Q.6 A) i)

Activation Functions used in Neural Network

Linear Function:

- We start off with the simplest function, the linear function. The value of f(z) increases proportionally with the value of z. The input value is the weighted sum of the weights and biases of the neurons in a layer. The linear function solves the issue of a binary step function where it reports only a value of 0 and 1.

Sigmoid Function (σ):

- The sigmoid function takes a value as input and outputs another value between 0 and 1. It is non-linear and easy to work with when constructing a neural network model. The good part about this function is that it is continuously differentiable over different values of z and has a fixed output range.

Tanh Function:

- The Tanh function is a modified or scaled up version of the sigmoid function. What we saw in sigmoid was that the value of f(z) is bounded between 0 and 1. However, in the case of tanh the values are bounded between -1 and 1.

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Rectified Linear Unit Function (RELU):

- The Rectified Linear Unit or ReLU for short would be considered the most commonly used activation function in deep learning models. The function simply outputs the value of 0 if it receives any negative input, but for any positive value z, it returns that value back like a linear function.

So it can be written as -

$$f(z) = \max(0, z)$$

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Q.6 (B) i)

Logistic Regression with an example

Logistic Regression

- It is a predictive algorithm using independent variables to predict the dependent variable, just like linear regression, but with a difference that the dependent variable should be categorical variable.
- Independent variables can be numeric or categorical variables but the dependent variable will always be categorical. Logistic regression is a statistical model that uses logistic function to model the conditional probability.
- For binary regression, we calculate the conditional probability of the dependent variable Y, given independent variable X. It can be written as P( Y=1 | X) or P( Y = 0 | X) where P(Y | X) is approximated as a sigmoid function applied to a linear combination of input features.
- An example of logistic regression can be to find if a person will default their credit card payment or not. The probability of a person defaulting their credit card payment can be based on the pending credit card balance and income etc.

Hence we can write P( default = yes | balance).

When the P( default = yes) ≥ 0.5, then we say the person will default their payment.

When the P( default = yes) < 0.4, then we say the person will NOT default their payment.

- The probability will always range between 0 and 1.
- In the case of binary classification, the probability of defaulting payment and not defaulting payment will sum up to 1.

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Q 6 B) ii)

Sol$^n$:

| X | Y | (X - X') | (Y - Y') | (X - X') (Y - Y') |
|---|---|---|---|---|
| 340 | 500 | -400 | -500 | 200000 |
| 1080 | 1700 | 340 | 700 | 238000 |
| 640 | 1100 | -100 | 100 | -10000 |
| 880 | 800 | -140 | -200 | -28000 |
| 990 | 1400 | 250 | 400 | 100000 |
| 510 | 500 | -230 | -500 | 115000 |
| | | | | |
| X' = 740 | Y' = 1000 | | | 615000 |

| $(X - X')^2$ |
|---|
| 160000 |
| 115600 |
| 10000 |
| 19600 |
| 62500 |
| 52900 |
| |
| 420600 |

$$b_1 = \frac{\Sigma (X_i - \bar{X})(Y_i - \bar{Y})}{\Sigma (X_i - \bar{X})^2}$$

$$= \underline{\underline{1.462197}}$$

$$b_0 = \frac{1}{n}\left(\Sigma Y_i - b_1 \Sigma X_i\right)$$

$$= \bar{Y} - b_1 \cdot \bar{X}$$

$$= \underline{\underline{-82.02578}}$$

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$$Y(850) = Y_i$$

$$= B_0 + B_1 X_i$$

$$= 1.46(850) - 82$$

$$= \underline{\underline{1159}}$$