Theoretical Machine Learning

Theoretical Assignment 1

Problem 1. Prove the following :

(a) A is an m x n matrix. $\vec{x}$ is an n x 1 vector. Then,
$\frac{d}{d\vec{x}}[A\vec{x}] = A$

(b) A is an n x n matrix, $\vec{x}$ is an n x 1 vector. Then,
$\frac{d}{d\vec{x}}[\vec{x}^T A\vec{x}] = \vec{x}^T(A + A^T)$

Problem 2. Suppose you have a matrix of dimension m x n, and you differentiating wrt a k x 1 vector, what is the dimension of the final result?

Problem 3. Solve :

(a) $$\frac{d\begin{bmatrix} 2sin^2(x)cos(y) \\ x^2 + 3e^y \end{bmatrix}}{d\begin{bmatrix} x \\ y \end{bmatrix}}$$

(b) $$\frac{d\begin{bmatrix} 3x^2y + xyzw \\ sin(x^2 + yw - z) \end{bmatrix}}{d\begin{bmatrix} x \\ y \\ z \\ w \end{bmatrix}}$$

Problem 4. **BONUS** : β is an n x 1 vector. $\vec{x}$ is an n x 1 vector. Solve for : $\frac{d}{d\vec{x}}[e^{\beta^T\vec{x}}]$