# Artificial Intelligence Theory Homework 2

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Date No.

1.1 For $f(x) = aX$, $a \in \mathbb{R}^{1\times d}$, $X \in \mathbb{R}^{d\times h}$

$Df(x)[H] = aH$, $H \in \mathbb{R}^{d\times h}$

For $f(x) = XX^T$, $X \in \mathbb{R}^{d\times n}$

$Df(x)[H] = HX^T + XH^T$, $H \in \mathbb{R}^{d\times n}$

1.2 $f(X) = XBX$, $X \in \mathbb{R}^{d\times d}$

$Df(x)[H] = HBX + XBH$, $H \in \mathbb{R}^{d\times d}$

$f(X) = AXBX^TCX$, $X \in \mathbb{R}^{d\times d}$, $\{A, B, C\} \in \mathbb{R}^{d\times d}$

$Df(x)[H] = AHBX^TCX + AXBH^TCX + AXBX^TCH$, $H \in \mathbb{R}^{d\times d}$

1.3 $f(X) = (x_1\ x_2)\begin{pmatrix} \ln x_1 & x_2^2 \\ 3 & \end{pmatrix} = (x_1 + x_2 \ln x_1 \quad x_1x_2^2 + 3x_2)$

$f(x_1, x_2) = (x_1 + x_2 \ln x_1 \quad x_1x_2^2 + 3x_2)$

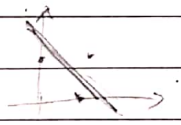
$f'(x) = \begin{pmatrix} 1 + \frac{x_2}{x_1} & x_2^2 \\ \ln x_1 & 2x_1x_2 + 3 \end{pmatrix}$

$Df(x) = \begin{pmatrix} 1 + \frac{x_2}{x_1} & x_2^2 \\ \ln x_1 & 2x_1x_2 + 3 \end{pmatrix} \Rightarrow Df(x)[H] = \begin{pmatrix} 1 + \frac{x_2}{x_1} & x_2^2 \\ \ln x_1 & 2x_1x_2 + 3 \end{pmatrix}\begin{pmatrix} h_1 \\ h_2 \end{pmatrix} = \begin{pmatrix} h_1 + \frac{x_2}{x_1}h_1 + h_2x_2^2 \\ h_1 \ln x_1 + 2h_2x_1x_2 + 3h_2 \end{pmatrix}$

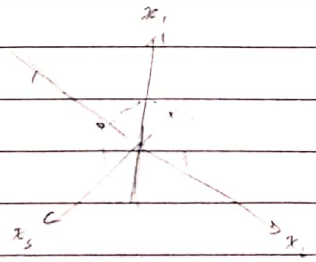
2 $L = 0.5\|w\|^2 + C\sum_i \max(0, 1 - y_i(w \cdot x_i + b))$

$\frac{\partial L}{\partial w} = w + C\sum_i \mathbb{1}[1 - y_i(w \cdot x_i + b) > 0]\, y_i(-x_i)$

3.1 $w_1 = -1$, $w_2 = -1$, $b = 1.5$



3.2 $w_1 = 1$, $w_2 = 1$, $w_3 = 1$, $b = 1$




$1(1) + 1(0) + 1(0) + 1 = +1$

$1(-7) + 1(-3) + 1(2) + 1 = -1$