

DNN

Experiment 2 Post Lab Questions

- 1] Describe the perceptron learning rule and how it updates the weights of perceptron.
- 1] A perceptron learning rule is a supervised algorithm that is used to adjust the weights of a neuron based on the error between the prediction and the target.

for an input vector $X = [x_1, x_2, x_3 \dots]$
weight vector $W = [w_1, w_2, w_3 \dots]$

The output (excluding bias is).

$$\text{net} = W^T \cdot X.$$

for regression tasks output is usually linear.

$$\hat{y} = \text{net} \rightarrow \text{predicted } y.$$

error is computed :

$$y - \hat{y} = e$$

$y \Rightarrow$ actual values.

Weight update rule.

$$W_{\text{new}} = W_{\text{old}} + \eta e X$$

η : learning rate.

- 2] What are the limitations of a single layer perceptron especially in terms of the types of functions it can model?

2] A perceptron can only model linearly separable functions for example it can only model AND, OR and not XOR, XNOR.

For a non linear problems the perceptron will never converge regardless of training time.

Since there are ~~only~~ no hidden features or weights the model cannot learn complex decision boundaries.

3] Implement the perceptron rule training for a network using $\text{sgn}(\text{net})$ as activation function learning rate = 1 and initial weights and training examples as given below.

$$W = [0 \ 1 \ 0]$$

$$X_1 = [2 \ 2 \ -1] \text{ and } y_1 = -1.$$

$$X_2 = [0 \ -2 \ 1] \text{ and } y_2 = 1.$$

for X_1 .

$$\begin{aligned} \text{net} &= 2(0) + 1(2) + (-1)0 \\ &= 2 \end{aligned}$$

$$\text{sgn}(\text{net}) = \hat{y}_1$$

$$\Rightarrow \hat{y}_1 = 1.$$

~~for X_2~~

$$\text{net} = 0(0) + 1(-2) + 1(1)$$

Error

$$\begin{aligned}e_1 &= y_1 - \hat{y} \\&= -1 - (1) \\&= -2\end{aligned}$$

$$\begin{aligned}\text{Weight update} &= [0 \ 1 \ 0] + -2[2 \ 1 \ -1] \\&= [-4 \ -1 \ 2].\end{aligned}$$

Training sample 2.

$$X_2 = [0 \ -1 \ 1] \quad y_2 = 1.$$

$$\begin{aligned}\text{net} &= -4(0) + (-1)(-1) + 2(-1) \\&= -1\end{aligned}$$

$$\text{output: } \hat{y}_2 = \text{sgn}(-1) = -1.$$

$$\begin{aligned}\text{error: } e_2 &= y_2 - \hat{y} = 1 - (-1) \\&= 2\end{aligned}$$

Weight update

$$\begin{aligned}W_{\text{new}} &= [-4 \ -1 \ 2] + 2[0 \ -1 \ -1] \\&= [-4 \ -3 \ 0].\end{aligned}$$