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Applied Probability and Statistics (FZO1 C955)



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Question: 1

95% CI = 50 ± 2 . SE = ?

- A. 1
- B. 2
- C. 4
- D. 0.5

Answer: A

Explanation:

A confidence interval has the structure estimate $\pm$ margin of error. The margin of error is calculated as critical value $\times$ standard error. For a 95% confidence interval using the normal approximation, the critical value is approximately 1.96, often rounded to 2 in introductory settings. The interval is given as 50 ± 2 , so the margin of error is 2. Using the approximate 95% critical value of 2, we solve $2 = 2 \times \text{SE}$, giving $\text{SE} = 1$. More exactly, using 1.96 gives $\text{SE} = 2/1.96 \approx 1.02$, which rounds to 1. Option B confuses the margin of error with the standard error. Option C is too large, and option D would produce a margin of error near 1 under a 95% critical value. The correct standard error is approximately 1. Study Guide references/topics: confidence intervals, standard error, critical value, margin of error.

Question: 2

Rare event count per interval modeled by:

- A. Poisson
- B. Binomial
- C. Normal
- D. Uniform

Answer: A

Explanation:

The Poisson distribution is used to model the number of events occurring in a fixed interval of time, space, area, or volume when the events occur independently at a constant average rate. It is especially common for rare event counts, such as calls arriving at a help desk per hour, accidents at an intersection per month, defects per production batch, or website errors per day. The defining parameter of the Poisson distribution is λ , the average number of events per interval. A binomial distribution instead models the number of successes in a fixed number of independent trials with a constant probability of success. A normal distribution models continuous, bell-shaped measurements. A uniform distribution assigns equal probability across outcomes or intervals. Because the prompt specifically says "rare event

count per interval,” the technical match is the Poisson distribution. Study Guide references/topics: Poisson distribution, event counts, rate parameter λ , discrete probability distributions.

Question: 3

Empirical probability = ?

- A. Based on observed data
- B. Theoretical
- C. Guess
- D. Uniform

Answer: A

Explanation:

Empirical probability is probability determined from observed data rather than from a purely theoretical model. It is calculated by dividing the number of times an event actually occurs by the total number of trials or observations. For example, if a basketball player makes 72 free throws in 100 attempts, the empirical probability of a made free throw is $72/100 = 0.72$. This differs from theoretical probability, which is derived from known equally likely outcomes, such as rolling a 3 on a fair six-sided die. It also differs from a guess or subjective estimate because empirical probability requires actual recorded evidence. The term “uniform” describes a distribution in which outcomes or intervals have equal probability, not the basis for empirical probability. Since the question asks for the definition of empirical probability, the correct selection is observed data. Study Guide references/topics: empirical probability, relative frequency, observed outcomes, probability interpretation.

Question: 4

Chi-square test used for:

- A. Association of categorical variables
- B. Means of two samples
- C. Regression
- D. Variance

Answer: A

Explanation:

A chi-square test is commonly used to analyze categorical data, especially to determine whether two categorical variables are associated. In a chi-square test of independence, data are arranged in a contingency table, and observed cell counts are compared with expected cell counts under the assumption that the variables are independent. If the observed counts differ substantially from the expected counts, there is evidence of association between the categorical variables. For example, a chi-square test could examine whether voting preference is associated with age group or whether product preference differs by region. Option B describes comparing means, which is typically handled by a t-test or related procedure. Option C refers to regression, which models relationships between variables,

often involving quantitative outcomes. Option D refers to variance, which is tested using different procedures depending on context. The key phrase is “categorical variables”: chi-square methods work with counts in categories. Study Guide references/topics: categorical data, contingency tables, chi-square test, association.

Question: 5

A team of scientists wants to understand the relationship between smoking and lung cancer. They collect data from 1,000 individuals, recording their smoking habits and whether they have been diagnosed with lung cancer. The scientists then analyze the data to find any correlations. Is this study observational or experimental?

- A. Experimental, because the researchers are analyzing the data to find correlations.
- B. Experimental, because the researchers are testing the effects of smoking on lung cancer.
- C. Observational, because the study involves a large sample size.
- D. Observational, because the researchers are collecting data without manipulating any variables.

Answer: D

Explanation:

This is an observational study because the scientists collect existing information about individuals' smoking habits and lung cancer diagnoses without assigning treatments or controlling exposure. In an experimental study, researchers impose a condition, treatment, or intervention and then measure the resulting effect. Here, the researchers are not requiring some individuals to smoke and others not to smoke; they are simply recording naturally occurring characteristics and outcomes. The purpose is to examine association, or correlation, between two variables: smoking status and lung cancer diagnosis. Both variables are categorical, so the analysis would likely involve proportions, conditional percentages, or contingency tables. Option A is incorrect because analyzing correlations does not make a study experimental. Option B is incorrect because “testing effects” would require manipulation or assignment. Option C identifies a true feature, a large sample size, but sample size does not determine study type. References/topics from the Study Guide: observational studies, experimental studies, association, categorical variables.

Question: 6

Expected value = ?

- A. Long-term average
- B. Median
- C. Mode
- D. 0

Answer: A

Explanation:

Expected value is the theoretical long-term average outcome of a random variable over many repeated trials. It is calculated by multiplying each possible value by its probability and then summing those products. For a discrete random variable, $E(X) = \sum xP(x)$. Expected value does not necessarily have to be an outcome that can occur in one trial. For example, the expected value of rolling a fair six-sided die is 3.5, even though no face shows 3.5. It represents the balance point of the probability distribution. The median is the middle value of an ordered distribution, and the mode is the most likely or most frequent value. Expected value may equal 0 in some distributions, but it is not defined as 0. The best conceptual definition is long-term average. Study Guide references/topics: expected value, random variables, probability distributions, long-run average.

Question: 7

The average commute time for workers in a city in 2021 was 35 minutes, with a standard deviation of 5 minutes.

Assuming a normal distribution, which two values encompass 95% of the data?

- A. 20 minutes and 50 minutes
- B. 30 minutes and 40 minutes
- C. 25 minutes and 45 minutes
- D. 35 minutes and 40 minutes

Answer: C

Explanation:

For a normally distributed variable, the empirical rule states that approximately 95% of observations fall within two standard deviations of the mean. The mean commute time is 35 minutes, and the standard deviation is 5 minutes. Two standard deviations equal $2 \times 5 = 10$ minutes. Therefore, the interval covering approximately 95% of the data is $35 - 10$ to $35 + 10$, which gives 25 minutes to 45 minutes. Option B, 30 to 40 minutes, represents only one standard deviation from the mean and would cover approximately 68% of the data, not 95%. Option A extends three standard deviations from the mean and would correspond to roughly 99.7% under the empirical rule. Option D is not centered properly around the mean and does not represent a standard normal interval. The correct interval is symmetric about the mean and uses the standard deviation as the spread measure. References/topics from the Study Guide: normal distribution, empirical rule, mean, standard deviation.

Question: 8

A standard deck of 52 playing cards, 13 with hearts, 13 with diamonds, 13 with clovers, and 13 with spades, is shuffled, and one card is drawn at random.

What is the probability of drawing a heart?

- A. $1/13$
- B. $1/2$
- C. $1/4$
- D. $1/3$

Answer: C

Explanation:

The probability of a simple event is calculated by dividing the number of favorable outcomes by the total number of equally likely outcomes. A standard deck contains 52 cards. The favorable outcomes are the hearts, and the question states that there are 13 hearts in the deck. Therefore, the probability of drawing a heart is $13/52$. This fraction simplifies by dividing both numerator and denominator by 13, giving $1/4$. Option A, $1/13$, would incorrectly treat one card as favorable out of 13 rather than 13 favorable hearts out of 52 total cards. Option B, $1/2$, would imply that half the deck consists of hearts, which is false. Option D, $1/3$, does not correspond to the four equally sized suits in a standard deck. Since the four suits are equally represented, each suit has probability one out of four. References/topics from the Study Guide: theoretical probability, equally likely outcomes, fractions, sample spaces.

Question: 9

Sample correlation $r = 0 \rightarrow$

- A. No linear relationship
- B. Strong positive
- C. Strong negative
- D. Perfect correlation

Answer: A

Explanation:

The correlation coefficient r measures the strength and direction of a linear relationship between two quantitative variables. Values close to 1 indicate strong positive linear association, values close to -1 indicate strong negative linear association, and values near 0 indicate no linear relationship. Therefore, $r = 0$ means there is no linear association detected by the correlation coefficient. It is important to interpret this precisely: $r = 0$ does not guarantee there is no relationship of any kind. A nonlinear relationship may still exist, but correlation measures only linear pattern. Option B and option C are incorrect because strong relationships require r to be close to 1 or -1 . Option D is incorrect because perfect correlation occurs at $r = 1$ or $r = -1$, not at 0. The correct interpretation is no linear relationship. Study Guide references/topics: correlation coefficient, linear association, scatterplots, correlation interpretation.

Question: 10

In a class of 40 students, the following data were collected on their favorite sport:

Soccer: 10 students

Basketball: 15 students

Tennis: 5 students

Swimming: 10 students

What is the relative frequency of students whose favorite sport is not basketball?

- A. 0.25

- B. 0.50
- C. 0.625
- D. 0.75

Answer: C

Explanation:

Relative frequency is the proportion of observations in a category compared with the total number of observations. The class has 40 students. Basketball accounts for 15 students, so the number of students whose favorite sport is not basketball is $40 - 15 = 25$. The relative frequency is therefore $25/40$. Dividing gives 0.625. This means 62.5% of the class selected a sport other than basketball. The same result can be found by adding the non-basketball categories directly: soccer 10, tennis 5, and swimming 10, giving $10 + 5 + 10 = 25$ students. Option A, 0.25, corresponds to 10 out of 40 and would represent soccer or swimming alone. Option B, 0.50, corresponds to 20 out of 40. Option D, 0.75, would imply 30 students, which is too high. References/topics from the Study Guide: relative frequency, categorical data, frequency tables, proportions.

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