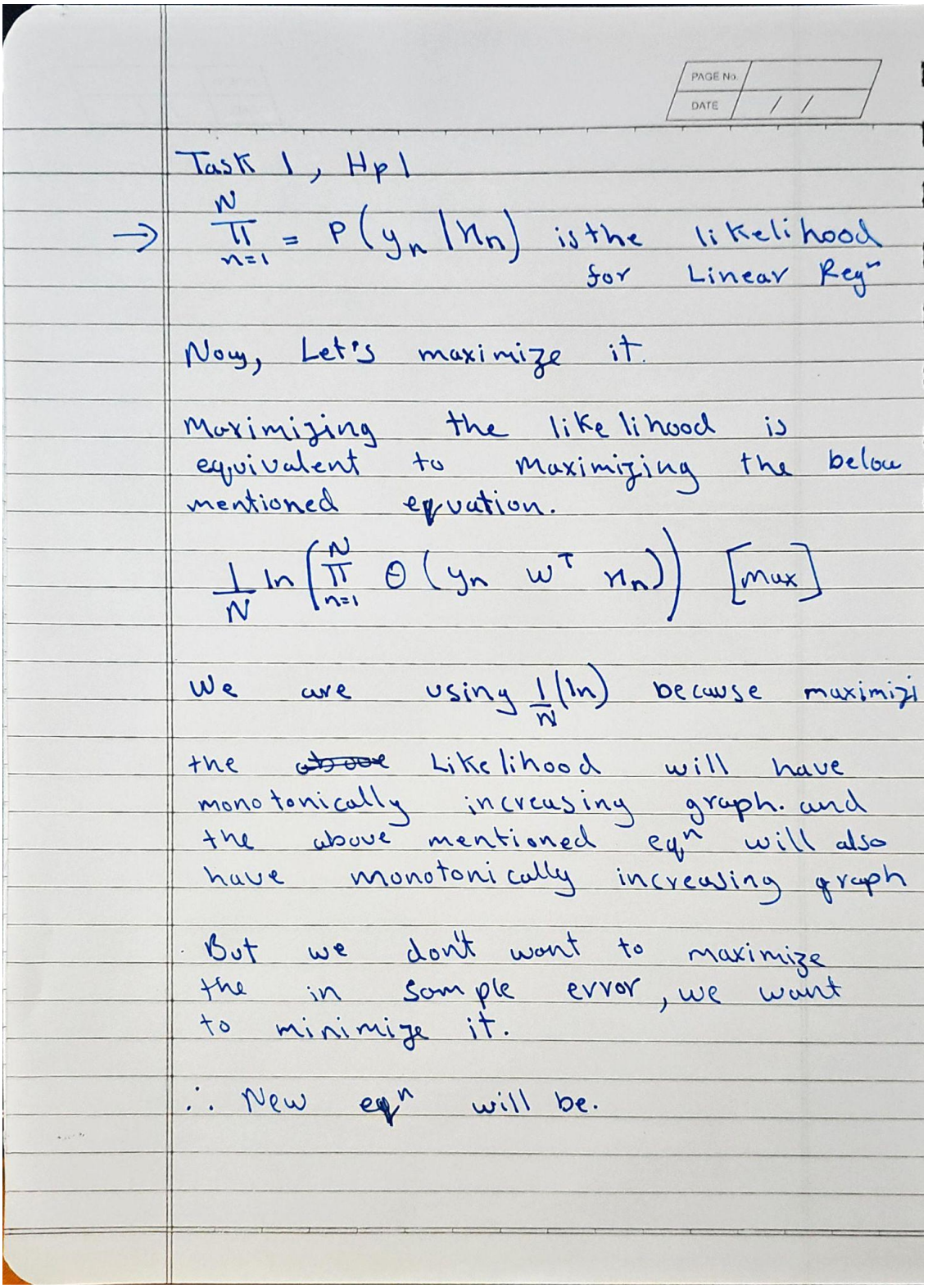
HW 2 – Machine Learning Introduction

All code is present in the GitHub repo
https://github.com/somesh-bagadiya/CMPE257-Fall23-Somesh-Bagadiya.git
Folder Name is HW 2

Task 1 HP 1



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$$-\frac{1}{N} \ln\left(\prod_{n=1}^{N} \theta(y_n w^T x_n)\right)$$

$$\rightarrow \frac{1}{N} \ln\left[\prod_{n=1}^{N} \left(\frac{1}{\theta(y_n w^T x_n)}\right)\right]$$

Since its Log/ln we can write above mentioned equation as

$$\Rightarrow \frac{1}{N} \sum_{n=1}^{N} \ln\left(\frac{1}{\theta(y_n w^T x_n)}\right)$$

Now, $\theta(y_n w^T x_n) = \frac{1}{1 + e^{-y_n w^T x_n}}$
(Signal)

thus,

$$\Rightarrow \frac{1}{N} \sum_{n=1}^{N} \ln\left(1 + e^{-y_n w^T x_n}\right) = E_{in}(w)$$

We know that likelihood is directly proportional to signal while Ein is inversely proportional to signal. Hence, we can state that maximizing likelihood will minimize in sample error.

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→ $\nabla E_{in}(w(t)) = ?$

$$E_{in}(w) = \frac{1}{N}\sum_{n=1}^{N} \ln\left(1 + e^{-y_n w^T x_n}\right)$$

$$\nabla E_{in} = \frac{1}{N}\sum_{n=1}^{N} \frac{1}{\left(1+e^{-y_n w^T x_n}\right)} \cdot \left(1 + e^{-y_n w^T x_n}\right)'$$

$$= \frac{1}{N}\sum_{n=1}^{N} \frac{1}{\left(1+e^{-y_n w^T x_n}\right)} \left[0 + \left(-y_n x_n e^{-y_n w^T x_n}\right)\right]$$

$$= \frac{1}{N}\sum_{n=1}^{N} \frac{1}{1+e^{-y_n w^T x_n}} \cdot \left(-y_n x_n e^{-y_n w^T x_n}\right)$$

$$= -\frac{1}{N}\sum_{n=1}^{N} y_n x_n \left(\frac{e^{-y_n w^T x_n}}{1+e^{-y_n w^T x_n}}\right)$$

$$\theta(s) = \frac{e^s}{1+e^s} = \frac{1}{1+e^{-s}}$$

$$\therefore \nabla E_{in}(w) = -\frac{1}{N}\sum_{n=1}^{N} y_n x_n \theta\left(y_n w^T x_n\right)$$

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Task 4

	+1	-1
+1	0	C_a
-1	C_r	0

a) i) Cost Accept = $(1 - g(x))\, C_a$

Complete classificat^n for Accept is True positive and False positive

$= g(x) \times TP + (1 - g(x)) \times FP$

$= g(x) \times 0 + (1 - g(x)) \times C_a = \underline{(1 - g(x))\, C_a}$

~~b)~~ ii) Similarly

Cost Reject = $g(x) \times C_r + (1 - g(x)) \times 0$

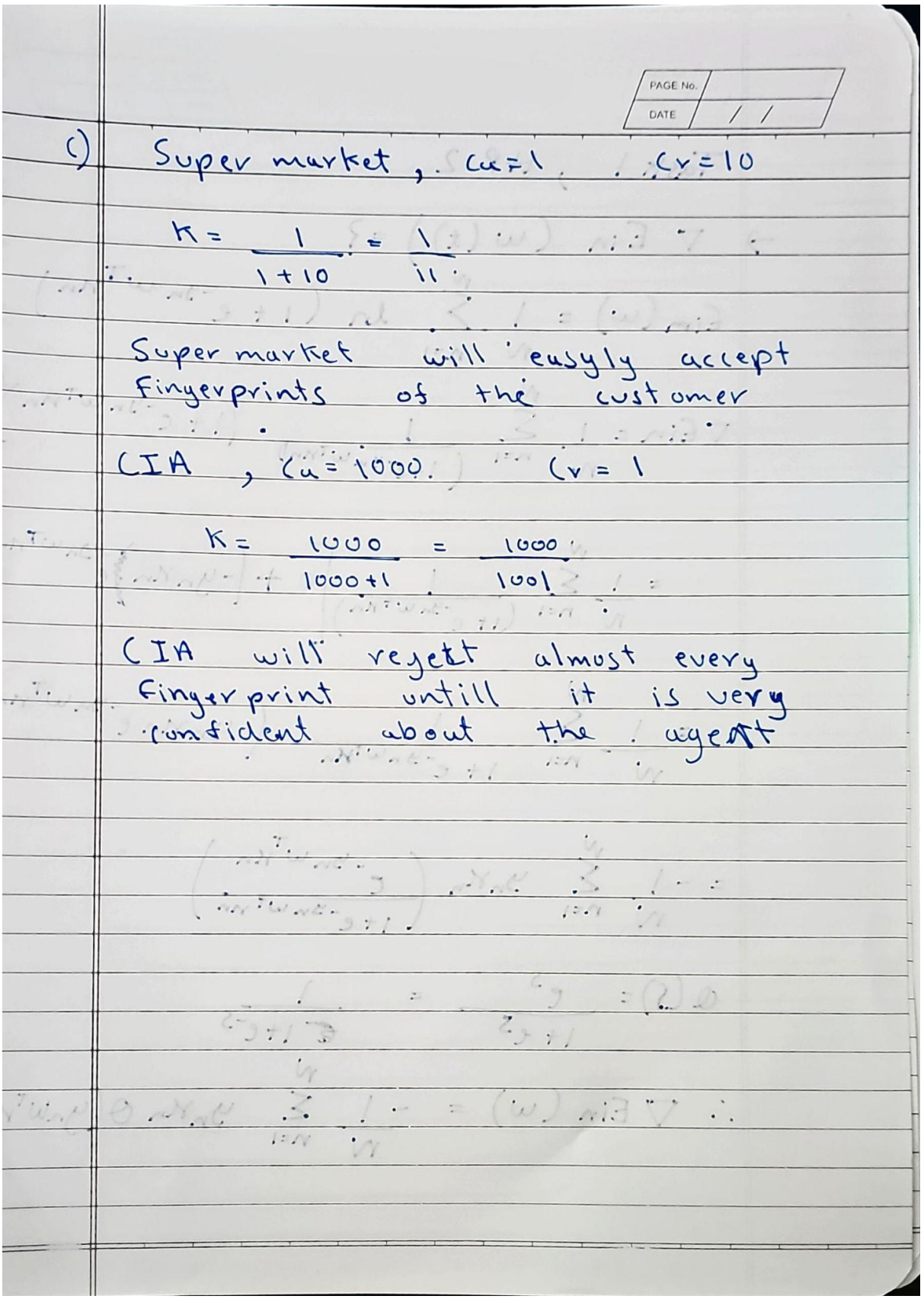
$= \underline{g(x) \cdot C_r}$

b) Threshold is K, and for the system to be fair Cost Accept = Cost Reject

$(1 - g(x)) \cdot C_a = g(x) \cdot C_r$

$\left(\frac{1}{g(x)} - 1\right) = \frac{C_r}{C_a}$

$\frac{1}{g(x)} = \frac{C_r + C_a}{C_a} \Rightarrow g(x) = \frac{C_a}{C_r + C_a} = K$



Task 2 and Task 3 are in the repo.
Please refer *.ipynb* files

Citations:

- Refrences from Abu-Mostafa Yaser Video lectures on youtube.
- Discussions with Arielle Shnayder and Mahima Suresh.
- Code snippets from Mahima Suresh.