

Question 1: Perceptron algorithm: It is a binary classification machine learning algorithm. It's the simplest type of neural network model. It has single node which takes a row of input values and predicts a class label.

This is calculated by weighted sum of input and a Bias (=1)

- Activation = Weights * Inputs + Bias
- Predict 1: If Activation > 0.0
- Predict 0: If Activation ≤ 0.0

Train

1: $w_d \leftarrow 0$, for all $d = 1 \dots D$ // initialize weights

2: $b \leftarrow 0$ // initialize bias

3: for iter = 1 . . . MaxIter do

4: for all $(x,y) \in D$ do

5: $a \leftarrow \sum_{d=1}^D w_d x_d + b$ // compute activation for this example

6: if $y_a \leq 0$ then

7: $w_d \leftarrow w_d + y x_d$, for all $d = 1 \dots D$ // update weights

8: $b \leftarrow b + y$ // update bias 9: end if 10: end for 11: end for 12: return w_0, w_1, \dots, w_D, b

Test:

1: $a \leftarrow \sum_{d=1}^D w_d \hat{x}_d + b$ // compute activation for the test example 2: return sign(a)

(Hal Daumé III, n.d.)

Data should be normalised or standardized before using this model for better results. Inputs are multiplied with model coefficients. Model coefficients are input weights and then it is train by gradient descent optimization model.

One at a time examples are shown to the model from the training data for prediction and then error is calculated. To reduce the error in the model weights are updated. This process is done for entire training data. Each time model weights are updated with small proportion of error to set the small value

Question 3

- Classification accuracy between Class1 and Class 2 - Average Training accuracy for 20 iterations is 97.06250000000001% and the test accuracy is 100%.
- Classification accuracy between Class2 and Class 3 - Average Training accuracy for 20 iterations is 94.24999999999997% and the test accuracy is 50%.
- Classification accuracy between Class1 and Class 3 - Average Training accuracy for 20 iterations is 97.625% and the test accuracy is 100%.

In this problem the classification between Class 2 and Class 3 is the most difficult to separate.

Question 4

The train test accuracy for one vs rest approach are: -

- Classification accuracy between Class 1 vs Rest - Average Training accuracy for 20 iterations is 97.79166666666667% and the test accuracy is 100%.
- Classification accuracy between Class 2 vs Rest - Average Training accuracy for 20 iterations is 94.79166666666664% and the test accuracy is 66.66666666666666
- Classification accuracy between Class 3 vs Rest - Average Training accuracy for 20 iterations is 96.41666666666664% and the test accuracy is 66.66666666666666
- Average Classification accuracy of One vs Rest approach - Average Training accuracy for 20 iterations is 96.3333333333% and the test accuracy is 77.777777778%.

Question 5

The train test accuracy for one vs rest approach with 0.01 regularization coefficient are: -

- Classification accuracy between Class 1 vs Rest - Average Training accuracy for 20 iterations is 98.125% and the test accuracy is 100%.
- Classification accuracy between Class 2 vs Rest - Average Training accuracy for 20 iterations is 94.83333333333333% and the test accuracy is 66.66666666666666
- Classification accuracy between Class 3 vs Rest - Average Training accuracy for 20 iterations is 96.45833333333332% and the test accuracy is 82.5
- Average Classification accuracy of One vs Rest approach - Average Training accuracy for 20 iterations is 96.4724% and the test accuracy is 83.053333%.

The train test accuracy for one vs rest approach with 0.1 regularization coefficient are: -

- Classification accuracy between Class 1 vs Rest - Average Training accuracy for 20 iterations is 97.95833333333335% and the test accuracy is 95%.
- Classification accuracy between Class 2 vs Rest - Average Training accuracy for 20 iterations is 94.83333333333333% and the test accuracy is 66.66666666666666
- Classification accuracy between Class 3 vs Rest - Average Training accuracy for 20 iterations is 96.70833333333334% and the test accuracy is 77.5
- Average Classification accuracy of One vs Rest approach - Average Training accuracy for 20 iterations is 96.49976% and the test accuracy is 79.72%.

The train test accuracy for one vs rest approach with 1.0 regularization coefficient are: -

- Classification accuracy between Class 1 vs Rest - Average Training accuracy for 20 iterations is 97.79166666666665% and the test accuracy is 100%.
- Classification accuracy between Class 2 vs Rest - Average Training accuracy for 20 iterations is 95.12499999999997% and the test accuracy is 66.66666666666666
- Classification accuracy between Class 3 vs Rest - Average Training accuracy for 20 iterations is 97.24999999999998% and the test accuracy is 72.5
- Average Classification accuracy of One vs Rest approach - Average Training accuracy for 20 iterations is 96.72 % and the test accuracy is 79.72%.

The train test accuracy for one vs rest approach with 10 regularization coefficient are: -

- Classification accuracy between Class 1 vs Rest - Average Training accuracy for 20 iterations is 96.50000000000001% and the test accuracy is 66.66666666666666%.
- Classification accuracy between Class 2 vs Rest - Average Training accuracy for 20 iterations is 96.20833333333332% and the test accuracy is 66.66666666666666
- Classification accuracy between Class 3 vs Rest - Average Training accuracy for 20 iterations is 97.41666666666667% and the test accuracy is 66.66666666666666
- Average Classification accuracy of One vs Rest approach - Average Training accuracy for 20 iterations is 96.70% and the test accuracy is 66.66%.

The train test accuracy for one vs rest approach with 100 regularization coefficient are: -

- Classification accuracy between Class 1 vs Rest - Average Training accuracy for 20 iterations is 94.12499999999996% and the test accuracy is 66.66666666666666%.
- Classification accuracy between Class 2 vs Rest - Average Training accuracy for 20 iterations is 96.75000000000002% and the test accuracy is 66.66666666666666
- Classification accuracy between Class 3 vs Rest - Average Training accuracy for 20 iterations is 97.20833333333335% and the test accuracy is 66.66666666666666
- Average Classification accuracy of One vs Rest approach - Average Training accuracy for 20 iterations is 96.027% and the test accuracy is 66.66%.

REFERENCES:

Hal Daumé III (n.d.). 4 / *THE PERCEPTRON Learning Objectives*. [online] Available at: http://ciml.info/dl/v0_99/ciml-v0_99-ch04.pdf.