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| No | Session | Name | Details |
|  | 1 | Q4.1 | Let  and  . Compute the matrix  a.  b.  c.  d.  e.  f.  g. |
|  | 1 | Q4.2 | Find the inverse of each of the following matrices.  a.  b.  c. |
|  | 1 | Q4.3 | Evaluate the determinant  a.  b.  c.  d.  e. |
|  | 1 | Q4.4 | Find the adjugate and the inverse of the matrix |
|  | 1 | Q4.5 | Let A and B be square matrices of order 4 such that  and . Find  a.  b.  c.  d. |
|  | 1 | Q4.6 | Find all values of k for which the matrix is not invertible  a.  b.  c. |
|  | 1 | Q4.7 | Find the characteristic polynomial of the matrix  a.  b.  c.  d. |
|  | 2 | Q4.8 | Find the eigenvalues and corresponding eigenvectors of the matrix  a.  b.  c.  d. |
|  | 2 | Q4.9 | Compute the eigenspaces of the matrix  a.  b.  c. |
|  | 2 | Q4.10 | Are the following matrices diagonalizable? If yes, determine their diagonal form and a basis with respect to which the transformation matrices are diagonal. If no, give reasons why they are not diagonalizable.  a.  b. |
|  | 3 | Q4.10 | Find the SVD of the matrix  a.  b. |
|  | 4 | Q4.11 | Find the rank-1 approximation of the matrix  a.  b. |
|  | 5 | Q5.1 | Compute the derivative  for  a.  b.  c. , where µ; σ2 are constants |
|  | 5 | Q5.2 | Compute the Taylor polynomials Tn, n = 0,1,…,5 of  at |
|  | 5 | Q5.3 | Find the linear approximation of the function at the given point.  a.  at  b.  at  c.  at |
|  | 6 | Q5.4 | Find the partial derivative of the function  a.  b.  c. |
|  | 6 | Q5.5 | Find the gradient of the function  a.  b.  c. |
|  | 6 | Q5.6 | Using Chain rule to compute the derivative of the function with respect to  a. , where  b. , where |
|  | 6 | Q5.7 | Find the partial derivative of the vector-valued function  a.  b.  c. |
|  | 7 | Q5.8 | Find the Jacobian of the function  a.  b.  c.  d. |
|  | 7 | Q5.9 | Using Chain rule to find the partial derivative of with respect to  and  a. , where  b. , where |
|  | 7 | Q5.10 | Find the Jacobian of the function  a. , where  b. , where  c. , where |
|  | 8 | Q5.11 | Find the Hessian matrix of the function  a.  b. at (0,0) |
|  | 8 | Q5.12 | Find the first order Taylor polynomial of the function at the given point  a.  at (1,1)  b.  at (1,2) |
|  | 9 | Q5.13 | Find the second order Taylor polynomial of the function at the given point  a.  at (0,0)  b.  at (0,0) |
|  | 11 | Q6.1 | A sample of **two items** is selected without replacement from a batch. Describe the (ordered) sample space for each of the following batches:  a. The batch contains the items {a, b, c}.  b. The batch contains the items {a, b, c, d}. |
|  | 11 | Q6.2 | A school survey found that 7 out of 30 workers walk to company. If four workers are selected at random without replacement, what is the probability that all four walk to company? |
|  | 12 | Q6.3 | Let P(A) = 0.4, P(B) = 0.5 and P(A + B) = 0.7. Find  a) P(AB)  b) P(A’B)  c) P(A|B)  d) P(B|A’) |
|  | 12 | Q6.4 | An e-mail filter is planned to separate valid e-mails from spam. The word free occurs in 60% of the spam messages and only 5% of the valid messages. Also, 20% of the messages are spam. Determine the following probabilities:  a) The message contains free.  b) The message is spam given that it contains free.  c) The message is valid given that it does not contain free. |
|  | 12 | Q6.5 | In the 2012 presidential election, exit polls from the critical state of Ohio provided the following results:  Total Obama Romney  No college degree (60%): 52% 45%  College graduate (40%): 47% 51%  a. What is the probability a randomly selected respondent voted for Obama?  b. Suppose that a respondent voted for Romney, Find the probability that the person has college graduated. |
|  | 12 | Q6.6 | Verify that the following functions are probability mass functions  x -2 -1 0 1 2  f(x) 0.2 0.4 0.1 0.2 0.1  Determine the following:  a) P(X ≤ 2)  b) P(1 < X ≤ 1)  c) E(X)  d) Var(X)  e) σ(X)  f) Find the cumulative function F(x) of X. |
|  | 13 | Q6.7 | The diameter of a particle of contamination (in micrometers) is modeled with the probability density function f(x) = m/x^4 for x > 1. Determine the following:  a) The value of m.  b) P(X ≤ 2)  c) P(3 ≤ X < 5)  d) E(X)  e) Var(X)  f) The cumulative function F(x)  g) E(2X-3) |
|  | 13 | Q6.8 | Assume X is normally distributed with a mean of 5 and a standard deviation of 4. Determine the following:  a) P(3 ≤ X ≤ 7)  b) P(3 < X < 7)  c) P(X > 5)  d) P(X ≤ 4) |
|  | 13 | Q6.9 | The compressive strength of samples of cement can be modeled by a normal distribution with a mean of 6000 kilograms per square centimeter and a standard deviation of 100 kilograms per square centimeter.  a) What is the probability that a sample’s strength is less than 6250 Kg/cm2?  b) What is the probability that a sample’s strength is between 5800 and 5900 Kg/cm2? |
|  | 13 | Q6.10 | Show that the following function satisfies the properties of a joint probability mass function    Determine the following:  a. P(X < 2.5,Y < 3) b. P(X < 2.5)  c. P(Y < 3) d. P( X > 1.8,Y > 4.7)  e. E(X), E(Y) ,Var(X), Var(Y), cov(X,Y) and corr(X,Y)  f. Marginal probability distribution of X  g. Conditional probability distribution of Y given that X = 1.5 h. Conditional probability distribution of X given that Y = 2  i. E(Y|X = 1.5) j. Are ) X and Y independent? |
|  | 13 | Q6.11 | Determine the value of c that makes the function  for 0 < x, y < 3 satisfied the properties of a joint probability density function.  Determine the following:  a. P(X < 2, Y < 3) b. P(X < 2.5)  c. P(1 < Y < 2.5) d. P(X > 1.8, 1 < Y < 2.5)  e. E(X), E(Y) ,Var(X), Var(Y), cov(X,Y) and corr(X,Y)  f. Marginal probability distribution of X  g. Conditional probability distribution of Y given that X = 1.5 h. E(Y|X = 1.5) j. P(Y < 2|X = 1.5 )  k. Conditional probability distribution of X given that Y = 2 |
|  | 14 | Q6.12 | In an acid-base titration, a base or acid is gradually added to the other until they have completely neutralized each other. Let X and Y denote the milliliters of acid and base needed for equivalence, respectively. Assume that X and Y have a bivariate normal distribution with    Determine the following:  a. Covariance between X and Y  b. Marginal probability distribution of X  c. P(X < 116)  d. Conditional probability distribution of X given that Y = 102 e. P(X < 116|Y = 102) |
|  | 14 | Q6.13 | Consider the following bivariate distribution  of two discrete random variables X and Y.    Compute the following:  a. The marginal distribution  and .  b. The condition distribution  and |
|  | 14 | Q6.14 | Consider a mixture of two Gaussian distribution:    a. Compute the marginal distribution for each dimension.  b. Compute the mean and variance for each marginal distribution.  c. Compute the mean and covariance matrix for two-dimension distribution. |
|  | 15 | Q7.1 | Solve the optimization problem using gradient descent and partial derivative methods  a.  b.  c.  d. |
|  | 15 | Q7.2 | Solve the constrained optimization problem  a.  subject to  b.  subject to  c.  subject to |
|  | 16 | Q7.3 | Consider the univariate function    Find its stationary points and indicate whether they are maximum, minimum, or saddle points. |
|  | 17 | Q7.4 | Consider whether the following statements are true or false:  a. The intersection of any two convex sets is convex.  b. The union of any two convex sets is convex.  c. The difference of a convex set A from another convex set B is convex. |
|  | 17 | Q7.5 | Consider the function:    a. Find  b. Find  subject to |
|  | 19 | Q9.1 | Perform regression and classification on the given data.  Hind: Use variables in the data to formulate research questions  <https://docs.google.com/spreadsheets/d/1EvbUcytpaoqL-NGC9gRUCv1yY_lHpha-/edit?usp=sharing&ouid=113426150085744632295&rtpof=true&sd=true> |
|  | 20 | Q9.2 | What are evaluation metrics for regression? |
|  | 21 | Q9.3 | What are evaluation metrics for classification? |
|  | 22 | Q10.1 | Perform PCA on the given data to explore latent variable |
|  | 23 | Q10.2 | Use PCA for dimensionality reduction |
|  | 24 | Q10.3 | Eigenvector Computation and Low-Rank Approximations |
|  | 26 | Q12 | Classification with Support Vector Machines |