HypoTesting

Multiple Choice
Identify the choice that best completes the statement or answers the question.

_____ 1. A Type II error is committed if we make:
    a.   a correct decision when the null hypothesis is false.
    b.   a correct decision when the null hypothesis is true.
    c.   an incorrect decision when the null hypothesis is false.
    d.   an incorrect decision when the null hypothesis is true.

_____ 2. The hypothesis of most interest to the researcher is:
    a.   the alternative hypothesis.
    b.   the null hypothesis.
    c.   both hypotheses are of equal interest.
    d.   Neither hypothesis is of interest.

_____ 3. A Type I error occurs when we:
    a.   reject a false null hypothesis.
    b.   reject a true null hypothesis.
    c.   don't reject a false null hypothesis.
    d.   don't reject a true null hypothesis.

_____ 4. A Type II error is defined as:
    a.   rejecting a true null hypothesis.
    b.   rejecting a false null hypothesis.
    c.   not rejecting a true null hypothesis.
    d.   not rejecting a false null hypothesis.

_____ 5. The probability of a Type II error is denoted by:
    a. α
    b. β
    c. $1 - \alpha$
    d. $1 - \beta$

_____ 6. Which of the following would be an appropriate alternative hypothesis?
    a.   The mean of a population is equal to 70.
    b.   The mean of a sample is equal to 70.
    c.   The mean of a population is greater than 70.
    d.   The mean of a sample is greater than 70.

_____ 7. Suppose we wish to test H_0: $\mu = 45$ vs. H_1: $\mu > 45$. What will result if we conclude that the mean is greater than 45 when the actual mean is 50?
    a.   We have made a Type I error.
    b.   We have made a Type II error.
    c.   We have made both a Type I error and a Type II error.
    d.   We have made the correct decision.

_____ 8. Researchers claim that 60 tissues is the average number of tissues a person uses during the course of a cold. The company who makes Kleenex brand tissues thinks that fewer of their tissues are needed. What are their null and alternative hypotheses?
   a. H_0: $\mu = 60$ vs. H_1: $\mu > 60$
   b. H_0: $\mu = 60$ vs. H_1: $\mu < 60$
   c. H_0: $\overline{X} = 60$ vs. H_1: $\overline{X} < 60$
   d. H_0: $\mu < 60$ vs. H_1: $\mu = 60$

_____ 9. Which of the following p-values will lead us to reject the null hypothesis if the level of significance equals 0.05?
   a. 0.150
   b. 0.100
   c. 0.051
   d. 0.025

_____ 10. Suppose that we reject a null hypothesis at the 0.05 level of significance. Then for which of the following α-values do we also reject the null hypothesis?
   a. 0.06
   b. 0.04
   c. 0.03
   d. 0.02

_____ 11. In a two-tail test for the population mean, if the null hypothesis is rejected when the alternative hypothesis is true:
   a. a Type I error is committed.
   b. a Type II error is committed.
   c. a correct decision is made.
   d. a one-tail test should be used instead of a two-tail test.

_____ 12. Using a confidence interval when conducting a two-tail test for μ, we do not reject H_0 if the hypothesized value for μ:
   a. is to the left of the lower confidence limit (LCL).
   b. is to the right of the upper confidence limit (UCL).
   c. falls between the LCL and UCL.
   d. falls in the rejection region.

_____ 13. In testing the hypothesis H_0: $\mu = 100$ vs. H_1: $\mu > 100$, the p-value is found to be 0.074, and the sample mean is 105. Which of the following statements is true?
   a. The probability of observing a sample mean at least as large as 105 from a population whose mean is 100 is 0.074.
   b. The probability of observing a sample mean smaller than 105 from a population whose mean is 100 is 0.074.
   c. The probability that the population mean is larger than 100 is 0.074.
   d. None of these choices.

____ 14. The *p*-value of a test is the:
   a. smallest α at which the null hypothesis can be rejected.
   b. largest α at which the null hypothesis can be rejected.
   c. smallest α at which the null hypothesis cannot be rejected.
   d. largest α at which the null hypothesis cannot be rejected.

____ 15. We have created a 95% confidence interval for μ with the results (10, 25). What conclusion will we make if we test H_0: $\mu = 26$ vs. H_1: $\mu \neq 26$ at <u>$\alpha = 0.025$</u>?
   a. Reject H_0 in favor of H_1
   b. Accept H_0 in favor of H_1
   c. Fail to reject H_0 in favor of H_1
   d. We cannot tell from the information given.

____ 16. The owner of a local nightclub has recently surveyed a random sample of $n = 300$ customers of the club. She would now like to determine whether or not the mean age of her customers is over 35. If so, she plans to alter the entertainment to appeal to an older crowd. If not, no entertainment changes will be made. Suppose she found that the sample mean was 35.5 years and the population standard deviation was 5 years. What is the *p*-value associated with the test statistic?
   a. 0.9582
   b. 1.7300
   c. 0.0418
   d. 0.0836

____ 17. The numerical quantity computed from the data that is used in deciding whether to reject H_0 is the:
   a. significance level.
   b. critical value.
   c. test statistic.
   d. parameter.

____ 18. The owner of a local nightclub has recently surveyed a random sample of $n = 300$ customers of the club. She would now like to determine whether or not the mean age of her customers is over 35. If so, she plans to alter the entertainment to appeal to an older crowd. If not, no entertainment changes will be made. If she wants to be 99% confident in her decision, what rejection region she use if the population standard deviation σ is known?
   a. Reject H_0 if $z < -2.33$
   b. Reject H_0 if $z < -2.58$
   c. Reject H_0 if $z > 2.33$
   d. Reject H_0 if $z > 2.58$

____ 19. For a given level of significance, if the sample size increases, the probability of a Type II error will:
   a. remain the same.
   b. increase.
   c. decrease.
   d. be equal to 1.0 regardless of α.

_____ 20. The power of a test is measured by its capability of:
    a.   rejecting a null hypothesis that is true.
    b.   not rejecting a null hypothesis that is true.
    c.   rejecting a null hypothesis that is false.
    d.   not rejecting a null hypothesis that is false.

_____ 21. If the probability of committing a Type I error for a given test is decreased, then for a fixed sample size n, the probability of committing a Type II error will:
    a.   decrease.
    b.   increase.
    c.   stay the same.
    d.   Not enough information to tell.

_____ 22. The power of a test is denoted by:
    a. α
    b. β
    c. $1 - \alpha$
    d. $1 - \beta$

_____ 23. For a given level of significance α, if the sample size n is increased, the probability of a Type II error β will:
    a.   decrease.
    b.   increase.
    c.   remain the same.
    d.   Not enough information to tell.

_____ 24. For statistical inference about the mean of a single population when the population standard deviation is unknown, the degrees for freedom for the t-distribution equal $n - 1$ because we lose one degree of freedom by using the:
    a.   sample mean as an estimate of the population mean.
    b.   sample standard deviation as an estimate of the population standard deviation.
    c.   sample proportion as an estimate of the population proportion.
    d.   sample size as an estimate of the population size.

_____ 25. A major department store chain is interested in estimating the average amount its credit card customers spent on their first visit to the chain's new store in the mall. Fifteen credit card accounts were randomly sampled and analyzed with the following results: $\bar{x} = \$50.50$ and $s^2 = 400$. A 95% confidence interval for the average amount the credit card customers spent on their first visit to the chain's new store in the mall is:
    a. $\$50.50 \pm \$9.09$.
    b. $\$50.50 \pm \$10.12$.
    c. $\$50.50 \pm \$11.08$.
    d.   None of these choices.

_____ 26. Under what condition(s) does the test statistic for p have an approximate normal distribution?
    a.   When $np > 5$.
    b.   When np and $np(1 - p)$ are both > 5.
    c.   When $n > 30$.
    d.   When np and $n(1 - p)$ are both > 5.

____ 27. After calculating the sample size needed to estimate a population proportion to within 0.04, your statistics professor told you the maximum allowable error must be reduced to just .01. If the original calculation led to a sample size of 800, the sample size will now have to be:
   a. 800
   b. 3200
   c. 12,800
   d. 6400

____ 28. The width of a confidence interval estimate for a proportion will be:
   a. narrower for 99% confidence than for 95% confidence.
   b. wider for a sample size of 100 than for a sample size of 50.
   c. narrower for 90% confidence than for 95% confidence.
   d. narrower when the sample proportion if 0.50 than when the sample proportion is 0.20.

True/False
Indicate whether the statement is true or false.

____ 29. There is an inverse relationship between the probabilities of Type I and Type II errors; as one increases, the other decreases, and vice versa.

____ 30. For a given level of significance, if the sample size is increased, the probability of committing a Type II error will decrease.

____ 31. The critical values will bound the rejection and non-rejection regions for the null hypothesis.

____ 32. A one-tail test for the population mean μ produces a test-statistic $z = -0.75$. The p-value associated with the test is 0.7734.

____ 33. For a given level of significance, if the sample size is increased, the probability of committing a Type I error will decrease.

____ 34. The power of the test refers to the probability of rejecting a false null hypothesis.

____ 35. As the alternative value of μ increases, so does the power of the test.

____ 36. The statistic $(\bar{x} - \mu)/(s/\sqrt{n})$ when the sampled population is normal is Student t-distributed with n degrees of freedom.

____ 37. The lower limit of the 90% confidence interval for the population proportion p, given that $n = 400$ and $\hat{p} = 0.10$, is 0.0247.

____ 38. In determining the sample size needed to estimate the population proportion p, we let the sample proportion $\hat{p} = 1$ if we have no knowledge of even the approximate values of $\hat{p}$.

Short Answer

39. Suppose a delivery company states that their packages arrive within two days or less on average. You want to find out whether the actual average delivery time is longer than this. You conduct a hypothesis test.

   a.   Set up the null and alternative hypotheses.
   b.   Suppose you conclude wrongly that the company's statement about average delivery time is within two days. What type of error is being committed and what is the impact of that error?
   c.   Suppose you conclude wrongly that the delivery company's average time to delivery is in fact longer than two days. What type of error did you commit and what is the impact of this error?
   d.   Which error is worse from the company's standpoint, a Type I or a Type II error? Why?
   e.   Which error is worse from a consumer standpoint, a Type I or a Type II error? Why?

   GRE Scores

   The Admissions officer for the graduate programs at Michigan State University (MSU) believes that the average score on the GRE exam at his university is significantly higher than the national average of 1,300. An accepted standard deviation for GRE scores is 125. A random sample of 25 scores had an average of 1,375.

40. {GRE Scores Narrative} Calculate the value of the test statistic and set up the rejection region at the 0.025 level. What is your conclusion?

41. {GRE Scores Narrative} Calculate the p-value.

   Grocery Receipts

   A simple random sample of 100 grocery receipts was drawn from a normal population. The mean and standard deviation of the sample were $120 and $25, respectively.

42. {Grocery Receipts Narrative} Test the hypothesis H_0: $\mu = 125$ vs. H_1: $\mu \neq 125$ at the 10% significance level.

43. A drug company has just developed a new pill to alleviate the symptoms of allergies and colds. However, they are concerned about the variability in the amount of time until the drug becomes effective. In a random sample of 10 individuals who suffer from allergies, the amount of time (in hours) for the pill to take effect was recorded and listed as follows: 5, 7, 6, 10, 9, 12, 8, 17, 4, and 16. Estimate with 90% confidence the variance of the time for the drug to become effective.

   Independent Voters

   A pollster wants to challenge a claim that 5% of the registered voters in her state are Independent; she thinks the percentage is lower than that. In a test of hypothesis, H_0: $p = 0.05$ vs. H_1: $p < 0.05$, her random sample of size 1,000 registered voters revealed that the number of Independents was 40.

44. {Independent Voters Narrative} Compute the p-value and explain how to use it to test the hypotheses.

Union Contract

A union composed of several thousand employees is preparing to vote on a new contract. A random sample of 500 employees yielded 320 who planned to vote yes. It is believed that the new contract will receive more than 60% yes votes.

45. {Union Contract Narrative} Compute the *p*-value for the test.

New Product

After a financial analysis, the general manager of a large company decided that if more than 8% of potential buyers of a new product purchase that product, the company would show a profit. In a preliminary survey of 500 potential buyers, 56 people say that they will buy the product.

46. {New Product Narrative} Is there sufficient evidence at the 5% significance level that the product will produce a profit?

Allergy Drug

A company claims that 10% of the users of a certain allergy drug experience drowsiness. In clinical studies of this allergy drug, 81 of the 900 subjects experienced drowsiness

47. {Allergy Drug Narrative} Is there enough evidence at the 5% significance level to infer that the competitor is correct?

Car Dealership

An accountant was performing an audit for a car dealership. An auditor wants to examine the monetary error made by the purchasing order department in the month of July. He decided to randomly sample 100 of the 925 purchase orders for the month of July, and found the amount of error in each one. The statistics for this sample were: $\overline{x}$ = $6.0 and *s* = $17.012.

48. {Car Dealership Narrative} Estimate with 95% confidence the average amount of error per purchase order for the entire month of July.

HypoTesting
Answer Section

MULTIPLE CHOICE

1.	ANS: C	PTS: 1	REF:	SECTION 11.1
2.	ANS: A	PTS: 1	REF:	SECTION 11.1
3.	ANS: B	PTS: 1	REF:	SECTION 11.1
4.	ANS: D	PTS: 1	REF:	SECTION 11.1
5.	ANS: B	PTS: 1	REF:	SECTION 11.1
6.	ANS: C	PTS: 1	REF:	SECTION 11.1
7.	ANS: D	PTS: 1	REF:	SECTION 11.1
8.	ANS: B	PTS: 1	REF:	SECTION 11.1
9.	ANS: D	PTS: 1	REF:	SECTION 11.2
10.	ANS: A	PTS: 1	REF:	SECTION 11.2
11.	ANS: C	PTS: 1	REF:	SECTION 11.2
12.	ANS: C	PTS: 1	REF:	SECTION 11.2
13.	ANS: A	PTS: 1	REF:	SECTION 11.2
14.	ANS: A	PTS: 1	REF:	SECTION 11.2
15.	ANS: D	PTS: 1	REF:	SECTION 11.2
16.	ANS: C	PTS: 1	REF:	SECTION 11.2
17.	ANS: C	PTS: 1	REF:	SECTION 11.2
18.	ANS: C	PTS: 1	REF:	SECTION 11.2
19.	ANS: C	PTS: 1	REF:	SECTION 11.3
20.	ANS: C	PTS: 1	REF:	SECTION 11.3
21.	ANS: B	PTS: 1	REF:	SECTION 11.3
22.	ANS: D	PTS: 1	REF:	SECTION 11.3
23.	ANS: A	PTS: 1	REF:	SECTION 11.3
24.	ANS: A	PTS: 1	REF:	SECTION 12.1
25.	ANS: C	PTS: 1	REF:	SECTION 12.1
26.	ANS: D	PTS: 1	REF:	SECTION 12.3
27.	ANS: C	PTS: 1	REF:	SECTION 12.3
28.	ANS: C	PTS: 1	REF:	SECTION 12.3

TRUE/FALSE

29.	ANS: T	PTS: 1	REF:	SECTION 11.1
30.	ANS: T	PTS: 1	REF:	SECTION 11.2
31.	ANS: T	PTS: 1	REF:	SECTION 11.2
32.	ANS: F	PTS: 1	REF:	SECTION 11.2
33.	ANS: F	PTS: 1	REF:	SECTION 11.2
34.	ANS: T	PTS: 1	REF:	SECTION 11.3
35.	ANS: T	PTS: 1	REF:	SECTION 11.3
36.	ANS: F	PTS: 1	REF:	SECTION 12.1

37. ANS: F   PTS: 1   REF: SECTION 12.3
38. ANS: F   PTS: 1   REF: SECTION 12.3

SHORT ANSWER

39. ANS:

a. H_0: $\mu = 2$ days vs. H_1: $\mu > 2$ days
b. You did not reject the company's claim but you should have. This is a Type II error. It is a missed opportunity to say the company's claim is wrong. The impact is that people will not get their packages delivered within 2 days on average, and could eventually become dissatisfied.
c. You rejected the company's claim but you should not have. This is a Type I error. You caused a false alarm. The impact is that the company loses its credibility needlessly. This could cause some real problems for the person who made the false alarm.
d. The company does not want to lose its reputation unfairly, so they want to minimize the chance for a Type I error. However, this increases the chance that customers will get their packages delivered later than promised, on average.
e. The consumer wants to know their packages are being delivered as promised (on average), so they want to decrease the chance of a Type II error. However, this increases the chance of a false alarm.

PTS: 1   REF: SECTION 11.1

40. ANS:
Test statistic: $z = 3.0$
Rejection region: $z > z_{.025} = 1.96$
Conclusion: Reject H_0. There is enough statistical evidence to infer that the average GRE for all graduate students at MSU is higher than 1,300.

PTS: 1   REF: SECTION 11.2

41. ANS:
p-value $= 0.0013$

PTS: 1   REF: SECTION 11.2

42. ANS:
Rejection region: $|t| > t_{0.05,99} = 1.66$
Test statistic: $t = -2.0$
Conclusion: Reject H_0. We can infer that the population mean is not equal to 125. According to our data, the mean is lower than that.

PTS: 1   REF: SECTION 12.1

43. ANS:

$LCL = (n-1)s^2 / \chi^2_{0.05,9} = 10.426$

$UCL = (n-1)s^2 / \chi^2_{0.95,9} = 53.051$

We estimate that the variance of the time for the drug to become effective lies between 10.426 and 53.051.

PTS: 1   REF: SECTION 12.2

44. ANS:
p-value = 0.0735.
Since p-value = $0.0735 > \alpha = 0.05$, don't reject H_0.

PTS: 1   REF: SECTION 12.3

45. ANS:
p-value = 0.0336

PTS: 1   REF: SECTION 12.3

46. ANS:
Rejection region: $z > z_{0.05} = 1.645$
Test statistic: $z = 2.638$
Conclusion: Reject H_0. Yes, there is sufficient evidence at the 5% significance level that the product will produce a profit.

PTS: 1   REF: SECTION 12.3

47. ANS:
Rejection region: $|z| > z_{0.025} = 1.96$
Test statistic: $z = -1.0$
Conclusion: Don't reject H_0. Not enough evidence at the 5% significance level to infer that the company is incorrect.

PTS: 1   REF: SECTION 12.3

48. ANS:

$$\bar{x} \pm t_{\alpha/2} \cdot \frac{s}{\sqrt{n}} \sqrt{\frac{N-n}{N-1}} = 6.0 \pm 1.984 \frac{17.012}{\sqrt{100}} \sqrt{\frac{825}{924}} = 6.0 \pm 3.189$$

LCL = \$2.81, and UCL = \$9.19 error per purchase order.

PTS: 1   REF: SECTION 12.4-12.5