End Course Summative Assignment

VideoLink:

https://us05web.zoom.us/clips/share/UubLe5a0UkYYWv1W5WwCNu16hTbcUszX4bNsVp515kuSfIL5pNO-pkGtmBL71YBmlNNbP3kvas4c6c7UJpXkbOXx9g.qcsGi36-oI0C9JOz

Problem Statement: Write the Solutions to the Top 50 Interview Questions and Explain any 5 Questions in a Video

1. What is a vector in mathematics?

Solution: Vectors, in Mathematics, are objects which have both, magnitude and direction. Magnitude defines the size of the vector. It is represented by a line with an arrow, where the length of the line is the magnitude of the vector and the arrow shows the direction.

2. How is a vector different from a scalar?

Solution: A scalar quantity has only magnitude, but no direction. Vector quantity has both magnitude and direction. Every scalar quantity is one-dimensional. Vector quantity can be one, two or three-dimensional.

3. What are the different operations that can be performed on vectors?

Solution: 6 Vector Operations

- Scalar multiplication.
- Vector addition.
- The dot product.
- The scalar component.
- The cross product (R3 R 3 only)

4. How can vectors be multiplied by a scalar?

Solution: When a vector is multiplied by a scalar, each component of the vector is multiplied by the scalar value. For example, if we have a vector A = (a1, a2, a3) and a scalar c, the scalar multiplication of the vector is c * A = (c * a1, c * a2, c * a3).

5. What is the magnitude of a vector?

Solution: The magnitude of a vector is the length of the vector. The magnitude of the vector a is denoted as // a //

6. How can the direction of a vector be determined?

Solution: The slope of a line that passes through the origin and a point (x, y) is y/x. We also know that if θ is the angle made by this line, then its slope is tan θ, i.e., tan θ = y/x. Hence, $\theta = \tan^{-1} (y/x)$. Thus, the direction of a vector (x, y) is found using the formula $\tan^{-1}$.

7. What is the difference between a square matrix and a rectangular matrix?

Solution: A square matrix is a matrix that contains the same number of rows and the same number of columns. If a matrix is not a square matrix, then it is known as a rectangular matrix. We can also say that the matrices which have different numbers of rows and columns are called rectangular matrices

8. What is a basis in linear algebra?

Solution: A basis B of a vector space V over a field F (such as the real numbers R or the complex numbers C) is a linearly independent subset of V that spans V. This means that a subset B of V is a basis if it satisfies the two following conditions: linear independence for every finite subset.

9. What is a linear transformation in linear algebra?

Solution: A linear transformation is a function from one vector space to another that respects the underlying (linear) structure of each vector space. A linear transformation is also known as a linear operator or map

10. What is an eigenvector in linear algebra?

Solution: Eigenvectors are the vectors (non-zero) that do not change the direction when any linear transformation is applied. It changes by only a scalar factor.

11. What is the gradient in machine learning?

Solution: A gradient simply measures the change in all weights with regard to the change in error. You can also think of a gradient as the slope of a function. The higher the gradient, the steeper the slope and the faster a model can learn. But if the slope is zero, the model stops learning.

12. What is backpropagation in machine learning?

Solution: Backpropagation is the process of adjusting the weights of a neural network by analyzing the error rate from the previous iteration. Hinted at by its name, backpropagation involves working backward from outputs to inputs to figure out how to reduce the number of errors and make a neural network more reliable.

13. What is the concept of a derivative in calculus?

Solution: Derivatives are defined as the varying rate of change of a function with respect to an independent variable. The derivative is primarily used when there is some varying quantity, and the rate of change is not constant.

14. How are partial derivatives used in machine learning?

Solution: Partial derivatives and gradient vectors are used very often in machine learning algorithms for finding the minimum or maximum of a function. Gradient vectors are used in the training of neural networks, logistic regression, and many other classification and regression problems.

15. What is probability theory?

Solution: This theory is used to know the probability

1. Step 1: Count the number of possible outcomes of the event.
2. Step 2: Count the number of desirable outcomes of the event.
3. Step 3: Divide the number of desirable outcomes by the number of possible outcomes.
4. Step 4: Express this probability as a percentage.

Probability Theory FormulasTheoretical Probability Formula: (Number of Favourable Outcomes) / (Number of Total Outcomes) Empirical Probability Formula: (Number of times event A happened) / (Total number of trials) Addition Rule of Probability: $P(A \cup B) = P(A) + P(B) – P(A \cap B)$

16. What are the primary components of probability theory?

Solution: The probability space associated with a random experiment is determined by three components: the outcome space Ω whose element ω is an outcome of the experiment, a collection of events F whose elements are subsets of Ω, and a probability measure IP assigned to the elements in F.

17. What is conditional probability, and how is it calculated?

Solution: The probability of occurrence of any event A when another event B in relation to A has already occurred is known as conditional probability. It is depicted by P(A|B)

18. What is Bayes theorem, and how is it used?

Solution: The Bayes theorem is a mathematical formula for calculating conditional probability in probability and statistics. In other words, it's used to figure out how likely an event is based on its proximity to another. Bayes law or Bayes rule are other names for the theorem.

19. What is a random variable, and how is it different from a regular variable?

Solution: A random variable is a variable whose value is unknown or a function that assigns values to each of an experiment's outcomes. A random variable can be either discrete (having specific values) or continuous (any value in a continuous range).

20. What is the law of large numbers, and how does it relate to probability theory?

Solution: The law of large numbers, in probability and statistics, states that as a sample size grows, its mean gets closer to the average of the whole population. This is due to the sample being more representative of the population as the sample becomes larger

21. What is the central limit theorem, and how is it used?

Solution: The central limit theorem says that the sampling distribution of the mean will always be normally distributed, as long as the sample size is large enough. Regardless of whether the population has a normal, Poisson, binomial, or any other distribution, the sampling distribution of the mean will be normal

22. What is the difference between discrete and continuous probability distributions?

Solution: A discrete distribution is one in which the data can only take on certain values, for example integers. A continuous distribution is one in which data can take on any value within a specified range (which may be infinite).

23. What are some common measures of central tendency, and how are they calculated?

Solution: Here, mid-range or mid-extreme of a set of statistical data values is the arithmetic mean of the maximum and minimum values in a data set

24. What is the purpose of using percentiles and quartiles in data summarization?

Solution: The values that divide a rank-ordered set of data into 100 equal parts are called percentiles. Percentiles are used to compare and interpret data. For example, an observation at the 50^{th} percentile would be greater than 50 percent of the other observations in the set. Quartiles divide data into quarters

25. How do you detect and treat outliers in a dataset?

Solution: Below are some of the methods of treating the outliers:

1. Step 1: Trimming/Remove the outliers. In this technique, we remove the outliers from the dataset. ...
2. Step 2: Quantile Based Flooring and Capping. ...

3. Step 3: Mean/Median Imputation. ...
4. Step 5: Visualizing the Data after Treating the Outlier.

26. How do you use the central limit theorem to approximate a discrete probability distribution?

Solution: The central limit theorem can be applied to sums of discrete random variables as well as continuous random variables. Let X1, X2, be i.e. copies of a discrete random variable X with E[X]=μ E [X] = μ and var(X)=σ2 var (X) = σ 2. Further suppose that the support of X is in the non-negative integers {0, 1, …}

27. How do you test the goodness of fit of a discrete probability distribution?

Solution: The chi-square test is an alternative to the Anderson-Darling and Kolmogorov-Smirnov goodness-of-fit tests. The chi-square goodness-of-fit test can be applied to discrete distributions such as the binomial and the Poisson. The Kolmogorov-Smirnov and Anderson-Darling tests are restricted to continuous distributions.

28. What is a joint probability distribution?

Solution: A joint probability distribution represents a probability distribution for two or more random variables. Instead of events being labeled A and B, the condition is to use X and Y as given below. F (x, y) = P (X = x, Y = y) The main purpose of this is to look for a relationship between two variables.

29. How do you calculate the joint probability distribution?

Solution: P ((X, Y) ∈A) = ∫∫ A f XY (x, y) dx dy. The function f XY (x, y) is known as the Joint Probability Density Function of X and Y. Example: Suppose one wants to find the probability that the sum of locations X+Y>3 i.e., P(X+Y>3).

30. What is the difference between a joint probability distribution and a marginal probability distribution?

Solution: Joint probability is the probability of two events occurring simultaneously. Marginal probability is the probability of an event irrespective of the outcome of another variable. Conditional probability is the probability of one event occurring in the presence of a second event.

31. What is the covariance of a joint probability distribution?

Solution: The covariance of X and Y for the given joint probability distribution is: X/Y

32. How do you determine if two random variables are independent based on their joint probability distribution?

Solution: Intuitively, two random variables X and Y are independent if knowing the value of one of them does not change the probabilities for the other one. In other words, if X and Y are independent, we can write P(Y=y|X=x) =P(Y=y), for all x,y .

33. What is the relationship between the correlation coefficient and the covariance of a joint probability distribution?

Solution: The correlation coefficient is the standardized covariance between two random variables. The joint distribution of two random variables can be visualized with a scatter plot. Multivariate distributions can model the joint distribution of more than two random variables.

34. What is sampling in statistics, and why is it important?

Solution: Samples are used in statistical testing when population sizes are too large for the test to include all possible members or observations. A sample should represent the population as a whole and not reflect any bias toward a specific attribute

35. What are the different sampling methods commonly used in statistical inference?

Solution: Probability sampling methods include simple random sampling, systematic sampling, stratified sampling, and cluster sampling. What is non-probability sampling? In non-probability sampling, the sample is selected based on non-random criteria, and not every member of the population has a chance of being included.

36. What is the central limit theorem, and why is it important in statistical inference?

Solution: The central limit theorem (CLT) states that the distribution of sample means approximates a normal distribution as the sample size gets larger, regardless of the population's distribution. Sample sizes equal to or greater than 30 are often considered sufficient for the CLT to hold.

37. What is the difference between parameter estimation and hypothesis testing?

Solution: Estimation estimates values of specific population parameters; hypothesis testing tests whether the value of a population parameter is equal to a specified value

38. What is the p-value in hypothesis testing?

Solution: The P-value is known as the level of marginal significance within the hypothesis testing that represents the probability of occurrence of the given event. The P-value is used as an alternative to the rejection point to provide the least significance at which the null hypothesis would be rejected

39. What is confidence interval estimation?

Solution: The confidence interval is the range of values that you expect your estimate to fall between a certain percentage of the time if you run your experiment again or re-sample the population in the same way.

40. What are Type I and Type II errors in hypothesis testing?

Solution: In statistical hypothesis testing, a type I error, or a false positive, is the rejection of the null hypothesis when it is true. For example, an innocent person may be convicted. A type II error, or a false negative, is the failure to reject a null hypothesis that is false.

41. What is the difference between correlation and causation?

Solution: Causation means one thing causes another—in other words, action A causes outcome B. On the other hand, correlation is simply a relationship where action A relates to action B—but one event doesn't necessarily cause the other event to happen.

42. How is a confidence interval defined in statistics?

Solution: A confidence interval shows the probability that a parameter will fall between a pair of values around the mean. Confidence intervals show the degree of uncertainty or certainty in a sampling method. They are constructed using confidence levels of 95% or 99%

43. What does the confidence level represent in a confidence interval?

Solution: The confidence level is the percentage of times you expect to get close to the same estimate if you run your experiment again or resample the population in the same way. The confidence interval consists of the upper and lower bounds of the estimate you expect to find at a given level of confidence.

44. What is hypothesis testing in statistics?

Solution: Hypothesis testing is a form of statistical inference that uses data from a sample to conclude a population parameter or a population probability distribution. First, a tentative assumption is made about the parameter or distribution. This assumption is called the null hypothesis and is denoted by H0.

45. What is the purpose of a null hypothesis in hypothesis testing?

Solution: The null hypothesis is a kind of hypothesis that explains the population parameter whose purpose is to test the validity of the given experimental data. This hypothesis is either rejected or not rejected based on the viability of the given population or sample.

46. What is the difference between a one-tailed and a two-tailed test?

Solution: The main difference between one-tailed and two-tailed tests is that one-tailed tests will only have one critical region whereas two-tailed tests will have two critical regions. If we require a 100(1−α) 100 (1 − α) % confidence interval we have to make some adjustments when using a two-tailed test.

47. What is experiment design, and why is it important?

Solution: Experimental design is the process of carrying out research in an objective and controlled fashion so that precision is maximized and specific conclusions can be drawn regarding a hypothesis statement. Generally, the purpose is to establish the effect that a factor or independent variable has on a dependent variable.

48. What are the key elements to consider when designing an experiment?

Solution: Key things to consider when designing your experiment:

- Ensure your experiment is unbiased.
- Make sure your experiment is adequately powered.
- Consider the range of applicability of your experiment.
- Simplify your experiment.
- Indicate the uncertainty in your results.
- References and further reading.

49. How can sample size determination affect experiment design?

Solution: The smaller the difference or effect size you expect, the larger the sample size that will be required. Sample size increases proportionally to the variance. The larger the uncertainty of the outcome measurement (variability of a result), the larger the sample size must be.**50. What are some strategies to mitigate potential sources of bias in experiment design?**

Solution:

- Define a clear hypothesis.
- Choose a suitable design. ...
- Select a representative sample. ...
- Randomize and blind the experiment. ...
- Use valid and reliable measures. ...
- Report and interpret the results objectively. ...
- Here's what else to consider.

----------X----------X----------

51. What is the geometric interpretation of the dot product?

52. What is the geometric interpretation of the cross-product?

53. How are optimization algorithms with calculus used in training deep learning models?

54. What are observational and experimental data in statistics?

55. How are confidence tests and hypothesis tests similar? How are they different?

56. What is the left-skewed distribution and the right-skewed distribution?

57. What is Bessel's correction?

58. What is kurtosis?

59. What is the probability of throwing two fair dice when the sum is 5 and 8?

60. What is the difference between Descriptive and Inferential Statistics?

61. Imagine that Jeremy took part in an examination. The test has a mean score of 160, and it has a standard deviation of 15. If Jeremy's z-score is 1.20, what would be his score on the test?

62. In an observation, there is a high correlation between the time a person sleeps and the amount of productive work he does. What can be inferred from this?

63. What is the meaning of degrees of freedom (DF) in statistics?

64. If there is a 30 percent probability that you will see a supercar in any 20-minute time interval, what is the probability that you see at least one supercar in the period of an hour (60 minutes)?

65. What is the empirical rule in Statistics?

66. What is the relationship between sample size and power in hypothesis testing?

67. Can you perform hypothesis testing with non-parametric methods?

68. What factors affect the width of a confidence interval?

69. How does increasing the confidence level affect the width of a confidence interval?

70. Can a confidence interval be used to make a definitive statement about a specific individual in the population?

71. How does sample size influence the width of a confidence interval?

72. What is the relationship between the margin of error and confidence interval?

73. Can two confidence intervals with different widths have the same confidence level?

74. What is a Sampling Error and how can it be reduced?

75. What is a Chi-Square test?

76. What is a t-test?

77. What is the ANOVA test?

78. How is hypothesis testing utilised in A/B testing for marketing campaigns?

79. What is the difference between one-tailed and two tailed t-tests?

80. What is an inlier?