

Assignment 4

Question 1

A Lie detector machine can correctly detect 96% of the time if a person tells a lie and correctly detect 95% of the time if a person tells a truth. In a jury board, the probability of a person telling a lie is 2%. Now, the lie detector machine declares that a person has told a lie.

- a) What is more likely, the person is a liar or not? **Apply** proper theorem and show full calculation.
- b) What is the probability of the person not being a liar? **Apply** proper theorem and show calculation

Question 2

SL	Outlook	Humidity	Temp	Wind	Play Tennis
1	Overcast	Cool	Normal	TRUE	Yes
2	Sunny	Mild	High	FALSE	No
3	Sunny	Cool	Normal	FALSE	Yes
4	Rainy	Mild	Normal	FALSE	Yes
5	Sunny	Mild	High	FALSE	No
6	Overcast	Mild	High	TRUE	Yes
7	Sunny	Hot	High	TRUE	No
8	Sunny	Mild	Normal	TRUE	Yes

- a) Is a player going to play tennis given the outlook is Sunny, humidity is Mild, temperature is Normal, and the weather is windy? **Apply** Naive Bayes and show proper calculations with the learning phase.
- b) Is the player going to play tennis if the outlook is overcast, humidity is hot instead? **Show** full calculation,

Question 3

X	Y
2	14
4	29
8	42

-If you fit the above data samples using $Y=mx+b$, where $m = 3$ and $b = 1$, calculate the amount of error using mean square error loss function.

-Perform one iteration of gradient descent to update both m and b , assume that the learning rate is 0.01

Question 4

Color	Size	Shape	Edible
Yellow	Small	Round	Yes
Yellow	Small	Round	No
Green	Small	Irregular	Yes
Green	Large	Irregular	No
Yellow	Large	Round	Yes
Yellow	Small	Round	Yes
Yellow	Small	Round	Yes
Yellow	Small	Round	Yes
Green	Small	Round	No
Yellow	Large	Round	No
Yellow	Large	Round	Yes
Yellow	Large	Round	No
Yellow	Large	Round	No
Yellow	Large	Round	No
Yellow	Small	Irregular	Yes
Yellow	Large	Irregular	Yes

- Considering 'Edible' as the class, **Compute** entropy for this dataset.
- Between Color, Size, and Shape, which one is the better feature? **Show** full calculation and **explain**.

Question 05

	Exam = Good		Exam = Bad	
	Result = Pass	Result = Fail	Result = Pass	Result = Fail
Prepared	0.352	0.001	0.101	0.100
!Prepared	0.152	0.121	0.052	0.121

Consider that the above joint distribution table is formed from a sample distribution table where there are two features, namely 'Exam' and 'Prepared', alongside one label, 'Result'. Now, calculate the information gain for 'Exam' and 'Prepared' to determine which one is the better feature to be placed in the root node of a decision tree. [10]

Question 6

You are training a logistic regression model with two input features. The prediction is:

$$y = \sigma(z) \text{ where } z = w_1 x_1 + w_2 x_2 + b, \sigma(z) = 1 / (1 + e^{-z}).$$

You are given:

- Input: $x_1 = 1$ and $x_2 = 2$
- True label: $y=0$
- Initial weights: $w_1 = 0.5$ and $w_2 = -0.25$
- Bias: $b=0$
- Learning rate: $\alpha=0.1$

- Compute the value of z and the predicted output y' . [1]
- Using Binary Cross-entropy as the loss, we found, $\frac{\partial \text{Loss}}{\partial w_1} = (y' - y)x$. Using this equation, perform one step of gradient descent to update w_1 . [2]
- What is the effect of using a decaying learning rate in training a logistic regression model? Explain briefly. [2]

Question 7

In this part we train a feedforward neural network using the same two inputs.

Network Structure:

- **2 input features**, Input: $x_1 = 1$ and $x_2 = 2$
- **Hidden Layer 1**: 2 neurons
- **Hidden Layer 2**: 1 neuron
- **Output Layer**: 1 neuron
- Activation: sigmoid at all layers $\sigma(z) = 1 / (1 + e^{-z})$

- Based on the scenario above, draw a schematic diagram of the feedforward neural network. Clearly label each layer and its neurons, the outputs (activations) of the neurons, the flow of data through the network.
- The activation outputs from Hidden Layer 1 are .5 and .5. The weights for Hidden Layer 2 are (.1 and .5). What is the activation output from the second layer?
- Hidden Layer 1 has two activation outputs, while Hidden Layer 2 has only one. Why is there a difference in the number of outputs between these layers? Explain briefly.