

# CE5033 Statistical Methods and Data Mining

## 20240326 Exercise

1. When conducting hypothesis testing, the significance level ( $\alpha$ ) is set at 0.05. This level signifies:  
(A) A 95% probability that the null hypothesis is true.  
(B) A 5% chance of committing a Type I error by rejecting a true null hypothesis.  
(C) A guarantee of a 5% effect size in the population parameters.  
(D) That the p-value must be greater than 0.05 to reject the null hypothesis.

Reason: The significance level ( $\alpha$ ) represents the probability of rejecting the null hypothesis when it is actually true, not the probability that the null hypothesis is true or any guarantee about the effect size.

2. Given the importance of effect size in interpreting the results of a hypothesis test, which scenario illustrates the practical significance of a study's findings?  
(A) A large effect size with a p-value slightly above the significance level.  
(B) A small effect size with a p-value well below the significance level.  
(C) A large effect size with a p-value well below the significance level, indicating both statistical and practical significance.  
(D) A small effect size with a p-value slightly above the significance level, suggesting the findings are not practically significant.

Reason: Practical significance is about the real-world importance of the findings. A large effect size that is statistically significant suggests the findings are both statistically reliable and practically important.

3. For hypothesis testing, what is the primary purpose of setting a decision rule based on the test statistic and critical value?  
(A) To determine if the sample mean is significantly different from the population mean  
(B) To establish the minimum sample size required for the test  
(C) To decide whether to reject or not reject the null hypothesis based on the observed data  
(D) To calculate the p-value for the observed test statistic

Reason: The primary purpose of setting a decision rule (involving the test statistic and critical value) is to make a determination about the null hypothesis based on how the observed test statistic compares to a theoretical distribution.

4. What does the concept of “degrees of freedom” in a statistical test primarily represent?  
(A) The total number of variables in the dataset.  
(B) The count of independent observations in a sample.  
(C) The maximum allowable error margin in the test results.  
(D) The number of values in the final calculation of a statistic that are free to vary.

Reason: Degrees of freedom typically represent the number of independent pieces of information

remaining after estimating certain parameters (like means) and are used to determine the appropriate critical value for a test.

5. To display the frequency of different categories of a nominal variable, such as blood types in a sample of individuals, which figure is most appropriate?

(A) Pie chart      (B) Line graph      (C) Scatter plot      (D) Histogram

Reason: A pie chart is most appropriate for displaying the proportion of different categories within a nominal variable, such as blood types.

6. A researcher is interested in examining the distribution of a single continuous variable across the entire dataset. Which of the following figures would best allow the researcher to explore the distribution of this variable?

(A) Scatter plot      (B) Histogram      (C) Line graph      (D) Pie chart

Reason: A histogram is ideal for visualizing the distribution of a single continuous variable, showing the frequency of data points within specified intervals.

7. A study aims to test if a new teaching method increases the final exam scores of students compared to the traditional method. What is the appropriate null hypothesis ( $H_0$ )?

(A) The new teaching method does not change the final exam scores.  
(B) The new teaching method decreases the final exam scores.  
(C) The new teaching method increases the final exam scores.  
(D) The traditional teaching method is less effective.

Reason: The null hypothesis typically states there is no effect or change due to the intervention. The alternative hypothesis would then be that the new method increases (or decreases) scores.

8. In evaluating the effectiveness of a new drug, which type of error occurs if researchers conclude that the drug is effective when, in reality, it is not?

(A) Type I error      (B) Type II error      (C) Sampling error      (D) Measurement error

Reason: A Type I error occurs when the null hypothesis is incorrectly rejected, meaning concluding there is an effect (the drug is effective) when in reality, there isn't.

9. A researcher hypothesizes that there is no difference in the average IQ scores between males and females in a population. After conducting a statistical test, a p-value of 0.03 is obtained with a significance level set at 0.05. What should be the researcher's conclusion?

(A) Increase the sample size and retest.  
(B) Change the significance level to 0.01 and reevaluate the conclusion.  
(C) Reject the null hypothesis; there is a statistically significant difference in the average IQ scores.  
(D) Fail to reject the null hypothesis; there is no statistically significant difference in the average IQ scores.

Reason: A p-value of 0.03 is below the significance level of 0.05, indicating sufficient evidence to reject the null hypothesis of no difference.

10. In testing whether a diet leads to weight loss, researchers collect weight measurements before

and after the diet program for each participant. Which statistical test is most appropriate?

- (A) Independent samples t-test (B) ANOVA  
(C) Chi-squared test of independence (D) Paired samples t-test

Reason: A paired samples t-test is used when comparing measurements from the same participants under two different conditions, such as before and after a diet program.

11. A market researcher wants to understand the preference ranking of five different brands by consumers. Which figure would best visualize this data?

- (A) Bar chart (B) Pie chart (C) Line graph (D) Box plot

Reason: A bar chart is suitable for displaying the preference rankings of different brands, allowing for comparison across categories.

12. Which data type is characterized by ordered categories with no defined distance between categories?

- (A) Nominal (B) Ordinal (C) Interval (D) Ratio

Reason: Ordinal data are characterized by ordered categories where the order has meaning, but the distance between categories is not defined.

13. The probability of making a Type I error is represented by:

- (A) The power of the test. (B) The p-value. (C) The significance level. (D) The effect size.

Reason: The probability of making a Type I error is exactly what the significance level ( $\alpha$ ) represents in hypothesis testing.

14. What is the primary purpose of setting a lower alpha level (e.g., 0.01 instead of 0.05) in hypothesis testing?

- (A) To increase the power of the test (B) To decrease the chance of a Type I error  
(C) To reduce the sample size needed (D) To ensure a larger effect size

Reason: Lowering  $\alpha$  (e.g., from 0.05 to 0.01) reduces the risk of incorrectly rejecting the null hypothesis, thus making the criteria for finding significant results more stringent.

15. If a researcher fails to reject the null hypothesis, what can be concluded?

- (A) The null hypothesis is definitively true.  
(B) There was not enough evidence to support the alternative hypothesis.  
(C) The alternative hypothesis is false.  
(D) The test was inconclusive.

Reason: Failing to reject the null hypothesis means the data did not provide sufficient evidence against it; it does not prove the null hypothesis true or the alternative hypothesis false.

16. What does a two-tailed test in hypothesis testing imply about the research hypothesis?

- (A) It only tests for positive differences.  
(B) It only tests for negative differences.  
(C) It specifies direction (greater than or less than).  
(D) It does not specify direction but tests for any difference.

Reason: A two-tailed test is used when the research hypothesis does not predict the direction of the

difference or effect, merely that an effect exists.

17. What is meant by the term "power" in the context of hypothesis testing?

- (A) The likelihood of correctly rejecting a false null hypothesis.
- (B) The ability to detect a significant result when one does not exist.
- (C) The probability of accepting the null hypothesis when it is true.
- (D) The overall significance level of the test.

Reason: The power of a test is the probability of correctly rejecting the null hypothesis when it is false, thus detecting an actual effect when there is one.

18. When a hypothesis test concludes that there is enough evidence to support the alternative hypothesis, what decision is made about the null hypothesis?

- (A) It is proven true.
- (B) It is rejected.
- (C) It is accepted.
- (D) It remains undecided.

Reason: Concluding there is enough evidence to support the alternative hypothesis leads to the rejection of the null hypothesis.

19. Which of the following best defines the alternative hypothesis?

- (A) It is a statement that the parameter of interest is equal to a specific value.
- (B) It claims there is no difference or effect.
- (C) It is the hypothesis that researchers usually hope to support, suggesting there is an effect or difference.
- (D) It is always stated as a negative assertion.

Reason: The alternative hypothesis posits the presence of an effect, difference, or relationship that the research aims to demonstrate.

20. The confidence interval in the context of hypothesis testing primarily provides information about:

- (A) The range in which we expect the true population parameter to fall, with a certain level of confidence.
- (B) The probability that the null hypothesis is true.
- (C) The exact value of the sample mean.
- (D) The likelihood of committing a Type I error.

Reason: A confidence interval provides a range of values, estimated from the data, that is likely to contain the population parameter with a certain degree of confidence, typically 95% or 99%.