Theoretical ML Assignment 1

Ikrima

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Solution 1. Since A is scalar matrix,Apply product rule
$\frac{d(\mathbf{Ax})}{d\bar{\mathbf{x}}} = \mathbf{A} \cdot \mathbf{I} + 0$
As the differentiation of x vector with respect to itself is Identity matrix
$\frac{d\mathbf{x}}{d\mathbf{x}} = \mathbf{I}$
Solution b). Let $\mathbf{A}$ be an $n \times n$ matrix and $\mathbf{x}$ be an $n \times 1$ vector.

$$\frac{d}{d\mathbf{x}}(\mathbf{x}^T \mathbf{A} \mathbf{x}) = \mathbf{x}^T(\mathbf{A} + \mathbf{A}^T)$$

Using the product rule, we have:

$$\frac{d}{d\mathbf{x}}(\mathbf{x}^T \mathbf{A} \mathbf{x}) = \frac{d}{d\mathbf{x}}(\mathbf{x}^T)\mathbf{A}\mathbf{x} + \mathbf{x}^T \frac{d}{d\mathbf{x}}(\mathbf{A}\mathbf{x})$$

$$= \frac{d}{d\mathbf{x}}(\mathbf{x}^T)\mathbf{A}\mathbf{x} + \mathbf{x}^T \mathbf{A}$$

The derivative of $\mathbf{x}^T$ with respect to $\mathbf{x}$ is $\mathbf{x}^T$.

$$= \mathbf{x}^T \mathbf{A}\mathbf{x} + \mathbf{x}^T \mathbf{A}$$

$$= \mathbf{x}^T(\mathbf{A} + \mathbf{A}^T)$$

Solution 2.) The dimension would be mXnXk
Solution 3.)
J = $\begin{pmatrix} 4sin(x)cos(y)cos(x) & -2\sin^2(x)\sin(y) \\ 2x & 2e^y \end{pmatrix}$
$Solution 3b)$
$\mathbf{J} = \begin{pmatrix} 6xy + yzw & 3x^2 + xzw & xyw & xyz \\ 2x\cos(x^2 + yw - z) & w\cos(x^2 + yw - z) & -\cos(x^2 + yw - z) & y\cos(x^2 + yw - z) \end{pmatrix}$