CECS 456: Assignment #1

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1 Image Analysis

We first analyze images of the positive class and the negative class to become familiar with the data.

Figure 1.1: Corresponding images for a digit 1(class 1) with digit 5(class -1)

2 Data plotting

Two features were extracted from the data, Symmetry and Intensity of the images. From figure [2.1] we see that one digits tend to be clustered together while five digits tend to be more spread out. We also see that the data is not linearly separable.

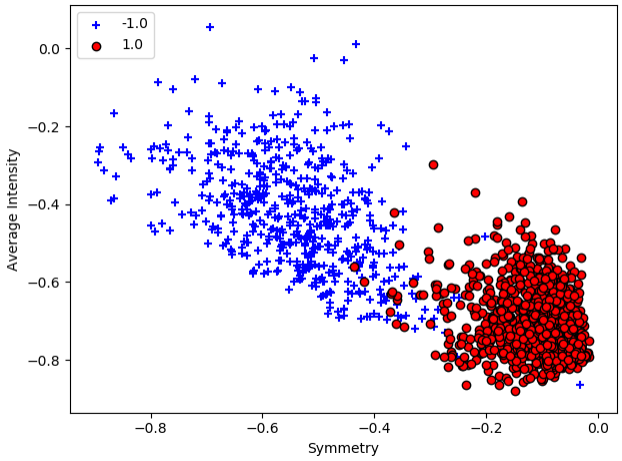

Figure 2.1: Training-set Plot

3 Applying the Perceptron Algorithm to the dataset

Algorithm 1 Perceptron Learning Algorithm (modified)

prodedure(X, y, max_iter, learning_rate) :
$w := 0^{1\times d}$
For max_iter :
  For every $(x^{(i)}, y^{(i)}) \in (X, y)$:
    $\hat{y} = sign(w^T x^{(i)})$
    if $\hat{y} \neq y^{(i)}$:
      $w := w + learning\_rate \times x^{(i)} \times y^{(i)}$
end

Even though the data is not linearly separable we use the Perceptron Learning Algorithm listed above to determine whether the Perceptron algorithm could find a good decision boundary to separate the classes. Note that because the data is not linearly separable we do a modified learning algorithm that allows the perceptron to run for a maximum number of epochs before stopping.

```
>>> test_accuracy()
Case 1 train accuracy:0.981422  test accuracy: 0.959906
Case 2 train accuracy:0.976938  test accuracy: 0.948113
Case 3 train accuracy:0.976938  test accuracy: 0.948113
Case 4 train accuracy:0.976297  test accuracy: 0.948113
Case 5 train accuracy:0.976297  test accuracy: 0.948113
Case 6 train accuracy:0.976297  test accuracy: 0.948113
Case 7 train accuracy:0.976297  test accuracy: 0.948113
Case 8 train accuracy:0.976297  test accuracy: 0.948113
Case 9 train accuracy:0.976297  test accuracy: 0.948113
Case 10 train accuracy:0.976297  test accuracy: 0.948113
accuracy test done!
```

Figure 3.1: Train and Test Accuracy of Perceptron

Testing the accuracy of the Perceptron we find that the Perceptron had an over 95% accuracy in regards to the training set and an over 90% test accuracy. Thus the Perceptron can still do well in datasets that are not linearly separable

4 Plotting the Decision Boundary

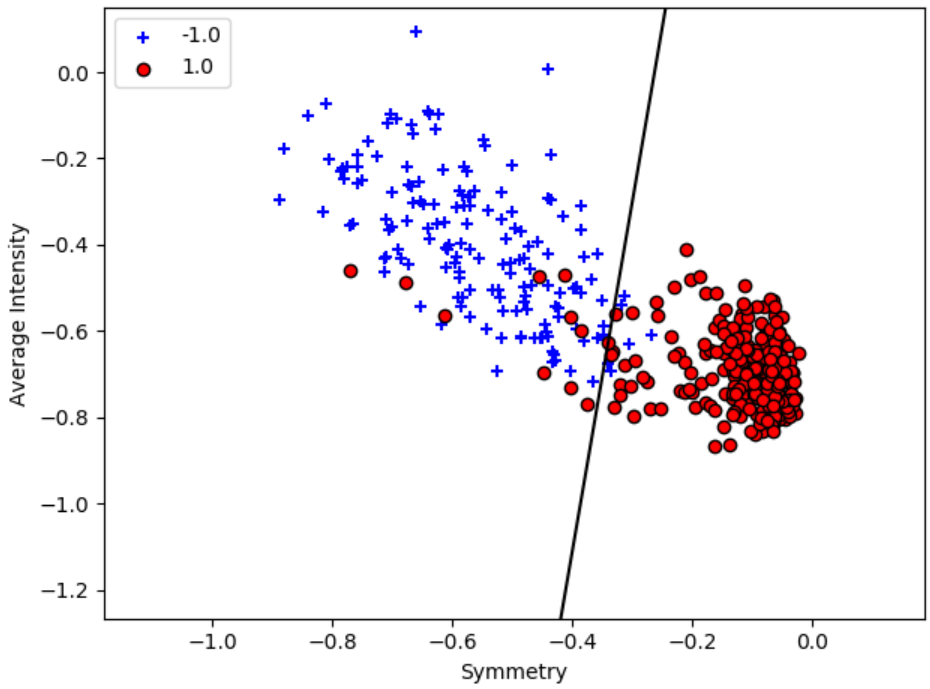

Figure 4.1: Test-set with Decision Boundary

Plotting the separator from the weight vector w obtained from the training set we plotted the decision boundary for the test set. We note that even though the perceptron cannot make a perfect decision boundary to separate the classes it still does a good job of finding a line for separation.