

# ENGR 421

## HW2 Report

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- **Data Generation:** The data and the labels were imported from the given files in the homework file.
- **The Discrimination Function:**

The discrimination function was based on the Discrimination by Regression method.

The following equations were used in order to produce the discrimination algorithm:

$$y_i = f(x)_i + \epsilon$$

The prediction function:

$$\hat{y}_i = \text{sigmoid}(w_i^T x_i + w_{i0}) = \frac{1}{1 + \exp(-(w_i^T x_i + w_{i0}))}$$

The update functions:

$$\Delta w_i = \eta \sum_i (y_i - \hat{y}_i) \hat{y}_i (1 - \hat{y}_i) x_i$$

$$\Delta w_{i0} = \eta \sum_i (y_i - \hat{y}_i) \hat{y}_i (1 - \hat{y}_i)$$

The updated parameter functions:

$$w_i^{t+1} = w_i^t + \Delta w_i$$

$$w_{i0}^{t+1} = w_{i0}^t + \Delta w_{i0}$$

- **Data Points Estimation:**

First of all, we will try to find the optimal  $w_i$  and  $w_{i0}$ . We do so by the gradient decent method, the  $w_i$  and  $w_{i0}$  are randomly initialized and plugged in the prediction function.

Then the prediction error is calculated and compared to a threshold value epsilon (epsilon = 0.001) if the error is less than the threshold we stop and return the  $w_i$  and  $w_{i0}$

parameters, else we update  $w_i$  and  $w_{i0}$  using the update functions and repeat until the optimal  $w_i$  and  $w_{i0}$  are found.

After finding the optimal parameters  $w_i$  and  $w_{i0}$  for  $i = 1, 2, 3, 4, 5$ . We use the prediction function with the corresponding parameters to predict the label of all the data elements. i.e., in order to predict the data that are supposed to have label 1 we use the  $w_1$  and  $w_{10}$  parameters.