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Discrimination of Civet Coffee Using Image Processing and Machine Learning

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ABSTRACT

This paper is about separating the two classes of civet coffee with the non-civet coffee. Image processing was used to extract the color and texture features of the civet and non-civet coffee, namely the red, green, blue, hue , saturation, brightness, entropy, energy, contrast, homogeneity. The 23 classifiers of MATLAB Classification Learner APP were used to classify the ten features. Among the 23 classifiers, the best in terms of accuracy is the quadratic support vector machine which achieved 79.7 % accuracy.

Key words : Civet Coffee, Non-Civet Coffee, Classification Learner App, Quadratic SVM, Scatter Plot, Confusion Matrix, ROC curve, parallel coordinates plot

1. INTRODUCTION

The civet coffee is one the highest priced coffee due to it's rarity. It is from the undigested coffee beans defecated by the civet cat (Paradoxurus hermaphrodites). Because the exotic coffee commands high price, people are now farming it. Instead of collecting the dung of the civet in the forest, farmers are now collecting it in their backyard. The farmers are force- feeding the caged civet cat, by not offering it other types of food except red coffee beans. Prolong eating of coffee beans for weeks can cause bleeding in the intestines of the civet cat. This is evident in the blood in the gathered civet's feces. In one coffee season if the civet is not given other foods , the civet cat could die. Many animal welfare groups are condemning thepractice of farming the civet for the civet coffee. Until now there is no standards whether the civet coffee sold in the market is authentic or from the caged civet.

Many researches have been done about civet coffee. In [1], results shows that civet coffee differs in aroma from non-civet coffee using an electronic nose. This difference in aroma was confirmed in another study where cupping quality was performed[2].It was found out that civet coffee differs from non-civet coffee in terms of sensitivity values to fluorescence spectroscopy[3] , ultraviolet visible spectroscopy[4] and near-infrared spectroscopy[5].

A number of studies used image processing for extracting features of an object such morphology, color and textures [6-21]. Different machine learning classifiers can classify objects using extracted features[22–25]. In this study, the color and texture features of the two groups were extracted by image processing techniques and were subjected to 23 classifiers to discriminate civet coffee from non-civet coffee.

2. METHODOLOGY

The study used a total of 600 coffee beans, 300 are civet coffee and 300 are non- civet or just plain robusta coffee beans. The civet coffee is from the feces of a caged civet bought from a farmer who is keeping a civet cat as a pet and was fed with red robusta beans. The feces were gathered, washed, dried and keep in a storage. From the same batch of robusta beans fed to the civet cat, red beans that were not fed to the civet cat were stripped of its skin, washed , dried and kept also in a storage. The civet coffee beans and normal robusta beans are in the storage for a year before they were used in the study. Both of the bean groups still have a husk when they were stored. The husks were remove and the beans were photographed with a webcam at a height of 12.5 cm. Using a Python program the color features composed of red. green, blue (RGB) and hue, saturation, and brightness values (HSV) and texture features composed of entropy, energy, contrast and homogeneity were extracted.

Table 1 shows the feature values of civet and normal robusta coffee beans. It can be seen the feature values of non-civet coffee are overlapping the range of the civet coffee values. The data was classified using the MATLAB's Classification Learner App using 6 folds of validation, which means that there are 250 training samples and 50 test samples used (300 divided by 6) for the two classes: civet coffee and normal robusta coffee beans.

Table 1 : Feature Values of Civet and Normal Robusta Coffee Beans

	Red	Green	Blue	Hue	Saturation	Brightness Values	Entropy	Energy	Contrast	Homoge-neity
Civet Coffee	91-150	81-149	71-128	123-151	50-72	93-157	6.36-6.62	28.77-104.29	10.94-38.36	2568-6028
Non-Civet coffee	118-128	116-125	97-106	123-152	45-64	94-166	6.28-7.35	26.54 -57.94	11.93-28.54	2835-5658

3. RESULTS AND DISCUSSION

Table 2 shows the result of classification using the CLA.

Table 2: Classification Results

Classifier	**Classifier Type**	**Accuracy (%)**
Decision Trees	Fine Tree	69.2
	Medium Tree	69.7
	Coarse Tree	66.7
Discriminant Analysis	Linear Discriminant	75.5
	Quadratic Discriminant	75.2
Logistic Regression	Logistic Regression	73.3

Support Vector Machines (SVM)	Linear SVM	75.2
	Quadratic SVM	**79.7**
	Cubic SVM	76.2
	Fine Gaussian SVM	71.7
	Medium Gaussian SVM	75
	Coarse Gaussian SVM	70.7
K Nearest Neighbor (KNN)	Fine KNN	70
	Medium KNN	71.8
	Coarse KNN	63
	Cosine KNN	72.7
	Cubic KNN	71.3
	Weighted KNN	73.8
Ensemble Classifiers	Boosted Trees	73.7
	Bagged Trees	74.3
	Subspace Discriminant	75
	Subspace KNN	68.5
	RUS Boosted Trees	70.3

Table 1 shows that quadratic SVM achieved the highest accuracy of 79.7 %. The CLA setting known as the Principal Component Analysis (PCA) was not used in the classification.

Figure 1 shows the scatter plot of Quadratic SVM.

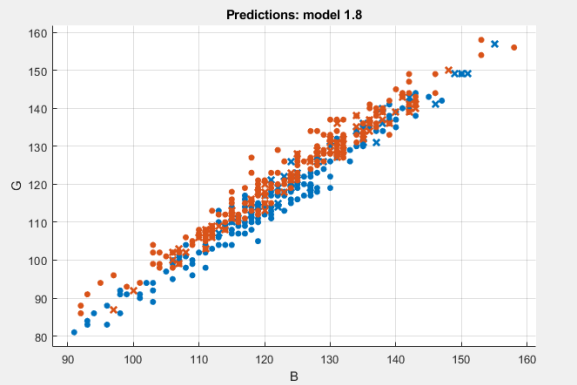

Figure 1: Scatter Plot of the Quadratic SVM Classifier

Figure 1 shows that the 10 features are overlapping for civet coffee and normal robusta coffee beans.

Figure 2 shows the Confusion Matrix of the Quadratic SVM classifier.

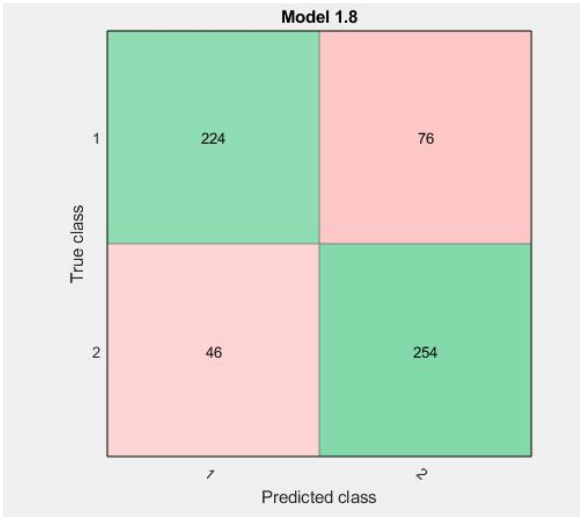

Figure 2: Confusion Matrix of the Quadratic SVM Classifier

It can be seen in Figure 2 , the confusion matrix that the Quadratic SVM Classifier was able to show more number of correct identification of civet coffee and normal robusta coffee than wrong identification.

Figure 3 shows the Receiver Operating Characteristic (ROC) curve of the Quadratic SVM.

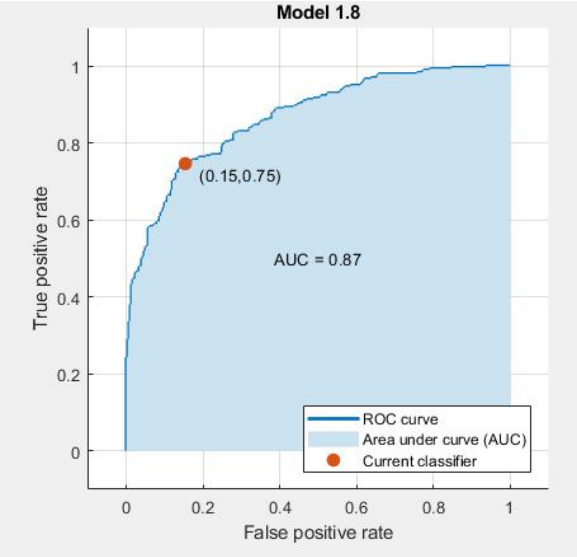

Figure 3: The ROC Curve of Quadratic SVM Classifier

In Figure 3 the area under the curve (AUC) is equal to 0.87. The AUC of the Quadratic SVM is equal to 0.87 which means that it has a better performance compared to other classifiers.

Figure 4 show the parallel coordinates plot of the quadratic SVM .

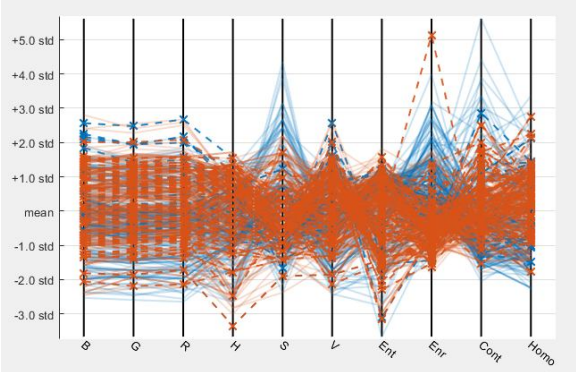

Figure 4: The Parallel Coordinates Plot of Quadratic SVM Classifier

The parallel coordinates plot shows the useful variables or features of the civet coffee and the normal robusta coffee that contributed to their discrimination . It can be seen in the plot that the features of the civet coffee does not vary that much as compared with the normal robusta coffee.

4. CONCLUSION

This paper used the different data mining algorithms in separating the civet coffee with the normal robusta coffee . The ten features of civet and normal robusta coffee namely red, green, blue, hue, saturation, brightness , entropy, energy, contracst and homogeneity were extracted using image processing and were subjected to 23 classifiers of the MATLAB's Classification Learner App. The highest classification accuracy is 79.7 % obtained by the quadratic SVM. It can be concluded that civet coffee and normal robusta coffee or the non-civet coffee does not vary or have very little difference in terms of color and texture.

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