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EE 562

Assignment 4

# Introduction

This report looks at several different neural networks and compares their performance. Performance is determined by training and validation accuracy based on the number of trainable parameters. Accuracies are then used to look at overfitting a model. The models to be discussed are: simple neural network, simple convolutional neural network, color-normalized simple convolutional neural network, color-normalized deep convolutional neural network, and a data-augmented color-normalized deep convolutional neural network.

A model is overfit if the training accuracy is higher than the test (validation) accuracy. Training accuracy is the percentage of correctly classified images in the training dataset while the test accuracy is the percentage of correctly classified images in a test dataset.

# Simple neural network

There are 346,373 trainable parameters for the simple neural network that produced a validation accuracy of 76.56% and a training accuracy of 75.74%. Because the training accuracy is lower than the validation accuracy, the model is not overfit. The simple neural network is a good baseline to compare other neural networks against.

# Simple convolutional neural network

There are 8,069 trainable parameters for the simple convolutional neural network that produced a validation accuracy of 82.68% and a training accuracy of 83.45%. Because the training accuracy is not substantially larger than the validation accuracy, the model is not overfit. The simple convolutional neural network has a higher best accuracy than the simple neural network. The simple convolutional neural network also had a smaller run-time, making it clearly better than the simple neural network.

# Color-normalized simple convolutional network

There are 8,069 trainable parameters for the color-normalized neural network that produced a validation accuracy of 85.80% and a training accuracy of 89.00%. The training accuracy is 3.20% higher than the validation accuracy, so there is slight overfitting in the color-normalized neural network. The color-normalized neural network has better accuracy than the simple convolutional neural network. With a similar runtime, the color-normalized neural network is better than the simple convolutional neural network.

# Color-normalized deep convolutional neural network

The color-normalized deep convolutional neural network with three convolutional layers of size 8, 16, and 32 with pooling had 29,077 trainable parameters and produced a validation accuracy of 86.92% and a training accuracy of 89.49%. The training accuracy is slightly higher than the validation accuracy, but less so than the color-normalized simple convolutional neural network. This means the color-normalized deep convolutional neural network has a higher accuracy and lower overfit than the color-normalized simple convolutional neural network. The color-normalized deep convolutional neural network is the best model so far.

# Color-normalized data-augmented deep neural network

The color-normalized data-augmented deep neural network with three convolutional layers of size 8, 16, and 32 with pooling with 29,077 trainable parameters produced a validation accuracy of 87.76% and a training accuracy of 87.06%. The training accuracy is nearly identical to the validation accuracy, so there is no overfitting. The color-normalized data-augmented deep neural network had the highest accuracy and lowest overfitting, so it is the best model.

# Conclusion

The color-normalized data-augmented deep neural network was the best model tested. Results for all models are shown in Table 1 below:

Table 1: Neural network training parameters, validation accuracy, and training accuracy

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Model | Trainable parameters | Validation accuracy (%) | Training accuracy (%) | Training accuracy – validation accuracy (%) |
| Simple neural network | 346,373 | 76.56 | 75.54 | -1.02 |
| Simple convolutional neural network | 8,069 | 82.68 | 83.45 | 0.77 |
| Color-normalized simple convolutional neural network | 8,069 | 85.80 | 89.00 | 3.20 |
| Color-normalized deep convolutional neural network | 29,077 | 86.92 | 89.49 | 2.57 |
| Color-normalized data-augmented deep neural network | 29,077 | 87.76 | 87.06 | -0.70 |

The color-normalized simple convolutional neural network has the most overfitting of any of the models with the most variation in training and validation accuracy. The models were tested in order of increasing accuracy with the simple neural network having the lowest accuracy and the color-normalized data-augmented deep neural network having the highest accuracy and smallest difference in training and validation accuracies.

To conclude, the color-normalized data-augmented deep neural network is the best model :)