Assignment 06

Instructions

1. Each assignment can contain both theoretical and practical questions.
2. Use LaTeX (preferred) or Word for theoretical question responses.
3. Practical questions are in the provided Jupyter notebook. Use Google Colab (Preferred) or Jupyter Notebook to complete questions directly in the Jupyter Notebook. Include code changes and reasoning in the Jupyter Notebook. Convert the Jupyter Notebook into an HTML page for submission.
4. Submit a PDF or Word file with reponses to theoretical questions, a Jupyter Notebook, and an HTML page (both files) with completed practical questions.
5. A 25% penalty applies to submissions on the first day after the due date, and a 50% penalty for submissions 24 to 48 hours late. No submissions will be accepted beyond 48 hours past the due date.

Theoretical Questions

Question 1

Suppose we have a following function

$$E(w) = w^2 - 4w + 4$$

we want to minimize this function using gradient descent. Our goal is to find the value of w that minimizes this function. Due to time constraint we are going to run only 3 iterations for gradient descent. So, your task is to find the value w after 3rd iteration i.e. w_3

Below are the given things

- Intial value of $w : w_0 = 0$
- Learning rate: $\eta = 0.1$

Show detailed calculations for each iteration (Iterantion 1, 2, 3)

Question 2

Assume that you are working on the cancer detection problem. You have 2 classes in your problem C1 = Cancer Positive and C2 = Cancer Negative.

The data point belongs to class C1 if value of discriminant function > 0 or else the data point belongs to C2. Our input data points are represented by 2D data as (x_i, y_i). We want to find the linear discriminant that separates these two classes.

Let's assume the weight vector $w(w_1, w_2)$ is (2, -3) and threshold value w_0 is 5.

For the given points (x,y), calculate following

a) Value of the discriminant function $g(x, y)$ for 2 points $(x_1, y_1) = (1, 2)$ and $(x_2, y_2) = (3, 4)$

b) Classify above both points into class C1 and C2 based on value of $g(x, y)$

Show detailed calculations

Question 3

Answer the following

a) What is gradient descent and why is it used in optimization?

b) What is the role of the learning rate in gradient descent?

Question 4

Answer the following questions

a) How does the linear discriminant model attribute importance to input features?

b) Explain the concept of ranking in machine learning and how it differs from classification and regression tasks.

Question 5

a) Explain the concept of pruning in decision trees. Discuss why pruning is important, and the methods commonly used for pruning decision trees. Additionally, outline any potential drawbacks or challenges associated with pruning decision trees, and provide insights into when pruning might not be advisable.

b) Is it possible to perform regression with decision tress? If yes how is it done. Explain with an example.

c) Explain the concept of rule induction from decision trees. Discuss why rule-based representations are preferred for model interpretability.

Quetion 6

a) Explain the concept of entropy in the context of decision trees.

b) Calculate the entropy of the dataset. The target variable for the dataset is **Play Tennis**.

Day	Outlook	Temperature	Humidity	Wind	Play Tennis
1	Sunny	Hot	High	Weak	No
2	Sunny	Hot	High	Strong	No
3	Overcast	Hot	High	Weak	Yes
4	Rain	Mild	High	Weak	Yes
5	Rain	Cool	Normal	Weak	Yes
6	Rain	Cool	Normal	Strong	No
7	Overcast	Cool	Normal	Strong	Yes
8	Sunny	Mild	High	Weak	No
9	Sunny	Cool	Normal	Weak	Yes
10	Rain	Mild	Normal	Weak	Yes
11	Sunny	Mild	Normal	Strong	Yes
12	Overcast	Mild	High	Strong	Yes
13	Overcast	Hot	Normal	Weak	Yes
14	Rain	Mild	High	Strong	No

Show detailed calculations

Practical Questions

Please refer to and answer Questions 7, 8, and 9 in the provided Jupyter Notebook