

### 1. NN

There are 346373 parameters in this model. The best training accuracy is 0.7629. The best validation accuracy is 0.7716. Because the training accuracy is not higher than the validation accuracy, there is no over fitting.

### 2. Simple CNN

There are 8069 parameters in this model. The best training accuracy is 0.8289. The best validation accuracy is 0.8244. It is better than NN because of higher accuracy and less parameters. CNN extracts feature in neighbor regions, so it needs less parameters and better fits how information is stored in images. Because the training accuracy is close to the validation accuracy, there is no over fitting.

### 3. Color Normalization

There are 8069 parameters in this model. The best training accuracy is 0.8838. The best validation accuracy is 0.8584. It is better than NN and CNN without color normalization because it standardizes lighting in every channel and therefore, improves accuracy by scaling different data points into a certain interval. This operation accelerates convergence. Because the training accuracy is higher than the validation accuracy, there is some over fitting problems.

### 4. Deep CNN

There are 29077 parameters in this model. The best training accuracy is 0.8992. The best validation accuracy is 0.8708. It is better than previous models because deep structure can extract more complex information from the images. Because the training accuracy is higher than the validation accuracy, there is some over fitting problems.

### 5. Data Augmentation

There are 29077 parameters in this model. The best training accuracy is 0.8697. The best validation accuracy is 0.8740. It is better than previous models because it can synthetically generate more training data for training to avoid over fitting. Data augmentation can improve model generalization by providing more data corresponding to the true distribution to train the model. Because the training accuracy is close to the validation accuracy, there is no over fitting.