EE 562: Artificial Intelligence for Engineers
Assignment 4

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1 Neural Network

Model	Trainable Parameter	Best Training Acc	Best Validation Acc
NN	346,373	75.984%	76.6%

The margin between training and validation accuracy is relatively small so the NN model is less likely to overfit on the training data.

2 Simple Convolution Neural Network

Model	Trainable Parameter	Best Training Acc	Best Validation Acc
NN	346,373	75.984%	76.6%
CNN	8,069	83.224%	82.72%

The validation accuracy for the simple convolution neural network is higher than the validation accuracy for the fully connected neural network. Even with far more less trainable parameters, the convolutional layer is consider to be make more sense when dealing with image classification task as it can preserve the features base on the pixel's position in comparison treating them as a sequence of number in the fully connected layer. Besides, the margin between training and validation accuracy is relatively small so the CNN model is less likely to overfit on the training data.

3 Color Normalization

Model	Trainable Parameter	Best Training Acc	Best Validation Acc
CNN	8,069	83.224%	82.72%
CNN + Color Normalization	8,069	88.176%	85.84%

As the problem statement mentioned, one way to resolve various lightning conditions in input images is to normalize the color of images. Therefore the number of trainable parameter in the model will not change, instead we implement the color normalization preprocessing using *transforms.Normalize()* with mean = 0.5 and standard deviation = 0.5 for every color channel. We can observed from the table that the color normalization we apply onto the training and validation images is helping the model to achieve a better classification result by an improvement of 5% on training accuracy and 3% on validation accuracy.

However, the margin between training and validation accuracy is now increase to 3% in comparison the the 1% without color normalization. So it is said that even the color normalization did help achieve a better classification result but also led the model to tend to be overfitting on the training data.

4 Deep Convolutional Neural Network

Model	Trainable Parameter	Best Training Acc	Best Validation Acc
CNN + Color Normalization	8,069	88.176%	85.84%
Deep CNN + Color Normalization	29,077	89.472%	86.88%

We built a deeper CNN using three convolutional layers and expect the model to extract somewhat more complex feature from the input images. The result from the table show that the deep CNN with more layer, and therefore more trainable parameters, achieve higher accuracy in both training and validation with a improvement of 1% each. Note that both of the model apply color normalization in order to provide fair comparison.

Again, the margin between training and validation accuracy can still be observed. And therefore the deep CNN had not yet provide solution to the overfitting problem we found during the previous section.

5 Data Augmentation

Model	Trainable Parameter	Best Training Acc	Best Validation Acc
Deep CNN	29,077	86.712%	85.32%
Deep CNN + Color Normalization	29,077	89.472%	86.88%
Deep CNN + Data Augmentation	29,077	87.216%	87.92%

Finally, we apply random affine and random horizontal flip on top of the color normalization transformation for experiment. The result from the table show that the data augmentation is not only helping the deep CNN model to achieve the highest validation accuracy among all models we implemented in this assignment but also gives a much smaller margin between the training and validation accuracy which implies that the data augmentation somehow alleviate the overfitting on the training data observed previously.