Scenario for questions 1, 2, 3 and 4

You trained a new AI video generator. You claim your videos are just as good as human-designed ones, which on average score 8.5/10 by users. You had 100 people rate your AI-generated videos. The average rating was 8.3/10, with a standard deviation of 0.8. At $\alpha = 0.01$, is your AI's video quality significantly different from human-made ones?

Question 1(MSQ)

Which of the following is correct?

- A) Test is 1 sided, Null Hypothesis (H_0): Average rating of the AI related video is equal to the average rating of human designed video.
- B) Alternate Hypothesis (H_1): Average rating of the AI related video is not equal to the average rating of human designed video. Null Hypothesis (H_0): Average rating of the AI related video is equal to the average rating of human designed video.
- C) Null Hypothesis (H_1): Average rating of the AI related video is not equal to the average rating of human designed video. Alternate Hypothesis (H_0): Average rating of the AI related video is equal to the average rating of human designed video.
- D) Test is 2 sided

Correct Answer: B, D

Approach: Understand the formulation of null and alternative hypotheses in hypothesis testing.

Explanation: The null hypothesis states there is no difference (H_0: Average rating of AI videos = Average rating of human-designed videos), while the alternative hypothesis states there is a difference (H_1: Average rating of AI videos ≠ Average rating of human-designed videos). This scenario typically involves a two-tailed test to assess if the AI video quality is either better or worse than human-designed ones.

Question 2 (MSQ)

Continuing with the same scenario as in Question 1, Which of the following is correct?

- A) Claimed mean is 8.3, Sample mean is 8.5
- B) z-score = -2
- C) Claimed mean is 8.5, Sample mean is 8.3

- D) sample standard deviation = 0.8

Correct Answer: C, D
Approach: Apply the concept of z-scores to statistical analysis.
Explanation: The claimed mean (population mean) is 8.5, and the sample mean is 8.3. The sample standard deviation is indeed 0.8. The z-score formula is z = (sample mean−claimed mean)/(sample standard deviationn/sqrt(n)), which in this case would be z=(8.3−8.50)/(0.8/sqrt(100)) = −0.20/0.08 = −2.5.

Question 3(MSQ)

Continuing with the same scenario as in Question 1 & 2. Which of the following is correct?

- A) Average rating of the AI related video is equal to the average rating of human designed video
- B) AI's video quality is significantly different from humans.
- C) P-value: 0.0124
- D) Z-score: -2.0

Correct Answer: A, C

Approach: Understand the calculation and interpretation of z-scores and p-values.

Explanation: The correct z-score is approximately -2.5, not -2.0. The p-value for a two-tailed test with a z-score of -2.5 is approximately 0.0124, indicating that the AI video quality is not significantly different from human-designed ones at α = 0.01.

Question 4(MSQ)

Continuing with the same scenario as in above questions. How does the standard deviation of the sample affect the z-score calculation?

- A) If std dev is increases then, z-score is decreased.
- B) It is used as a multiplier
- C) It determines the sample size
- D) It is used as a divisor

Correct Answer: A, D

Approach: Understand the role of standard deviation in z-score calculations.

Explanation: The standard deviation is used as a divisor in the z-score formula to standardize the measurement, If std dev increased then, z-score gets decreased.

Question 5

A pharmaceutical company is testing a new drug that claims to lower blood pressure. They conduct a clinical trial on 500 patients and measure the average decrease in blood pressure. Instead of relying on just a single sample mean, they calculate a confidence interval to estimate the true effect of the drug in the general population. What is the purpose of using a confidence interval in hypothesis testing?

- A) To determine the sample size
- B) To calculate the standard error
- C) To estimate the population parameter
- D) To find the critical z-score

Correct Answer: C

Approach: Apply the concept of confidence intervals to statistical analysis.

Explanation: Confidence intervals provide a range of values within which the population parameter is likely to lie, helping estimate the true population parameter.

Question 6

A researcher is conducting a study to estimate the average height of a population. They are considering how to balance the precision of their estimate with the cost of collecting data.

How does increasing the sample size affect the standard error of the mean in this study?

- A) It increases the standard error
- B) It decreases the standard error
- C) It has no effect on the standard error
- D) It depends on the population mean

Correct Answer: B

Approach: Understand the relationship between sample size and standard error.

Explanation: Increasing the sample size decreases the standard error, making the sample mean a more reliable estimate.

Question 7

In a quality control process, a company uses statistical methods to monitor the weights of products. They plot these weights on a bell curve to analyze the distribution.
What is the purpose of marking the critical weight boundaries on this bell curve?

- A) To visualize the distribution of sample weights
- B) To determine the sample size
- C) To set the threshold for rejecting the null hypothesis
- D) To calculate the standard error

Correct Answer: C

Approach: Apply the concept of critical values to hypothesis testing.

Explanation: Marking critical weight boundaries helps visualize the threshold beyond which the null hypothesis is rejected.

Question 8

A company (retailer) wants to check the average weight of protein shake products sent by another company (wholesaler). They have collected a sample of weights.
For determining if the average weight of the products received by retailer differs from the product weight as told by wholesaler, what are we actually doing here?

- A) Comparing two sample means
- B) Testing if a sample mean differs from a known population mean
- C) Determining the sample size
- D) Calculating the standard error

Correct Answer: B

Approach: Apply the concept of z-tests to statistical analysis.

Explanation: Here, we are determining if a sample mean significantly differs from a known population mean. For this we can use z-test.

Question 9

A researcher is testing whether a new fertilizer increases crop yield. They formulate a hypothesis that the fertilizer does not affect crop yield.
What is the purpose of using this null hypothesis in the study?

- A) To determine the sample size
- B) To calculate the standard error
- C) To provide a baseline for comparison
- D) None of the above

Correct Answer: C

Approach: Apply the concept of null hypotheses to statistical analysis.

Explanation: The null hypothesis provides a baseline assumption against which the observed data are compared.

Question 10

A developer is optimizing a bubble sort algorithm to improve its efficiency. They introduce a flag to track whether any swaps were made during a pass.
What is the purpose of the flag in the optimized bubble sort algorithm?

- A) To increase the number of iterations
- B) To stop iterations if no swaps occur
- C) To reduce the number of swaps
- D) To increase the number of comparisons

Correct Answer: B

Approach: Analyze the role of flags in algorithm optimization.

Explanation: The `swapped` flag allows the algorithm to terminate early if no swaps are needed, indicating the list is sorted.

Question 11

A programmer is implementing a selection sort algorithm to sort an array. The algorithm follows the standard selection sort procedure, where in each pass, the smallest element from the unsorted portion

of the array is selected and swapped with the first element of that portion.

Question: After which of the following passes does the array **[37, 15, 11, 90]** first become fully sorted and remains unchanged in subsequent passes when using selection sort?

- A) After the 1st pass
- B) After the 2nd pass
- C) After the 3rd pass
- D) After the 4th pass

Correct Answer: - C) After the 3rd pass

Approach: Understand how selection sort places the smallest available element in its correct position after each pass.

Explanation:
Selection sort works by selecting the minimum element from the remaining unsorted portion and swapping it with the first unsorted element.

- **Pass 1:** [**11**, 15, 37, 90] (11 is placed in the correct position)
- **Pass 2:** [11, **15**, 37, 90] (15 is placed in the correct position)
- **Pass 3:** [11, 15, **37, 90**] (37 is placed in the correct position)
- **Pass 4:** No changes needed, as the array is already sorted.

The array **first becomes fully sorted and remains unchanged after the 3rd pass.**

Question 12

You are working as a programmer and using bubble sort to sort an array.
What will be the state of the array ([37, 15, 11, 90]), after the 2nd pass of bubble sort?

- A) [15, 37, 11, 90]
- B) [11, 15, 37, 90]
- C) [11, 37, 15, 90]
- D) [15, 11, 37, 90]

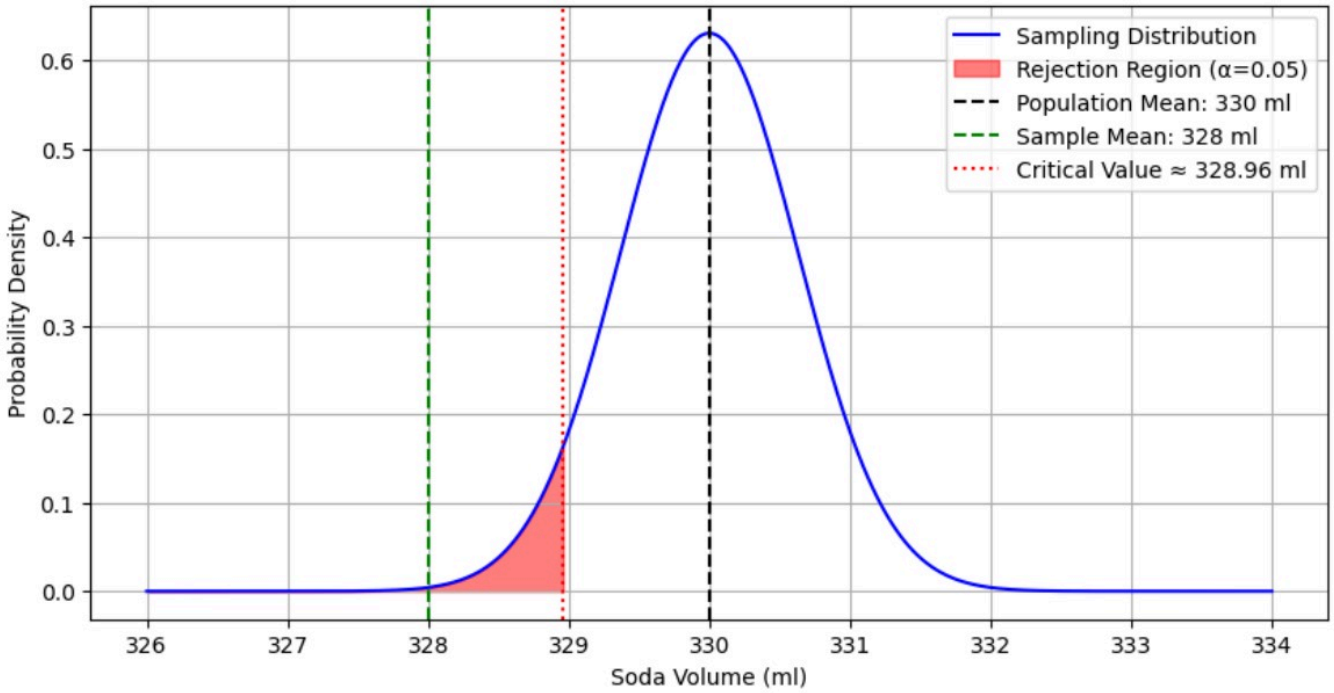
Correct Answer: B

Approach: Analyze the effect of bubble sort passes.

Explanation: After the first pass, the largest element (90) is at the end. After the second pass, the next largest element (37) is in its correct position, resulting in the array [11, 15, 37, 90].

Question 13(MSQ)

For the given image, Which of the following statements is true?



- A) Alternate hypothesis is accepted.
- B) This is a two tailed test
- C) Alternate hypothesis is rejected.
- D) Null hypothesis is rejected.

Correct Answer: A, D

Approach: Analyze the scenario depicted in the image.
Explanation: The sample mean of 328 ml (green dashed line) lies within the red shaded rejection region, which is beyond the critical value of approximately 328.96 ml (dotted red vertical line). Since the sample mean falls into the rejection region, the null hypothesis is rejected at a significance level of $\alpha=0.05$.

Question 14

A developer is optimizing a bubble sort algorithm to improve its efficiency. They introduce a flag to track whether any swaps were made during a pass.
How does the optimized version of bubble sort improve efficiency?

- A) By reducing the number of comparisons

- B) By increasing the number of swaps
- C) By maintaining the same number of iterations
- D) By using a different sorting algorithm

Correct Answer: A

Approach: Understand optimizations in bubble sort.

Explanation: The optimized version introduces a flag to stop iterations if no swaps occur, reducing unnecessary comparisons.

Question 15

A programmer is tasked with sorting a list that is already sorted (for some research purposes) using bubble sort.
Given a sorted list, what will be time complexity if bubble sort performed on it?

- A) O(n^2)
- B) O(log n)
- C) O(n)
- D) None of the above

Correct Answer: C

Approach: Analyze the best-case scenario of bubble sort.

Explanation: In the best-case scenario (when the list is already sorte- D), bubble sort has a time complexity of O(n) because it only needs to make one pass to confirm the list is sorted.