random sample of 822 people who do not use drugs contains 117 individuals who began smoking at age 12 or younger. Is there evidence that the population proportions of individuals who began smoking at age 12 or younger are not the same for both drug users and nonusers. Describe how to find a p-value as an area under a curve.
15. A statistician claims that the average score on a standardized test test of students who major in psychology is greater than that of students who major in mathematics. The results of the test, given to 50 students in each

group, are shown below. Is there enough evidence to support the statistician's claim at the 1% significance level?

Psychology

Mathematics

$$\bar{X}_1 = 118$$

$$\bar{X}_2 = 115$$

$$\sigma_1 = 15$$

$$\sigma_2 = 15$$

$$n_1 = 50$$

$$n_2 = 50$$

16. A real estate agent compares the selling prices of homes in two suburbs of Seattle to see whether there is a difference in price. In first suburb, the agent checked the price on 35 homes and found that they had an average price of \$63,255 with a standard deviation of \$5602. In the second suburb, the agent checked the price on 40 homes and found that they had an average price of \$59,102 with a standard deviation of \$4731. Is there evidence to reject the claim that the average cost of a home in both locations is the same? Use $\alpha = 0.05$.
17. A researcher wishes to check whether or not there is a difference in average miles traveled for each of two taxi companies during a randomly selected week. She interviewed 35 drivers for Moonview Cab and found that they had an average of 837 miles with a standard deviation of 30. She interviewed 40 drivers for Starlight Taxi and found that their average was 753 miles with a standard deviation of 40. Is there a difference in average miles? Assume that the populations are normally distributed. Test at the 10% significance level.
18. A large hospital instituted a fitness program to reduce absenteeism. The director reported that the average number of working hours lost due to illness per employee is 48 hours per year. After one year, a sample of 18 employees showed an average of 41 hours of work lost, with a standard

- deviation of 5. Did the program reduce absenteeism? Test at the 10% significance level.
19. A person claims that the average price of a car wash in West Newton is \$3.00. A sample of five car washes had an average price of \$3.70 and a standard deviation of \$0.30. At $\alpha = 0.05$, test the claim.
 20. A student suspected the average cost of a Saturday night date was no longer \$30.00. To test her hypothesis, she randomly selected 16 men from the dormitory and asked them how much they spent on a date last Saturday. She found that the average cost was \$31.17. The standard deviation of the sample was \$5.51. At the 5% significance level, is there enough evidence to support her claim?
 21. A researcher reports that the average salary of assistant professors is more than \$42,000. A sample of 30 assistant professors has a mean salary of \$43,260. At $\alpha = 0.01$, test the claim that assistant professor earn more than \$42,000 a year. The standard deviation of the population is \$5,230.
 22. A maker of frozen meals claims that the average caloric content of its meals is 800, and the standard deviation is 25. A researcher tested 12 meals and found that the average number of calories was 873. Is there enough evidence to reject the claim at the 5% significance level? Assume the variable is normally distributed.
 23. The state's education secretary claims that the average cost of one year's tuition for all private high schools in the state is \$2350. A sample of 30 private high schools is selected, and the average tuition is \$2315. The standard deviation for the population is \$38. At $\alpha = 0.10$, is there enough

evidence to reject the claim that the average cost of tuition is equal to \$2350?