

1. Give the rank of the following matrices

a) $\begin{bmatrix} 1 & 1 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 1 \end{bmatrix}$

b) $\begin{bmatrix} 1 & 0 \\ 1 & 1 \\ 0 & 1 \\ 2 & 3 \end{bmatrix}$

c) $\begin{bmatrix} 1 & 1 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$

d) $\begin{bmatrix} 5 & 0 & 0 \\ 3 & 0 & 0 \\ 0 & 2 & 1 \end{bmatrix}$

2. For the vector $x = \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$ in \mathbb{R}^3

$f(x) : \mathbb{R}^3 \rightarrow \mathbb{R}$ is given as

$$f(x) = x_1^2 + x_2^2 + x_3^2 + 2x_1x_2 + 2x_2x_3 + 2x_3x_1 + x_1x_2x_3$$

a. Find the gradient of f at x i.e. $\nabla f(x)$

b. Find the Hessian of f at x i.e. $H(x)$

3. For dataset

$$D = \{(a_1, b_1), (a_2, b_2), \dots, (a_n, b_n)\}$$

where $a_i \in \mathbb{R}^d$, $b_i \in \mathbb{R}^+$ $\forall i$

the regression loss for some

model $x \in \mathbb{R}^d$ is given as

$$f(x) = \sum_{i=1}^n (a_i^T x - b_i)^2$$

For this loss, write down the gradient descent update equation

i.e. find $\nabla f(x)$ and write

down the model x_{t+1} (in the $(t+1)$ th iteration)

in terms of x_t (i.e. model at the t^{th} iteration),

the learning rate ξ and the gradient.

4. Based on the , eq. obtained in

Question ③, try to implement linear

regression in python using gradient

descent. You can generate the synthetic

data using the same idea I used

in the Linear and Logistic Regression

.ipynb file & apply gradient

descent on it. Make different

choices of learning rate, no. of iterations

etc.

5. Update the provided Linear and

Logistic Regression .ipynb file

to apply SVM with RBF & Linear

kernels, Decision tree and Random

forest algorithms on the breastcancer

dataset. Use 80% data for

training, 20% for testing and report

your model's (SVM with both kernels,

Decision tree,

Random Forest) on

the test data.

6. Bayes' Rule in Practice :-

A Professor uses his

IPAD 30% of time, Laptop 30% of

the time and Physical Blackboard 40%

of the time to teach a class.

He makes error in writing 5%

of time when he uses IPAD, 3% when

he uses laptop and 2% when he uses

physical board.

Question :- What is the probability that he was using his laptop if he made an error in writing?