NAIVE BAYES AND PERCEPTRON CLASSIFIERS

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File Descriptions

- samples.py - This is a slightly modified version of the code found on the Berkeley AI page. Handles I/O.
- helper.py - Helper functions that prepare data, extract features, and evaluate classifier performance.
- naive_bayes.py - Implements the Naive Bayes Classifier algorithm. This file can be run directly to get an output performance summary in the terminal.
- perceptron.py - Implements the Perceptron Classifier algorithm. This can also be run directly through the terminal/IDE.
- analysis.py - This file generates graphs to compare the mean accuracy, standard deviation, and time vs. size of the data set between the two classifiers. This can be run directly to generate the graphs.

Naive Bayes

- In my implementation of Naive Bayes, the features are directly derived from pixel values. Each pixel is treated as a binary feature which determines whether the pixel is on or off.

  Training the model involved using the training data and calculating the prior probabilities of each label and then the conditional probability for each feature and label using Laplace smoothing with k = 1 to prevent multiplication with 0. These probabilities are stored in the model for later classification.

  For classification, I used logarithmic probabilities to prevent underflow errors, and the predicted label with the highest updated probability score would be selected.

  output on randomized data sets from 10% to 100%:

Figure 1: Face

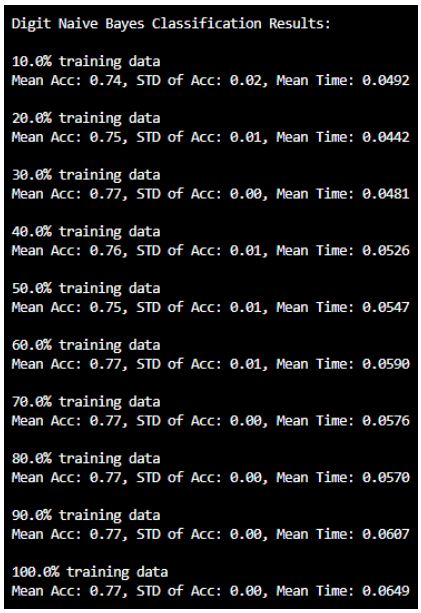

Figure 2: Digits

Perceptron

- For Perceptron, the same binary feature is used. A weight matrix is initialized to 0. Then, the algorithm iteratively reviews each sample in the training data to calculate scores based on weights and features. The weights are updated if the predicted class does not match the real class.

  For classification, the weight matrix is used to predict a label of a sample data by calculating the score using weights and features, and the label with the highest predicted score is chosen.

output on randomized data sets from 10% to 100%:

```
Face Perceptron Classification Results:

10.0% training data
Mean Acc: 0.77, STD of Acc: 0.04, Mean Time: 0.0056

20.0% training data
Mean Acc: 0.85, STD of Acc: 0.01, Mean Time: 0.0093

30.0% training data
Mean Acc: 0.85, STD of Acc: 0.01, Mean Time: 0.0094

40.0% training data
Mean Acc: 0.87, STD of Acc: 0.00, Mean Time: 0.0156

50.0% training data
Mean Acc: 0.87, STD of Acc: 0.00, Mean Time: 0.0156

60.0% training data
Mean Acc: 0.87, STD of Acc: 0.00, Mean Time: 0.0252

70.0% training data
Mean Acc: 0.87, STD of Acc: 0.00, Mean Time: 0.0292

80.0% training data
Mean Acc: 0.87, STD of Acc: 0.00, Mean Time: 0.0320

90.0% training data
Mean Acc: 0.87, STD of Acc: 0.00, Mean Time: 0.0344

100.0% training data
Mean Acc: 0.87, STD of Acc: 0.00, Mean Time: 0.0401
```

Figure 3: Face

```
Digit Perceptron Classification Results:

10.0% training data
Mean Acc: 0.77, STD of Acc: 0.02, Mean Time: 0.0254

20.0% training data
Mean Acc: 0.80, STD of Acc: 0.02, Mean Time: 0.0537

30.0% training data
Mean Acc: 0.81, STD of Acc: 0.01, Mean Time: 0.0762

40.0% training data
Mean Acc: 0.82, STD of Acc: 0.01, Mean Time: 0.0959

50.0% training data
Mean Acc: 0.82, STD of Acc: 0.01, Mean Time: 0.1243

60.0% training data
Mean Acc: 0.81, STD of Acc: 0.00, Mean Time: 0.1475

70.0% training data
Mean Acc: 0.82, STD of Acc: 0.01, Mean Time: 0.1654

80.0% training data
Mean Acc: 0.82, STD of Acc: 0.00, Mean Time: 0.1856

90.0% training data
Mean Acc: 0.82, STD of Acc: 0.00, Mean Time: 0.2119

100.0% training data
Mean Acc: 0.82, STD of Acc: 0.00, Mean Time: 0.2392
```

Figure 4: Digits

Analysis

- For Face, Naive Bayes had a higher Mean Accuracy compared to Perceptron after 70% of the data set was used for training, while perceptron flattened after about 50% data points were used.

  For Digits, Perceptron performed better overall.

- For Face, Naive Bayes had a significantly higher run time than Perceptron, but for digits, it had a significantly lower runtime vs Perceptron.

Perceptron V.s. Naive Bayes Plots:

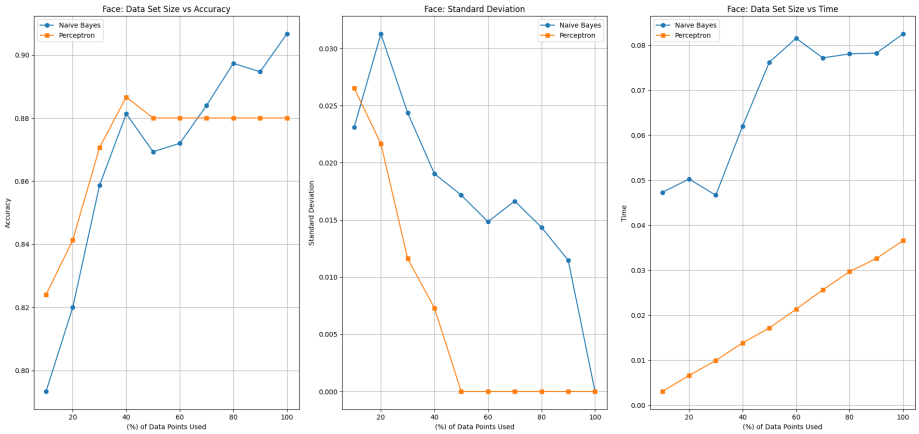

Figure 5: Face

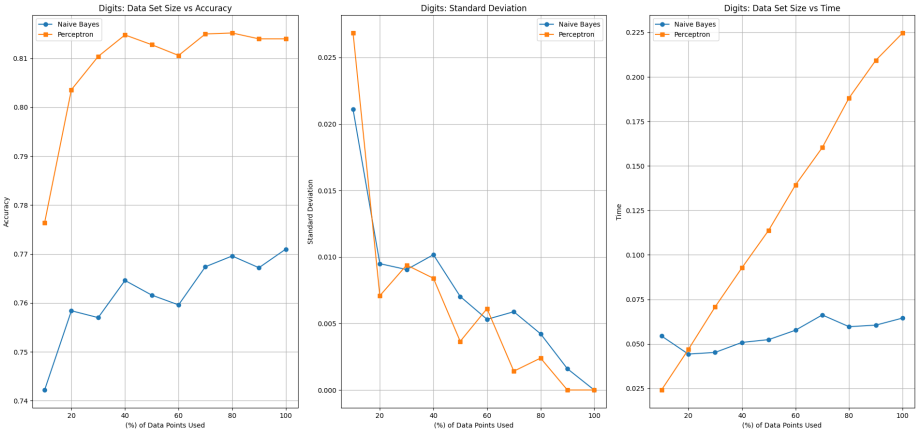

Figure 6: Digit