Assignment 3

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1 Abstract

The purpose of this assignment is to use the data of the image created from assignment 1 to build classification models in a distributed system in databricks in order to classify the choosen images and compare the results and run time to that of the model built in our local machine. This assignment utilized images from UCI respository as sample datasets that will be used to train a machine learning model. Images that were processed represented three fruits spanish pear, fuji apple, watermelon. These images were labeled as Image0, Image1, and Image2 respectively and their dataset was processed and dervied in assignment1 for both the non-overlapping and overlapping layer. These labels was then encoded to take in the values of 0, 1, and 2. The primary machine learning that was used in order to classify these images was random forest. Prior to training the machine learning model, additional methods were taken into account in feature selection and data scaling in order to reduce the size of the data and train the model with a sufficient outcome. The random forest model in databricks was then used to compare to the random forest model that was dervied in our local machine in assignment2.

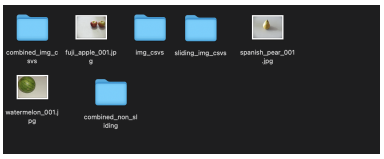
2 Task 1

In assignment1, the three images were divided into 8X8 pixel blocks, the grayscale images were then divided into sliding block of 8X8 pixels. Each feature was then assigned a label respectively to identify them. Two helper functions were used for this task, sliding blocks feature function which converts an image into sliding image blocks given an image object, and label feature function which create feature labels for

each image given a list that contains the array of sliding images. The dimension of the gray images were resized to height of 256 and width of 344. The purpose for these choosen dimensions was to keep its aspect ratio. Additionally, the resized height and width must also be divible by eight since this project divided the targeted image into sliding blocks and non-sliding blocks of 8 by 8 height and width. T he feature vector that was constructed from these images created 3400 feature vectors for the sliding block and 1600 feature vectors for the non-sliding block and each feature vector lies a 8 by 8 pixels who's value lies between 0-255 of the gray image scale. The features of each feature vector was then flatten to 64 features for each respective feature vector. These datasets was exported into cvs files in the data folder. The evidence of this dataset can be shown in 2.1 Figure 1.

2.1 Assignment 1 Figure

Figure 1: CVS Data Folder



In assignment2, the random forest classifier was used to classify the images of different set in non-overlapping image01, overlapping image01, non-overlapping image012, and overlapping image012. Feature selection was also used in this model to increase the speed of the training time and reduce the computational power. The select from model feature selection from Sklearn compare the average importance of all features at a threshold value and dropped features that were below the threshold. Additionally the elastic net model will also be presented. However, the random forest models will only be used to compare with the databricks model.

In the two class classification for non-overlapping image0 and image1, the training accuracy score was 0.95 and the testing accuracy score was 0.92 based on 2.2 Figure 2. There was not a significant difference between the train and test score, this suggests that the train-test split provided a well balanced data between the two classes. The confusion matrix in 2.2 Figure 3 confirmed a true prediction value of 240 and false prediction value of 32 for class 0 and a true prediction value of 269 and false prediction value of 10 for class 1. This indicate that the accuracy rate and the precision rate for class 0 and class 1 was relatively as seen in 2.2 Figure 4 of the derived accuracy score and precision for both class 0 and class 1 respectively. Class 0 had a precision rate of 0.92, while class 1 had a pre-

cision rate of 0.89. This model provided a good accruacy for each of the predicted classes.

2.2 Assignment 2 Figure

Figure 2: Non-Overlapping Image01 RF Score

```
Final Training Accuracy: 0.9545661063153112
Testing Accuracy :  0.9237749546279492
```

Figure 3: Non-Overlapping RF Confusion-Matrix

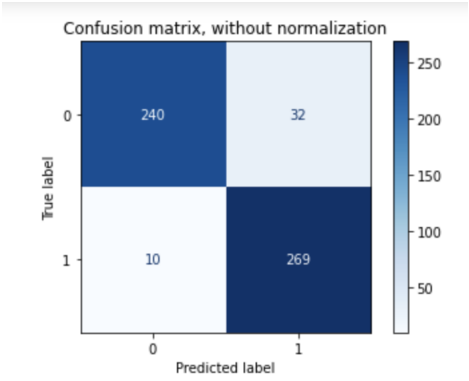


Figure 4: Non-Overlapping RF Derived Score

```
Accuracy : 0.7808716707021792
Precision class 0 : 0.8907563025210085
Precision class 1 : 0.7391304347826086
Precision class 2 : 0.7335640138408305
```

For the overlapping two-class classificaion of image0 and image1, the training accruacy score was 0.96 and the testing accuracy score was 0.92 based on 2.3 Figure 5. This small difference in accuracy score indicates that the train-test split provided an evenly balanced data for the test and train set for the random forest model. The confusion matrix on 2.3 Figure 6 provided the result of the test set as class 0 had 590 true prediction and 74 false prediction, while class 1 had 666 true prediction and 30 false prediction. This indicated a high precision value for both class 0 and class 1 because the model was able to make a prediction of the two images at a high accuracy rate. Based on the value of this confusion matrix, the hand calculation for accuracy score, precision for class 1 and precision for class 0 was derived. In 2.3 Figure 7, the accuracy score from the dervied calculation was 0.92 with a precision of 0.95 and 0.9 for class 0 and class 1 respectively. Based on these high precision values, it indicated that this model can be produced the same results when test with another dataset of the same characteristics. This model also performed significantly better than the elstaicnet for two-class classification of overlapping image0 and image1.

2.3 Assignment 2 Figure

Figure 5: Over-lapping Image01 RF Score

```
Final Training Accuracy: 0.9595588235294118
Testing Accuracy :  0.9235294117647059
```

Figure 6: Over-lapping RF Confusion-Matrix

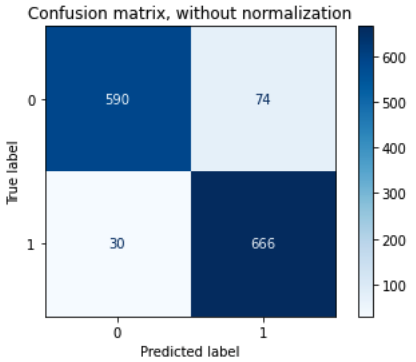


Figure 7: Over-lapping RF Derived Score

```
Accuracy : 0.9235294117647059
Precision class 0 : 0.9516129032258065
Precision class 1 : 0.9
```

In the non-overlapping elastic model, the data for non-overlapping image01 was used. The result of the model for non-overlapping image01 yielded a training accuracy of 0.69 and testing accuracy of 0.67 as shown in 2.4 Figure 8. A similar score in both the train and test set indicate that the data was balanced between the train and test set. The confusion matrix in 2.4 Figure 9 indicate that there were 197 predictions of True Positive for class 0 and 175 predictions of True Positive for class 1. These results was then used to manually derived the accuracy and precision. According to the manual derivated result in 2.4 Figure 10, the overall accuracy of the model was 0.72 with a precision of 0.72 for class 0 and 0.72 for class 1. This accuracy score indicate that there was a sufficient number of true postives for class 0 and class 1. However, the number of false postives was still indicative in affecting the accuracy score.

2.4 Assignment 2 Figure

Figure 8: Non-Overlapping Image01 Elastic-Net

```
Final Training Accuracy: 0.6942298955020445
Testing Accuracy :  0.6751361161524501
```

Figure 9: Non-Overlapping Image01 Elastic-Net Confusion-Matrix

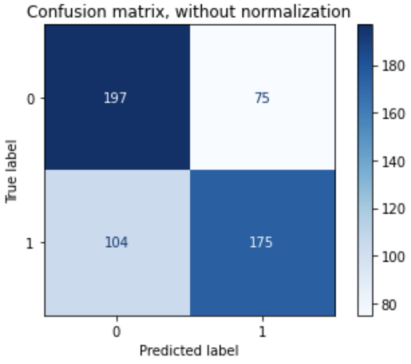


Figure 10: Non-Overlapping Image01 Elastic-Net Derived Score

```
Accuracy : 0.720508166969147
Precision class 0 : 0.7269230769230769
Precision class 1 : 0.7147766323024055
```

In the second elastic model, the data for overlapping image01 was used. The result of the model for overlapping image01 resulted in a

training accuracy of 0.60 and a testing accuracy of 0.59. This inidcated that the data had a great degree of randomeses and it was balanced in the train-test set. The confusion matrix in 2.5 Figure 11 resulted in 493 prediction of true prediction and 314 of true prediction for class 0 and 1 respectively. However, in the derived precision score for class 0 was relatively lower than that of class 1 as shown in 2.5 Figure 12. This could indicate that there was an imbalance in the dataset between class 0 and class 1. Additionally, because of the nature of the image choosen, the black and white image of apple and pear had similar texture and texture. The overlapping nature of the dataset could distort the elastic-net loss function, when it attempted to classify the two images. This also impacted the overall dervied accuracy score of the model with a value of 0.65 as shown in 2.5 Figure 13. An accuracy score of 0.65 indicate that this model was not sufficient enough for making a prediction.

2.5 Assignment 2 Figure

Figure 11: Overlapping Image01 Elastic-Net

```
Final Training Accuracy: 0.6071691176470588
Testing Accuracy :  0.5933823529411765
```

Figure 12: Overlapping Image01 Elastic-Net Confusion-Matrix

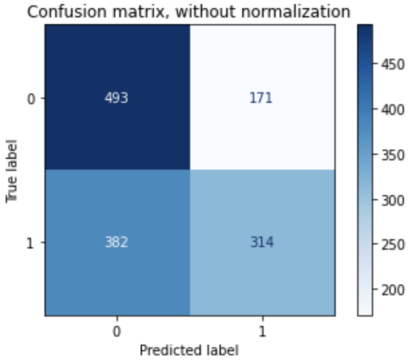


Figure 13: Overlapping Image01 Elastic-Net Derived Score

```
Accuracy : 0.6584615384615384
Precision class 0 : 0.5982800982800983
Precision class 1 : 0.7592592592592593
```

In contrast to the two-class non-overlapping classification random forest, the three-class classification of image0, image1 and image2 testing and training accuracy score deviate in larger degree. In 2.6 Figure 14, the training accuracy for this model is 0.89, whereas the testing accuracy for this model is 0.78. This may indicate an overfit in the model and that the train-test split set did not generate a well balanced enough data. The confusion matrix in 2.6 Figure 15 showed that a true prediction value of 212 for class 0, 221 for class 1, and 212 for class 2. These values was then used to dervied the caculated precision for each of the class. 2.6 Figure 16 indicated that class 0

had a 0.89 precision, class 1 had a precision of 0.74 and class 2 ha da precision of 0.73. The difference in this precision score can suggest that the model was overfitted to favor class 0.

2.6 Assisgnment 2 Figures

Figure 14: Non-Overlapping Image012 RF Score

```
Final Training Accuracy: 0.8994548758328286
Testing Accuracy :  0.7808716707021792
```

Figure 15: Non-Overlapping Image012 RF Confusion-Matrix

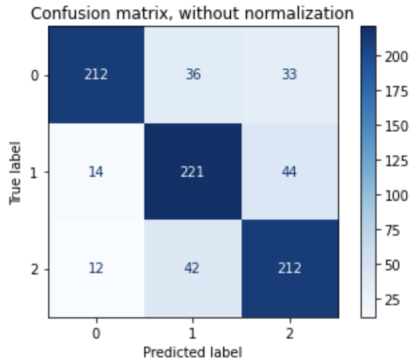


Figure 16: Non-Overlapping Image012 RF Derived Score

```
Accuracy : 0.7808716707021792
Precision class 0 : 0.8907563025210085
Precision class 1 : 0.7391304347826086
Precision class 2 : 0.7335640138408305
```

Similar to the three-class non-overlapping random forest model, the three-class classification of overlapping image0, image1 and image2 testing and training accuracy score also deviated to a noticeable extent. In 2.7 Figure 17, the training accuracy for this model is 0.91, whereas the testing accuracy for this model is 0.83. This may indicate a slight overfit in the model and that the train-test split set did not generate a well balanced enough data. The confusion matrix in 2.7 Figure 18 showed that a true prediction value of 552 for class 0, 608 for class 1, and 545 for class 2. These values was then used to dervied the caculated precision for each of the class. 2.7 Figure 19 indicated that class 0 had a 0.94 precision, class 1 had a precision of 0.77 and class 2 ha da precision of 0.81. The difference in this precision score can suggest that the model was overfitted to favor class 0, which is similar to that of the three-class random forest non-overlapping model. Although the dataset was randomly shuffled, the training set may have contained slightly more data for class 0 than that of class 2 and class 1.

2.7 Assisgnment 2 Figures

Figure 17: Overlaping Image012 RF Score

```
Final Training Accuracy: 0.9126225490196078
Testing Accuracy :  0.8357843137254902
```

Figure 18: Overlapping Image012 RF Confusion-Matrix

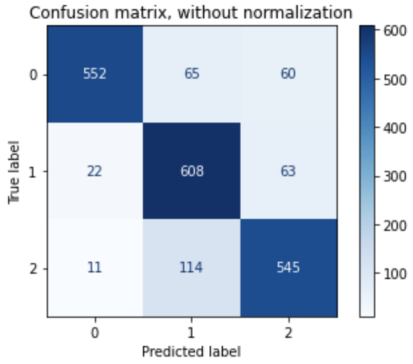


Figure 19: Overlapping Image012 RF Derived Score

```
Accuracy : 0.8357843137254902
Precision class 0 : 0.9435897435897436
Precision class 1 : 0.772554002541296
Precision class 2 : 0.8158682634730539
```