Reinforcement Learning?-homework

DAY2:LINEAR REGRESSION:

15/6/2024

1. What is Linear Regression?

- Answer: Linear regression is a supervised ml algortihm used to model the relationship between a dependent variable (target) and one or more independent variables (predictors).
- The goal is to find the best-fitting line through the data points that predicts the target variable.

Linear Regression Example

 Linear Regression

2.What are the Assumptions Made by Linear Regression?

- Answer:
- Linearity: The relationship between the independent variable(s) (X) and the dependent variable (Y) is linear.
- Homoscedasticity: The variance of the residuals (errors) is constant for any value of the independent variable(s).
- Independence: The observations are independent of each other.
- Normality: For any fixed value of the independent variable(s), the dependent variable is normally distributed.

3.Explain the mathematical intuition of linear regression

- *Answer:*
- ◦ Imagine we have a bunch of dots on a graph. Each dot represents something we want to predict (like house prices=y) and something that helps us predict it (like house size=x).
- ◦ Linear regression is like drawing a straight line through these dots. This line helps us make predictions for new data points. The goal is to find the line that best fits all the dots.

- ◦ Mathematically, this line is described by an equation:
- [Y = beta_0 + beta_1X]
- Here,
- (Y) is what we want to predict (like house price).
- (X) is what helps us predict (like house size).
- (\beta_0) is where the line crosses the Y-axis (the intercept).
- (\beta_1) is how steep the line is (the slope).

By finding the best (\beta_0) and (\beta_1), we can draw a line that predicts (Y) as accurately as possible based on (X). So, linear regression is about finding this optimal /best fit line to understand and predict relationship

4. Advantages of linear regression?

- Linear regression performs exceptionally well for linearly separable data
- Easy to implement and train the model

5. Disadvantages of linear regression?

- Sometimes Lot of Feature Engineering Is required
- If the independent features are correlated it may affect performance
- It is often quite prone to noise and overfitting

6.Gradient Descent:

- Gradient Descents an optimization algorithm commonly used in machine learning, including in the context of linear regression, to find the optimal parameters (coefficients) of a model by minimizing a cost function.
- In linear regression, gradient descent adjusts the slope and intercept of the regression line to **minimize the difference between predicted and actual values**. It iteratively improves the model's accuracy by moving towards the parameters that reduce prediction errors.
- Steps Involved in Gradient Descent:
- - Initialization: Start with initial values for the coefficients (often set randomly or to zero).

- Calculate Error: Compute the difference between the predicted values (using current coefficients) and the actual values (from the dataset).
- Cacluate the Gradient: Calculate the gradient (derivative) of the cost function with respect to each coefficient. The gradient indicates the direction of steepest ascent of the cost function.
- Update Coefficients: Adjust the coefficients in the opposite direction of the gradient to minimize the cost function. This involves multiplying the gradient by a learning rate (α), which determines the size of the steps taken towards the minimum.

- - Iterate: Repeat steps 2-4 until the algorithm converges to a minima. Convergence is achieved when the changes to the coefficients are minimal or when a predetermined number of iterations is reached.

Cost Function vs Residual Error: Explanation with Example

Residual Error:

- **Definition:** Residual error, also known simply as residuals, difference between actual data points and predicted data points
- **Example:** Suppose we have a linear regression model that predicts house prices based on their size. For a particular house:

    - Observed house price (actual value): $300 - Predictedhouseprice(fr$ 280
    - Residual error = Actual value - Predicted value = $300 - 280 = \$20$
- Ideally, we want residuals to be as small as possible, indicating accurate predictions.

Cost Function:

- **Definition:** A cost function (or loss function) measures the difference between predicted values by the model and actual values across all data points.
- **Example:** Consider we have multiple houses in our dataset. The cost function aggregates the residuals for all houses to compute the overall model performance.
    - Suppose we have three houses:

        - House 1: Actual price $300,000$, $Predicted price$ 280,000 (Residual $20,000)
        - House 2: Actual price $400,000$, $Predicted price$ 390,000 (Residual $10,000)
        - House 3: Actual price $250,000$, $Predicted price$ 260,000 (Residual -$10,000)
    - Cost function (Mean Squared Error, for example) = Average of squared residuals:
        - MSE = (\frac{1}{3}[(20,000)^2 + (10,000)^2 + (-10,000)^2])
- It provides a single number that represents the model's performance across all predictions.

DAY2 END