Assignment 1 Theoretical ML

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May 2024

1 Question 1

1.1 Part 1

When calculating $\mathbf{c} = A\mathbf{x}$ with the given specifications we get $\mathbf{c}$ as a column vector with element $c_i = \sum_{j=1}^{n} a_{ij}x_j$. As we differentiate $\mathbf{c}$ with respect to $\mathbf{x}$ we get a n*n matrix D with $d_{ij} = a_{ij}$. Hence $D = A$ which proves the above statement. Here i have considered the fact that $\frac{dx_i}{dx_j} = 0 \ \forall i \neq j$

1.2 Part 2

$\mathbf{x}^T A\mathbf{x}$ is a matrix of size 1*1 with its element can be written as $\sum_{i=1,j=1}^{n} a_{ij}x_ix_j$.
Differentiating that with respect to $\mathbf{x}$ we get a row vector $\mathbf{c}$ with
$c_i = x_i \sum_{j=1}^{n}(a_{ij} + a_{ji})$ which is same as the RHS.

2 Question 2

m*n*k

3 Question 3

3.1 Part 1

$$\begin{pmatrix} 2\sin(2x)\cos(y) & -2\sin^2(x)\sin(y) \\ 2x & 3e^y \end{pmatrix}$$

3.2 Part 2

$$\begin{pmatrix} 6xy + yzw & 3x^2 + xzw & xyw & xyz \\ 2x\cos(x^2 + yw - z) & w\cos(x^2 + yw - z) & y\cos(x^2 + yw - z) & -\cos(x^2 + yw - z) \end{pmatrix}$$

4 Question 4

$\beta^T \cdot \mathbf{x}$ is a 1×1 matrix with its only element as $\sum_{i=1}^n \beta_i x_i$. $[e^{\beta^T \cdot \mathbf{x}}]$ is also a 1×1 matrix with its element $e^{\sum_{i=1}^n \beta_i x_i}$. Now differentiating this element with $\mathbf{x}$ we get a row matrix β^T multiplied by a scalar $e^{\sum_{i=1}^n \beta_i x_i}$. So the answer is $e^{\sum_{i=1}^n \beta_i x_i} \beta^T$