CAP 4630 – Intro to AI – Fall 2016

Final Project: Cats vs Dogs Classification

**Introduction**

Matlab was used in this project to create a classification model capable of identifying cats and dogs appropriately when given an image as input. Starter code provided by Dr Marques was used to get familiar with the data set and the machine learning work flow. Once familiar with the data, multiple machine learning parameters were adjusted and cross-validation and testing results were compared to determine the most accurate model for the given Cat vs Dog classification problem.

A pre-trained convolutional neural net, AlexNet, is used to extract features from the data set. Beginning with 100 observations from the Kaggle data set, and increasing to 1000 observations, Discriminant Analysis and the Support Vector Machine are used to generate models using the features that were extracted from the AlexNet CNN. Additionally, image pre-processing filters are applied to detect changes in overall accuracy.

**Image Pre-Processing**

AlexNet CNN is used to extract features from 100 images, 50 cat and 50 dog, and then applied to a SVM to create a classification model. A Gaussian Filter is applied to each image before features are extracted, smoothing the image and creating a blur effect. The Gaussian Filter is expected to soften some of the images edges, minimizing noise and insignificant features. Matlab’s Gaussian Filter function accepts a standard deviation parameter ‘sigma’, and as sigma increases the output image appears blurrier.

[*B*](https://www.mathworks.com/help/images/ref/imgaussfilt.html#outputarg_B)*= imgaussfilt([A](https://www.mathworks.com/help/images/ref/imgaussfilt.html" \l "inputarg_A),*[*sigma*](https://www.mathworks.com/help/images/ref/imgaussfilt.html#inputarg_sigma)*) filters image A with a 2-D Gaussian smoothing kernel with standard deviation specified by sigma.*

The Gaussian Filter was applied to the Kaggle data set before feature extraction as a pre-processing technique. Values of sigma were adjusted from 0 to 3 to determine which value for standard deviation led to the best model.

As depicted in the below graph, when no Gaussian Filter is applied, the AlexNet feature extraction and SVM model predict on the test set with 90% accuracy. A Gaussian Filter with standard deviation equal to 0.5 led to a SVM model with 97% accuracy. These results have determined that a standard deviation of 0.5 is best for the Cat Vs Dog Classification problem. Therefore, all future Gaussian Filter pre-processing will use a standard deviation of 0.5

**Discriminant Analysis**

Discriminant analysis models were trained using features extracted from Kaggle dataset by the AlexNet CNN. For all models, data was partitioned as 60% training, 20% cross-validation, and %20 testing. Matlab’s Classification Learner App was used to train Linear Discriminant and Quadratic Discriminant models. Holdout validation on the 20% cross-validation data was used during training, and the final models were tested on the final 20% of data.

**Discriminant Analysis Results with 200 Observations**

A) Linear Discriminant with No Gaussian Filter

Cross Validation Accuracy = 92.5%

Confusion Matrix =

1.0000 0

0.2500 0.7500

B) Quadratic Discriminant with No Gaussian Filter

Cross Validation Accuracy = 92.5%  
Confusion Matrix =

1.0000 0

0.2500 0.7500

C) Linear Discriminant with Gaussian Filter Pre-Processing

Cross Validation Accuracy = 90%  
Confusion Matrix =

1.0000 0

0.0500 0.9500

C) Quadratic Discriminant with Gaussian Filter Pre-Processing

Cross Validation Accuracy = 90%

Confusion Matrix =

1.0000 0

0.1500 0.8500

**Discriminant Analysis Results with 1000 Observations**

A) Linear Discriminant with Gaussian Filter Pre-Processing

Cross Validation Accuracy = 94.5%

Confusion Matrix =

0.9800 0.0200

0.1000 0.9000

B) Quadratic Discriminant with Gaussian Filter Pre-Processing

Cross Validation Accuracy = 92.5%  
Confusion Matrix =

0.9700 0.0300

0.1300 0.8700

**Discriminant Analysis Conclusion**

Comparing Discriminant Analysis models and their results suggests that the Linear Discriminant model trained on 1000 observations using Gaussian Filter is the most accurate, with a Cross Validation Accuracy of 94.5% and a Test set Accuracy of 94%. It makes sense that results appear slightly less accurate as the dataset is increased, because the test set of 20% also increases. More images to test on leaves room for more error.