Machine Learning Project Report

Group Members:

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Task:
Object-centric Image recognition task

Dataset:

CIFAR10, Caltech101, Caltech256, CIFAR100

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CIFAR-10

Introduction:

The CIFAR-10 dataset consists of 60000 32x32 colour images in 10 classes, with 6000 images per class. There are 50000 training images and 10000 test images.

The dataset is divided into five training batches and one test batch, each with 10000 images. The test batch contains exactly 1000 randomly-selected images from each class. The training batches contain the remaining images in random order, but some training batches may contain more images from one class than another. Between them, the training batches contain exactly 5000 images from each class.

Dataset Link: https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz

Model:

We have used Keras model based on VGG16 architecture for CIFAR-10 dataset.

VGG16 Architecture:

This network is characterized by its simplicity, using only *3×3* convolutional layers stacked on top of each other in increasing depth. Reducing volume size is handled by max pooling. Two fully-connected layers, each with 4,096 nodes are then followed by a softmax classifier.

Source Code:

```
from __future__ import print_function
import keras
from keras.datasets import cifar10
from keras.preprocessing.image import ImageDataGenerator
from keras.models import Sequential
from keras.layers import Dense, Dropout, Activation, Flatten
from keras.layers import Conv2D, MaxPooling2D, BatchNormalization
from keras import optimizers
import numpy as np
from keras.layers.core import Lambda
from keras import backend as K
from keras import regularizers
```

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```
import time
from sklearn.metrics import accuracy_score

class cifar10vgg:
    def __init__(self,train=True):
        self.num_classes = 10
        self.weight_decay = 0.0005
        self.x_shape = [32,32,3]

        self.model = self.build_model()
        if train:
            self.model = self.train(self.model)
        else:
            self.model.load_weights('cifar10vgg.h5')

    def build_model(self):
        # Build the network of vgg for 10 classes with massive dropout and weight decay as described in the
 paper.

        model = Sequential()
        weight_decay = self.weight_decay

        model.add(Conv2D(64, (3, 3), padding='same',
                         input_shape=self.x_shape,kernel_regularizer=regularizers.l2(weight_decay)))
        model.add(Activation('relu'))
        model.add(BatchNormalization())
        model.add(Dropout(0.3))

        model.add(Conv2D(64, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
        model.add(Activation('relu'))
        model.add(BatchNormalization())

        model.add(MaxPooling2D(pool_size=(2, 2)))

        model.add(Conv2D(128, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
        model.add(Activation('relu'))
        model.add(BatchNormalization())
        model.add(Dropout(0.4))

        model.add(Conv2D(128, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
        model.add(Activation('relu'))
        model.add(BatchNormalization())

        model.add(MaxPooling2D(pool_size=(2, 2)))

        model.add(Conv2D(256, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
```

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```
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(Dropout(0.4))

model.add(Conv2D(256, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(Dropout(0.4))

model.add(Conv2D(256, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
model.add(Activation('relu'))
model.add(BatchNormalization())

model.add(MaxPooling2D(pool_size=(2, 2)))

model.add(Conv2D(512, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(Dropout(0.4))

model.add(Conv2D(512, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(Dropout(0.4))

model.add(Conv2D(512, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
model.add(Activation('relu'))
model.add(BatchNormalization())

model.add(MaxPooling2D(pool_size=(2, 2)))

model.add(Conv2D(512, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(Dropout(0.4))

model.add(Conv2D(512, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
model.add(Activation('relu'))
model.add(BatchNormalization())
model.add(Dropout(0.4))

model.add(Conv2D(512, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
model.add(Activation('relu'))
model.add(BatchNormalization())

model.add(MaxPooling2D(pool_size=(2, 2)))
```

```
        model.add(Dropout(0.5))

        model.add(Flatten())
        model.add(Dense(512,kernel_regularizer=regularizers.l2(weight_decay)))
        model.add(Activation('relu'))
        model.add(BatchNormalization())

        model.add(Dropout(0.5))
        model.add(Dense(self.num_classes))
        model.add(Activation('softmax'))
        return model

    def normalize(self,X_train,X_test):
        #this function normalize inputs for zero mean and unit variance
        # it is used when training a model.
        # Input: training set and test set
        # Output: normalized training set and test set according to the trianing set statistics.
        mean = np.mean(X_train,axis=(0,1,2,3))
        std = np.std(X_train, axis=(0, 1, 2, 3))
        X_train = (X_train-mean)/(std+1e-7)
        X_test = (X_test-mean)/(std+1e-7)
        return X_train, X_test

    def normalize_production(self,x):
        #this function is used to normalize instances in production according to saved training set statistics
        # Input: X - a training set
        # Output X - a normalized training set according to normalization constants.

        #these values produced during first training and are general for the standard cifar10 training set nor
malization
        mean = 120.707
        std = 64.15
        return (x-mean)/(std+1e-7)

    def predict(self,x,normalize=True,batch_size=50):
        if normalize:
            x = self.normalize_production(x)
        return self.model.predict(x,batch_size)

    def train(self,model):

        #training parameters
        batch_size = 128
        maxepoches = 250
        learning_rate = 0.1
        lr_decay = 1e-6
```

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```
lr_drop = 20
# The data, shuffled and split between train and test sets:
(x_train, y_train), (x_test, y_test) = cifar10.load_data()
x_train = x_train.astype('float32')
x_test = x_test.astype('float32')
x_train, x_test = self.normalize(x_train, x_test)

y_train = keras.utils.to_categorical(y_train, self.num_classes)
y_test = keras.utils.to_categorical(y_test, self.num_classes)

def lr_scheduler(epoch):
    return learning_rate * (0.5 ** (epoch // lr_drop))
reduce_lr = keras.callbacks.LearningRateScheduler(lr_scheduler)

#data augmentation
datagen = ImageDataGenerator(
    featurewise_center=False,  # set input mean to 0 over the dataset
    samplewise_center=False,  # set each sample mean to 0
    featurewise_std_normalization=False,  # divide inputs by std of the dataset
    samplewise_std_normalization=False,  # divide each input by its std
    zca_whitening=False,  # apply ZCA whitening
    rotation_range=15,  # randomly rotate images in the range (degrees, 0 to 180)
    width_shift_range=0.1,  # randomly shift images horizontally (fraction of total width)
    height_shift_range=0.1,  # randomly shift images vertically (fraction of total height)
    horizontal_flip=True,  # randomly flip images
    vertical_flip=False)  # randomly flip images
# (std, mean, and principal components if ZCA whitening is applied).
start = time.time()
datagen.fit(x_train)


#optimization details
sgd = optimizers.SGD(lr=learning_rate, decay=lr_decay, momentum=0.9, nesterov=True)
model.compile(loss='categorical_crossentropy', optimizer=sgd,metrics=['accuracy'])

# training process in a for loop with learning rate drop every 25 epoches.

historytemp = model.fit_generator(datagen.flow(x_train, y_train,
                                 batch_size=batch_size),
                    steps_per_epoch=x_train.shape[0] // batch_size,
                    epochs=maxepoches,
                    validation_data=(x_test, y_test),callbacks=[reduce_lr],verbose=2)
model.save_weights('cifar10vgg.h5')
end = time.time()
print("Training Time: ",(end-start))
return model
```

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```
if __name__ == '__main__':

    (x_train, y_train), (x_test, y_test) = cifar10.load_data()
    x_train = x_train.astype('float32')
    x_test = x_test.astype('float32')

    y_train = keras.utils.to_categorical(y_train, 10)
    y_test = keras.utils.to_categorical(y_test, 10)

    model = cifar10vgg()

    predicted_x = model.predict(x_test)
    accuracy = accuracy_score(np.argmax(predicted_x,1) , np.argmax(y_test,1))
    print("Accuracy: ",accuracy*100,"%" )
```

Output:

First Run:

```
Epoch 1/250
 - 32s - loss: 19.2023 - acc: 0.1889 - val_loss: 17.2594 - val_acc: 0.1217
Epoch 2/250
 - 27s - loss: 13.6068 - acc: 0.2380 - val_loss: 10.1019 - val_acc: 0.1634
Epoch 3/250
 - 28s - loss: 7.5740 - acc: 0.2756 - val_loss: 6.2211 - val_acc: 0.1888
Epoch 4/250
 - 28s - loss: 5.1312 - acc: 0.3028 - val_loss: 5.4339 - val_acc: 0.1549
Epoch 5/250
 - 28s - loss: 5.0240 - acc: 0.2932 - val_loss: 4.6637 - val_acc: 0.2218
Epoch 6/250
 - 27s - loss: 3.5551 - acc: 0.3966 - val_loss: 3.6040 - val_acc: 0.1930
Epoch 7/250
 - 28s - loss: 2.4914 - acc: 0.4785 - val_loss: 2.3857 - val_acc: 0.4381
Epoch 8/250
 - 27s - loss: 1.9851 - acc: 0.5427 - val_loss: 1.9532 - val_acc: 0.5015
Epoch 9/250
 - 28s - loss: 1.7069 - acc: 0.5986 - val_loss: 1.8182 - val_acc: 0.5782
Epoch 10/250
 - 28s - loss: 1.5898 - acc: 0.6369 - val_loss: 1.5059 - val_acc: 0.6916
Epoch 11/250
 - 28s - loss: 1.5718 - acc: 0.6557 - val_loss: 1.4599 - val_acc: 0.6838
```

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```
Epoch 12/250
 - 27s - loss: 1.4975 - acc: 0.6826 - val_loss: 1.4220 - val_acc: 0.7159
Epoch 13/250
 - 27s - loss: 1.4755 - acc: 0.6961 - val_loss: 1.5002 - val_acc: 0.6911
Epoch 14/250
 - 27s - loss: 1.4805 - acc: 0.7036 - val_loss: 1.3736 - val_acc: 0.7338
Epoch 15/250
 - 27s - loss: 1.4720 - acc: 0.7109 - val_loss: 1.5302 - val_acc: 0.6971
Epoch 16/250
 - 27s - loss: 1.4873 - acc: 0.7099 - val_loss: 1.5039 - val_acc: 0.7041
Epoch 17/250
 - 27s - loss: 1.4616 - acc: 0.7217 - val_loss: 1.3945 - val_acc: 0.7454
Epoch 18/250
 - 27s - loss: 1.4736 - acc: 0.7263 - val_loss: 1.6964 - val_acc: 0.6644
Epoch 19/250
 - 27s - loss: 1.4721 - acc: 0.7323 - val_loss: 1.3471 - val_acc: 0.7733
Epoch 20/250
 - 27s - loss: 1.4864 - acc: 0.7302 - val_loss: 1.5061 - val_acc: 0.7329
Epoch 21/250
 - 27s - loss: 1.3163 - acc: 0.7730 - val_loss: 1.2446 - val_acc: 0.7805
Epoch 22/250
 - 27s - loss: 1.2260 - acc: 0.7799 - val_loss: 1.1218 - val_acc: 0.8046
Epoch 23/250
 - 27s - loss: 1.1954 - acc: 0.7804 - val_loss: 1.1525 - val_acc: 0.7937
Epoch 24/250
 - 26s - loss: 1.1939 - acc: 0.7833 - val_loss: 1.1571 - val_acc: 0.7919
Epoch 25/250
 - 26s - loss: 1.1867 - acc: 0.7843 - val_loss: 1.1062 - val_acc: 0.8129
Epoch 26/250
 - 26s - loss: 1.1968 - acc: 0.7862 - val_loss: 1.1712 - val_acc: 0.7984
Epoch 27/250
 - 26s - loss: 1.1880 - acc: 0.7910 - val_loss: 1.1188 - val_acc: 0.8132
Epoch 28/250
 - 26s - loss: 1.1982 - acc: 0.7912 - val_loss: 1.1058 - val_acc: 0.8210
Epoch 29/250
 - 26s - loss: 1.2004 - acc: 0.7920 - val_loss: 1.1170 - val_acc: 0.8162
Epoch 30/250
 - 26s - loss: 1.2014 - acc: 0.7956 - val_loss: 1.1423 - val_acc: 0.8137
Epoch 31/250
 - 26s - loss: 1.2059 - acc: 0.7945 - val_loss: 1.1261 - val_acc: 0.8167
Epoch 32/250
 - 26s - loss: 1.2034 - acc: 0.7964 - val_loss: 1.1947 - val_acc: 0.8004
Epoch 33/250
 - 26s - loss: 1.2102 - acc: 0.7975 - val_loss: 1.1822 - val_acc: 0.8084
Epoch 34/250
 - 26s - loss: 1.2160 - acc: 0.7965 - val_loss: 1.1477 - val_acc: 0.8262
Epoch 35/250
 - 26s - loss: 1.2164 - acc: 0.8001 - val_loss: 1.2160 - val_acc: 0.7997
Epoch 36/250
 - 26s - loss: 1.2203 - acc: 0.7993 - val_loss: 1.1232 - val_acc: 0.8275
Epoch 37/250
 - 26s - loss: 1.2149 - acc: 0.8025 - val_loss: 1.1194 - val_acc: 0.8327
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```
Epoch 38/250
 - 26s - loss: 1.2166 - acc: 0.8030 - val_loss: 1.2035 - val_acc: 0.8083
Epoch 39/250
 - 26s - loss: 1.2274 - acc: 0.8020 - val_loss: 1.1566 - val_acc: 0.8187
Epoch 40/250
 - 26s - loss: 1.2154 - acc: 0.8044 - val_loss: 1.1749 - val_acc: 0.8182
Epoch 41/250
 - 26s - loss: 1.0978 - acc: 0.8364 - val_loss: 0.9581 - val_acc: 0.8696
Epoch 42/250
 - 26s - loss: 1.0231 - acc: 0.8449 - val_loss: 0.9451 - val_acc: 0.8592
Epoch 43/250
 - 26s - loss: 0.9858 - acc: 0.8440 - val_loss: 0.9199 - val_acc: 0.8638
Epoch 44/250
 - 26s - loss: 0.9756 - acc: 0.8424 - val_loss: 0.9457 - val_acc: 0.8518
Epoch 45/250
 - 26s - loss: 0.9623 - acc: 0.8455 - val_loss: 0.8753 - val_acc: 0.8745
Epoch 46/250
 - 26s - loss: 0.9580 - acc: 0.8433 - val_loss: 1.0023 - val_acc: 0.8285
Epoch 47/250
 - 26s - loss: 0.9539 - acc: 0.8432 - val_loss: 0.8915 - val_acc: 0.8608
Epoch 48/250
 - 26s - loss: 0.9466 - acc: 0.8455 - val_loss: 1.0366 - val_acc: 0.8156
Epoch 49/250
 - 26s - loss: 0.9617 - acc: 0.8418 - val_loss: 0.8748 - val_acc: 0.8720
Epoch 50/250
 - 26s - loss: 0.9519 - acc: 0.8452 - val_loss: 0.9278 - val_acc: 0.8546
Epoch 51/250
 - 26s - loss: 0.9555 - acc: 0.8442 - val_loss: 0.9278 - val_acc: 0.8555
Epoch 52/250
 - 26s - loss: 0.9481 - acc: 0.8488 - val_loss: 0.9034 - val_acc: 0.8629
Epoch 53/250
 - 26s - loss: 0.9440 - acc: 0.8503 - val_loss: 0.9807 - val_acc: 0.8423
Epoch 54/250
 - 25s - loss: 0.9560 - acc: 0.8468 - val_loss: 0.9160 - val_acc: 0.8604
Epoch 55/250
 - 26s - loss: 0.9564 - acc: 0.8485 - val_loss: 0.9399 - val_acc: 0.8535
Epoch 56/250
 - 26s - loss: 0.9605 - acc: 0.8493 - val_loss: 0.9484 - val_acc: 0.8505
Epoch 57/250
 - 26s - loss: 0.9576 - acc: 0.8502 - val_loss: 0.9273 - val_acc: 0.8602
Epoch 58/250
 - 26s - loss: 0.9614 - acc: 0.8502 - val_loss: 0.9504 - val_acc: 0.8533
Epoch 59/250
 - 26s - loss: 0.9616 - acc: 0.8496 - val_loss: 0.9192 - val_acc: 0.8653
Epoch 60/250
 - 25s - loss: 0.9689 - acc: 0.8496 - val_loss: 0.9281 - val_acc: 0.8630
Epoch 61/250
 - 26s - loss: 0.8729 - acc: 0.8768 - val_loss: 0.8090 - val_acc: 0.8937
Epoch 62/250
 - 26s - loss: 0.8249 - acc: 0.8862 - val_loss: 0.8332 - val_acc: 0.8769
Epoch 63/250
 - 26s - loss: 0.8053 - acc: 0.8854 - val_loss: 0.8140 - val_acc: 0.8796
```

```
Epoch 64/250
 - 26s - loss: 0.7862 - acc: 0.8862 - val_loss: 0.7936 - val_acc: 0.8856
Epoch 65/250
 - 26s - loss: 0.7682 - acc: 0.8890 - val_loss: 0.7498 - val_acc: 0.8929
Epoch 66/250
 - 26s - loss: 0.7573 - acc: 0.8898 - val_loss: 0.7741 - val_acc: 0.8825
Epoch 67/250
 - 25s - loss: 0.7554 - acc: 0.8880 - val_loss: 0.7396 - val_acc: 0.8936
Epoch 68/250
 - 26s - loss: 0.7462 - acc: 0.8880 - val_loss: 0.7291 - val_acc: 0.8959
Epoch 69/250
 - 26s - loss: 0.7428 - acc: 0.8888 - val_loss: 0.7072 - val_acc: 0.8981
Epoch 70/250
 - 25s - loss: 0.7430 - acc: 0.8877 - val_loss: 0.7468 - val_acc: 0.8890
Epoch 71/250
 - 25s - loss: 0.7405 - acc: 0.8870 - val_loss: 0.7448 - val_acc: 0.8899
Epoch 72/250
 - 26s - loss: 0.7409 - acc: 0.8858 - val_loss: 0.7575 - val_acc: 0.8858
Epoch 73/250
 - 25s - loss: 0.7391 - acc: 0.8866 - val_loss: 0.7401 - val_acc: 0.8905
Epoch 74/250
 - 26s - loss: 0.7409 - acc: 0.8868 - val_loss: 0.7210 - val_acc: 0.8901
Epoch 75/250
 - 26s - loss: 0.7388 - acc: 0.8884 - val_loss: 0.8357 - val_acc: 0.8617
Epoch 76/250
 - 26s - loss: 0.7382 - acc: 0.8874 - val_loss: 0.7601 - val_acc: 0.8826
Epoch 77/250
 - 26s - loss: 0.7370 - acc: 0.8889 - val_loss: 0.7198 - val_acc: 0.8960
Epoch 78/250
 - 26s - loss: 0.7356 - acc: 0.8878 - val_loss: 0.7542 - val_acc: 0.8824
Epoch 79/250
 - 26s - loss: 0.7389 - acc: 0.8885 - val_loss: 0.7284 - val_acc: 0.8907
Epoch 80/250
 - 26s - loss: 0.7369 - acc: 0.8888 - val_loss: 0.7737 - val_acc: 0.8822
Epoch 81/250
 - 26s - loss: 0.6750 - acc: 0.9077 - val_loss: 0.6911 - val_acc: 0.9031
Epoch 82/250
 - 26s - loss: 0.6451 - acc: 0.9129 - val_loss: 0.6512 - val_acc: 0.9099
Epoch 83/250
 - 26s - loss: 0.6357 - acc: 0.9126 - val_loss: 0.6334 - val_acc: 0.9164
Epoch 84/250
 - 26s - loss: 0.6195 - acc: 0.9181 - val_loss: 0.6839 - val_acc: 0.8996
Epoch 85/250
 - 25s - loss: 0.6071 - acc: 0.9184 - val_loss: 0.6758 - val_acc: 0.9030
Epoch 86/250
 - 26s - loss: 0.5996 - acc: 0.9196 - val_loss: 0.6563 - val_acc: 0.9052
Epoch 87/250
 - 26s - loss: 0.5987 - acc: 0.9169 - val_loss: 0.6187 - val_acc: 0.9150
Epoch 88/250
 - 26s - loss: 0.5895 - acc: 0.9195 - val_loss: 0.6113 - val_acc: 0.9150
Epoch 89/250
 - 26s - loss: 0.5860 - acc: 0.9189 - val_loss: 0.6247 - val_acc: 0.9074
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```
Epoch 90/250
 - 25s - loss: 0.5806 - acc: 0.9195 - val_loss: 0.6087 - val_acc: 0.9138
Epoch 91/250
 - 26s - loss: 0.5747 - acc: 0.9202 - val_loss: 0.6242 - val_acc: 0.9068
Epoch 92/250
 - 26s - loss: 0.5723 - acc: 0.9191 - val_loss: 0.6404 - val_acc: 0.9028
Epoch 93/250
 - 26s - loss: 0.5714 - acc: 0.9194 - val_loss: 0.6095 - val_acc: 0.9104
Epoch 94/250
 - 26s - loss: 0.5630 - acc: 0.9207 - val_loss: 0.6242 - val_acc: 0.9065
Epoch 95/250
 - 26s - loss: 0.5643 - acc: 0.9197 - val_loss: 0.6291 - val_acc: 0.9071
Epoch 96/250
 - 26s - loss: 0.5623 - acc: 0.9213 - val_loss: 0.6162 - val_acc: 0.9052
Epoch 97/250
 - 26s - loss: 0.5656 - acc: 0.9184 - val_loss: 0.6174 - val_acc: 0.9077
Epoch 98/250
 - 25s - loss: 0.5620 - acc: 0.9208 - val_loss: 0.6310 - val_acc: 0.9011
Epoch 99/250
 - 25s - loss: 0.5592 - acc: 0.9206 - val_loss: 0.6732 - val_acc: 0.8890
Epoch 100/250
 - 26s - loss: 0.5554 - acc: 0.9216 - val_loss: 0.6391 - val_acc: 0.9000
Epoch 101/250
 - 26s - loss: 0.5239 - acc: 0.9307 - val_loss: 0.5800 - val_acc: 0.9174
Epoch 102/250
 - 25s - loss: 0.5028 - acc: 0.9360 - val_loss: 0.5999 - val_acc: 0.9133
Epoch 103/250
 - 25s - loss: 0.4956 - acc: 0.9377 - val_loss: 0.5657 - val_acc: 0.9188
Epoch 104/250
 - 26s - loss: 0.4831 - acc: 0.9401 - val_loss: 0.5611 - val_acc: 0.9190
Epoch 105/250
 - 25s - loss: 0.4764 - acc: 0.9411 - val_loss: 0.5510 - val_acc: 0.9227
Epoch 106/250
 - 26s - loss: 0.4737 - acc: 0.9414 - val_loss: 0.5818 - val_acc: 0.9127
Epoch 107/250
 - 26s - loss: 0.4633 - acc: 0.9433 - val_loss: 0.5500 - val_acc: 0.9225
Epoch 108/250
 - 25s - loss: 0.4668 - acc: 0.9413 - val_loss: 0.5684 - val_acc: 0.9165
Epoch 109/250
 - 26s - loss: 0.4597 - acc: 0.9424 - val_loss: 0.5637 - val_acc: 0.9190
Epoch 110/250
 - 25s - loss: 0.4535 - acc: 0.9443 - val_loss: 0.5521 - val_acc: 0.9215
Epoch 111/250
 - 25s - loss: 0.4519 - acc: 0.9442 - val_loss: 0.5480 - val_acc: 0.9193
Epoch 112/250
 - 26s - loss: 0.4474 - acc: 0.9447 - val_loss: 0.5420 - val_acc: 0.9216
Epoch 113/250
 - 26s - loss: 0.4472 - acc: 0.9432 - val_loss: 0.5465 - val_acc: 0.9199
Epoch 114/250
 - 25s - loss: 0.4410 - acc: 0.9448 - val_loss: 0.5360 - val_acc: 0.9240
Epoch 115/250
 - 25s - loss: 0.4375 - acc: 0.9455 - val_loss: 0.5677 - val_acc: 0.9116
```

```
Epoch 116/250
 - 26s - loss: 0.4354 - acc: 0.9444 - val_loss: 0.5392 - val_acc: 0.9197
Epoch 117/250
 - 25s - loss: 0.4373 - acc: 0.9456 - val_loss: 0.5536 - val_acc: 0.9142
Epoch 118/250
 - 25s - loss: 0.4344 - acc: 0.9452 - val_loss: 0.5414 - val_acc: 0.9177
Epoch 119/250
 - 26s - loss: 0.4311 - acc: 0.9433 - val_loss: 0.5358 - val_acc: 0.9196
Epoch 120/250
 - 25s - loss: 0.4285 - acc: 0.9462 - val_loss: 0.5566 - val_acc: 0.9124
Epoch 121/250
 - 26s - loss: 0.4106 - acc: 0.9495 - val_loss: 0.5175 - val_acc: 0.9231
Epoch 122/250
 - 26s - loss: 0.3942 - acc: 0.9546 - val_loss: 0.5628 - val_acc: 0.9144
Epoch 123/250
 - 25s - loss: 0.3891 - acc: 0.9579 - val_loss: 0.5226 - val_acc: 0.9243
Epoch 124/250
 - 25s - loss: 0.3846 - acc: 0.9583 - val_loss: 0.5164 - val_acc: 0.9254
Epoch 125/250
 - 26s - loss: 0.3813 - acc: 0.9594 - val_loss: 0.5022 - val_acc: 0.9263
Epoch 126/250
 - 25s - loss: 0.3807 - acc: 0.9580 - val_loss: 0.5138 - val_acc: 0.9242
Epoch 127/250
 - 26s - loss: 0.3722 - acc: 0.9586 - val_loss: 0.5083 - val_acc: 0.9257
Epoch 128/250
 - 26s - loss: 0.3705 - acc: 0.9610 - val_loss: 0.5180 - val_acc: 0.9240
Epoch 129/250
 - 25s - loss: 0.3689 - acc: 0.9596 - val_loss: 0.5063 - val_acc: 0.9273
Epoch 130/250
 - 26s - loss: 0.3678 - acc: 0.9596 - val_loss: 0.5078 - val_acc: 0.9262
Epoch 131/250
 - 26s - loss: 0.3609 - acc: 0.9618 - val_loss: 0.5176 - val_acc: 0.9221
Epoch 132/250
 - 25s - loss: 0.3613 - acc: 0.9607 - val_loss: 0.4954 - val_acc: 0.9284
Epoch 133/250
 - 26s - loss: 0.3558 - acc: 0.9619 - val_loss: 0.4997 - val_acc: 0.9249
Epoch 134/250
 - 25s - loss: 0.3506 - acc: 0.9634 - val_loss: 0.4969 - val_acc: 0.9275
Epoch 135/250
 - 26s - loss: 0.3528 - acc: 0.9622 - val_loss: 0.5027 - val_acc: 0.9254
Epoch 136/250
 - 25s - loss: 0.3465 - acc: 0.9633 - val_loss: 0.5257 - val_acc: 0.9215
Epoch 137/250
 - 26s - loss: 0.3488 - acc: 0.9624 - val_loss: 0.5019 - val_acc: 0.9255
Epoch 138/250
 - 26s - loss: 0.3495 - acc: 0.9619 - val_loss: 0.4962 - val_acc: 0.9277
Epoch 139/250
 - 26s - loss: 0.3449 - acc: 0.9626 - val_loss: 0.4905 - val_acc: 0.9289
Epoch 140/250
 - 26s - loss: 0.3405 - acc: 0.9633 - val_loss: 0.4916 - val_acc: 0.9269
Epoch 141/250
 - 26s - loss: 0.3401 - acc: 0.9635 - val_loss: 0.4860 - val_acc: 0.9296
```

Machine Learning Project Report

```
Epoch 142/250
 - 26s - loss: 0.3299 - acc: 0.9664 - val_loss: 0.4716 - val_acc: 0.9295
Epoch 143/250
 - 25s - loss: 0.3223 - acc: 0.9686 - val_loss: 0.4749 - val_acc: 0.9307
Epoch 144/250
 - 26s - loss: 0.3192 - acc: 0.9697 - val_loss: 0.4854 - val_acc: 0.9269
Epoch 145/250
 - 25s - loss: 0.3202 - acc: 0.9696 - val_loss: 0.4780 - val_acc: 0.9286
Epoch 146/250
 - 25s - loss: 0.3164 - acc: 0.9695 - val_loss: 0.4860 - val_acc: 0.9276
Epoch 147/250
 - 26s - loss: 0.3138 - acc: 0.9706 - val_loss: 0.4753 - val_acc: 0.9313
Epoch 148/250
 - 25s - loss: 0.3116 - acc: 0.9703 - val_loss: 0.4784 - val_acc: 0.9302
Epoch 149/250
 - 26s - loss: 0.3108 - acc: 0.9707 - val_loss: 0.4736 - val_acc: 0.9322
Epoch 150/250
 - 26s - loss: 0.3097 - acc: 0.9708 - val_loss: 0.4760 - val_acc: 0.9308
Epoch 151/250
 - 26s - loss: 0.3093 - acc: 0.9708 - val_loss: 0.4734 - val_acc: 0.9287
Epoch 152/250
 - 25s - loss: 0.3049 - acc: 0.9719 - val_loss: 0.4751 - val_acc: 0.9293
Epoch 153/250
 - 25s - loss: 0.3047 - acc: 0.9714 - val_loss: 0.4758 - val_acc: 0.9300
Epoch 154/250
 - 25s - loss: 0.3032 - acc: 0.9713 - val_loss: 0.4820 - val_acc: 0.9280
Epoch 155/250
 - 25s - loss: 0.3028 - acc: 0.9716 - val_loss: 0.4759 - val_acc: 0.9276
Epoch 156/250
 - 26s - loss: 0.2977 - acc: 0.9727 - val_loss: 0.4707 - val_acc: 0.9311
Epoch 157/250
 - 26s - loss: 0.3000 - acc: 0.9720 - val_loss: 0.4855 - val_acc: 0.9276
Epoch 158/250
 - 25s - loss: 0.2943 - acc: 0.9736 - val_loss: 0.4693 - val_acc: 0.9323
Epoch 159/250
 - 25s - loss: 0.2961 - acc: 0.9722 - val_loss: 0.4684 - val_acc: 0.9310
Epoch 160/250
 - 26s - loss: 0.2929 - acc: 0.9735 - val_loss: 0.4822 - val_acc: 0.9275
Epoch 161/250
 - 26s - loss: 0.2876 - acc: 0.9747 - val_loss: 0.4760 - val_acc: 0.9286
Epoch 162/250
 - 26s - loss: 0.2847 - acc: 0.9751 - val_loss: 0.4732 - val_acc: 0.9299
Epoch 163/250
 - 26s - loss: 0.2805 - acc: 0.9770 - val_loss: 0.4789 - val_acc: 0.9277
Epoch 164/250
 - 26s - loss: 0.2812 - acc: 0.9764 - val_loss: 0.4702 - val_acc: 0.9294
Epoch 165/250
 - 26s - loss: 0.2819 - acc: 0.9756 - val_loss: 0.4788 - val_acc: 0.9289
Epoch 166/250
 - 26s - loss: 0.2791 - acc: 0.9769 - val_loss: 0.4671 - val_acc: 0.9320
Epoch 167/250
 - 25s - loss: 0.2774 - acc: 0.9780 - val_loss: 0.4773 - val_acc: 0.9292
```

```
Epoch 168/250
 - 26s - loss: 0.2786 - acc: 0.9769 - val_loss: 0.4694 - val_acc: 0.9306
Epoch 169/250
 - 26s - loss: 0.2748 - acc: 0.9776 - val_loss: 0.4665 - val_acc: 0.9319
Epoch 170/250
 - 25s - loss: 0.2770 - acc: 0.9768 - val_loss: 0.4680 - val_acc: 0.9309
Epoch 171/250
 - 25s - loss: 0.2762 - acc: 0.9765 - val_loss: 0.4721 - val_acc: 0.9302
Epoch 172/250
 - 26s - loss: 0.2764 - acc: 0.9771 - val_loss: 0.4824 - val_acc: 0.9282
Epoch 173/250
 - 25s - loss: 0.2727 - acc: 0.9783 - val_loss: 0.4733 - val_acc: 0.9295
Epoch 174/250
 - 25s - loss: 0.2730 - acc: 0.9778 - val_loss: 0.4712 - val_acc: 0.9308
Epoch 175/250
 - 26s - loss: 0.2687 - acc: 0.9784 - val_loss: 0.4782 - val_acc: 0.9280
Epoch 176/250
 - 25s - loss: 0.2717 - acc: 0.9773 - val_loss: 0.4701 - val_acc: 0.9305
Epoch 177/250
 - 25s - loss: 0.2719 - acc: 0.9772 - val_loss: 0.4765 - val_acc: 0.9291
Epoch 178/250
 - 25s - loss: 0.2687 - acc: 0.9779 - val_loss: 0.4700 - val_acc: 0.9318
Epoch 179/250
 - 25s - loss: 0.2666 - acc: 0.9799 - val_loss: 0.4632 - val_acc: 0.9329
Epoch 180/250
 - 25s - loss: 0.2678 - acc: 0.9790 - val_loss: 0.4699 - val_acc: 0.9315
Epoch 181/250
 - 25s - loss: 0.2635 - acc: 0.9795 - val_loss: 0.4698 - val_acc: 0.9310
Epoch 182/250
 - 26s - loss: 0.2633 - acc: 0.9798 - val_loss: 0.4681 - val_acc: 0.9322
Epoch 183/250
 - 25s - loss: 0.2619 - acc: 0.9800 - val_loss: 0.4704 - val_acc: 0.9303
Epoch 184/250
 - 25s - loss: 0.2606 - acc: 0.9810 - val_loss: 0.4741 - val_acc: 0.9304
Epoch 185/250
 - 25s - loss: 0.2591 - acc: 0.9814 - val_loss: 0.4680 - val_acc: 0.9315
Epoch 186/250
 - 26s - loss: 0.2606 - acc: 0.9805 - val_loss: 0.4640 - val_acc: 0.9341
Epoch 187/250
 - 25s - loss: 0.2586 - acc: 0.9806 - val_loss: 0.4677 - val_acc: 0.9318
Epoch 188/250
 - 26s - loss: 0.2569 - acc: 0.9814 - val_loss: 0.4731 - val_acc: 0.9304
Epoch 189/250
 - 26s - loss: 0.2611 - acc: 0.9798 - val_loss: 0.4702 - val_acc: 0.9321
Epoch 190/250
 - 25s - loss: 0.2612 - acc: 0.9804 - val_loss: 0.4757 - val_acc: 0.9316
Epoch 191/250
 - 26s - loss: 0.2553 - acc: 0.9818 - val_loss: 0.4702 - val_acc: 0.9326
Epoch 192/250
 - 25s - loss: 0.2568 - acc: 0.9809 - val_loss: 0.4679 - val_acc: 0.9324
Epoch 193/250
 - 25s - loss: 0.2589 - acc: 0.9801 - val_loss: 0.4671 - val_acc: 0.9320
```

Machine Learning Project Report

```
Epoch 194/250
 - 26s - loss: 0.2569 - acc: 0.9812 - val_loss: 0.4679 - val_acc: 0.9314
Epoch 195/250
 - 25s - loss: 0.2532 - acc: 0.9820 - val_loss: 0.4621 - val_acc: 0.9336
Epoch 196/250
 - 25s - loss: 0.2567 - acc: 0.9807 - val_loss: 0.4604 - val_acc: 0.9336
Epoch 197/250
 - 25s - loss: 0.2551 - acc: 0.9815 - val_loss: 0.4676 - val_acc: 0.9327
Epoch 198/250
 - 26s - loss: 0.2542 - acc: 0.9808 - val_loss: 0.4622 - val_acc: 0.9341
Epoch 199/250
 - 25s - loss: 0.2527 - acc: 0.9818 - val_loss: 0.4676 - val_acc: 0.9329
Epoch 200/250
 - 26s - loss: 0.2529 - acc: 0.9817 - val_loss: 0.4721 - val_acc: 0.9315
Epoch 201/250
 - 26s - loss: 0.2533 - acc: 0.9810 - val_loss: 0.4696 - val_acc: 0.9314
Epoch 202/250
 - 25s - loss: 0.2530 - acc: 0.9814 - val_loss: 0.4658 - val_acc: 0.9326
Epoch 203/250
 - 25s - loss: 0.2499 - acc: 0.9824 - val_loss: 0.4663 - val_acc: 0.9328
Epoch 204/250
 - 26s - loss: 0.2515 - acc: 0.9828 - val_loss: 0.4670 - val_acc: 0.9326
Epoch 205/250
 - 25s - loss: 0.2498 - acc: 0.9820 - val_loss: 0.4657 - val_acc: 0.9330
Epoch 206/250
 - 25s - loss: 0.2504 - acc: 0.9822 - val_loss: 0.4650 - val_acc: 0.9323
Epoch 207/250
 - 26s - loss: 0.2490 - acc: 0.9823 - val_loss: 0.4611 - val_acc: 0.9322
Epoch 208/250
 - 25s - loss: 0.2466 - acc: 0.9831 - val_loss: 0.4653 - val_acc: 0.9317
Epoch 209/250
 - 25s - loss: 0.2486 - acc: 0.9825 - val_loss: 0.4643 - val_acc: 0.9318
Epoch 210/250
 - 26s - loss: 0.2480 - acc: 0.9829 - val_loss: 0.4664 - val_acc: 0.9314
Epoch 211/250
 - 26s - loss: 0.2472 - acc: 0.9833 - val_loss: 0.4683 - val_acc: 0.9319
Epoch 212/250
 - 25s - loss: 0.2507 - acc: 0.9812 - val_loss: 0.4648 - val_acc: 0.9340
Epoch 213/250
 - 26s - loss: 0.2495 - acc: 0.9818 - val_loss: 0.4658 - val_acc: 0.9316
Epoch 214/250
 - 25s - loss: 0.2469 - acc: 0.9833 - val_loss: 0.4672 - val_acc: 0.9321
Epoch 215/250
 - 25s - loss: 0.2495 - acc: 0.9821 - val_loss: 0.4644 - val_acc: 0.9323
Epoch 216/250
 - 25s - loss: 0.2486 - acc: 0.9828 - val_loss: 0.4632 - val_acc: 0.9328
Epoch 217/250
 - 25s - loss: 0.2487 - acc: 0.9824 - val_loss: 0.4655 - val_acc: 0.9322
Epoch 218/250
 - 25s - loss: 0.2466 - acc: 0.9828 - val_loss: 0.4671 - val_acc: 0.9317
Epoch 219/250
 - 25s - loss: 0.2480 - acc: 0.9826 - val_loss: 0.4621 - val_acc: 0.9332
```

Machine Learning Project Report

```
Epoch 220/250
 - 25s - loss: 0.2467 - acc: 0.9836 - val_loss: 0.4614 - val_acc: 0.9323
Epoch 221/250
 - 25s - loss: 0.2451 - acc: 0.9831 - val_loss: 0.4609 - val_acc: 0.9326
Epoch 222/250
 - 26s - loss: 0.2470 - acc: 0.9828 - val_loss: 0.4605 - val_acc: 0.9332
Epoch 223/250
 - 26s - loss: 0.2449 - acc: 0.9841 - val_loss: 0.4606 - val_acc: 0.9338
Epoch 224/250
 - 25s - loss: 0.2479 - acc: 0.9825 - val_loss: 0.4619 - val_acc: 0.9332
Epoch 225/250
 - 25s - loss: 0.2441 - acc: 0.9829 - val_loss: 0.4597 - val_acc: 0.9340
Epoch 226/250
 - 25s - loss: 0.2442 - acc: 0.9833 - val_loss: 0.4601 - val_acc: 0.9330
Epoch 227/250
 - 25s - loss: 0.2465 - acc: 0.9819 - val_loss: 0.4608 - val_acc: 0.9331
Epoch 228/250
 - 25s - loss: 0.2441 - acc: 0.9835 - val_loss: 0.4598 - val_acc: 0.9330
Epoch 229/250
 - 26s - loss: 0.2415 - acc: 0.9840 - val_loss: 0.4625 - val_acc: 0.9326
Epoch 230/250
 - 25s - loss: 0.2446 - acc: 0.9832 - val_loss: 0.4588 - val_acc: 0.9336
Epoch 231/250
 - 25s - loss: 0.2457 - acc: 0.9829 - val_loss: 0.4593 - val_acc: 0.9333
Epoch 232/250
 - 25s - loss: 0.2440 - acc: 0.9835 - val_loss: 0.4620 - val_acc: 0.9337
Epoch 233/250
 - 25s - loss: 0.2468 - acc: 0.9823 - val_loss: 0.4601 - val_acc: 0.9331
Epoch 234/250
 - 26s - loss: 0.2456 - acc: 0.9829 - val_loss: 0.4606 - val_acc: 0.9338
Epoch 235/250
 - 26s - loss: 0.2440 - acc: 0.9835 - val_loss: 0.4611 - val_acc: 0.9342
Epoch 236/250
 - 25s - loss: 0.2428 - acc: 0.9843 - val_loss: 0.4615 - val_acc: 0.9339
Epoch 237/250
 - 25s - loss: 0.2434 - acc: 0.9830 - val_loss: 0.4606 - val_acc: 0.9338
Epoch 238/250
 - 25s - loss: 0.2452 - acc: 0.9835 - val_loss: 0.4595 - val_acc: 0.9336
Epoch 239/250
 - 26s - loss: 0.2420 - acc: 0.9832 - val_loss: 0.4589 - val_acc: 0.9332
Epoch 240/250
 - 26s - loss: 0.2429 - acc: 0.9839 - val_loss: 0.4609 - val_acc: 0.9332
Epoch 241/250
 - 26s - loss: 0.2434 - acc: 0.9834 - val_loss: 0.4595 - val_acc: 0.9337
Epoch 242/250
 - 26s - loss: 0.2427 - acc: 0.9832 - val_loss: 0.4596 - val_acc: 0.9337
Epoch 243/250
 - 26s - loss: 0.2432 - acc: 0.9832 - val_loss: 0.4602 - val_acc: 0.9337
Epoch 244/250
 - 25s - loss: 0.2409 - acc: 0.9847 - val_loss: 0.4612 - val_acc: 0.9336
Epoch 245/250
 - 25s - loss: 0.2430 - acc: 0.9835 - val_loss: 0.4595 - val_acc: 0.9339
```

Machine Learning Project Report

```
Epoch 246/250
 - 25s - loss: 0.2448 - acc: 0.9827 - val_loss: 0.4597 - val_acc: 0.9340
Epoch 247/250
 - 26s - loss: 0.2445 - acc: 0.9832 - val_loss: 0.4589 - val_acc: 0.9344
Epoch 248/250
 - 26s - loss: 0.2424 - acc: 0.9835 - val_loss: 0.4581 - val_acc: 0.9344
Epoch 249/250
 - 25s - loss: 0.2408 - acc: 0.9848 - val_loss: 0.4596 - val_acc: 0.9338
Epoch 250/250
 - 25s - loss: 0.2418 - acc: 0.9836 - val_loss: 0.4583 - val_acc: 0.9345
Training Time:  6452.848551273346
Accuracy:  93.45 %
```

Second Run:

```
Epoch 1/250
 - 33s - loss: 22.0208 - acc: 0.1882 - val_loss: 17.7246 - val_acc: 0.1387
Epoch 2/250
 - 27s - loss: 11.6296 - acc: 0.2733 - val_loss: 9.3304 - val_acc: 0.1512
Epoch 3/250
 - 27s - loss: 7.3973 - acc: 0.2360 - val_loss: 7.8169 - val_acc: 0.1271
Epoch 4/250
 - 27s - loss: 6.6897 - acc: 0.2450 - val_loss: 5.8401 - val_acc: 0.2071
Epoch 5/250
 - 27s - loss: 4.8519 - acc: 0.3264 - val_loss: 4.3972 - val_acc: 0.2241
Epoch 6/250
 - 27s - loss: 3.2290 - acc: 0.4056 - val_loss: 3.0917 - val_acc: 0.2920
Epoch 7/250
 - 27s - loss: 2.3470 - acc: 0.4721 - val_loss: 2.2098 - val_acc: 0.4187
Epoch 8/250
 - 27s - loss: 1.9149 - acc: 0.5345 - val_loss: 2.1548 - val_acc: 0.4675
Epoch 9/250
 - 27s - loss: 1.7388 - acc: 0.5777 - val_loss: 1.7121 - val_acc: 0.5983
Epoch 10/250
 - 27s - loss: 1.6145 - acc: 0.6198 - val_loss: 1.5373 - val_acc: 0.6542
Epoch 11/250
 - 27s - loss: 1.5361 - acc: 0.6504 - val_loss: 1.5947 - val_acc: 0.6437
Epoch 12/250
 - 27s - loss: 1.5094 - acc: 0.6720 - val_loss: 1.3756 - val_acc: 0.7259
Epoch 13/250
 - 27s - loss: 1.4905 - acc: 0.6846 - val_loss: 1.4603 - val_acc: 0.6914
Epoch 14/250
 - 26s - loss: 1.4783 - acc: 0.6960 - val_loss: 1.9989 - val_acc: 0.5897
Epoch 15/250
 - 27s - loss: 1.4834 - acc: 0.7035 - val_loss: 1.4743 - val_acc: 0.7181
Epoch 16/250
 - 26s - loss: 1.4790 - acc: 0.7106 - val_loss: 1.5071 - val_acc: 0.6970
Epoch 17/250
 - 27s - loss: 1.4862 - acc: 0.7169 - val_loss: 1.6156 - val_acc: 0.6750
Epoch 18/250
```

Machine Learning Project Report

```
 - 27s - loss: 1.4895 - acc: 0.7224 - val_loss: 1.5565 - val_acc: 0.7065
Epoch 19/250
 - 27s - loss: 1.4953 - acc: 0.7246 - val_loss: 1.4234 - val_acc: 0.7500
Epoch 20/250
 - 27s - loss: 1.5010 - acc: 0.7275 - val_loss: 1.4648 - val_acc: 0.7468
Epoch 21/250
 - 27s - loss: 1.3387 - acc: 0.7669 - val_loss: 1.1798 - val_acc: 0.8017
Epoch 22/250
 - 26s - loss: 1.2430 - acc: 0.7759 - val_loss: 1.1332 - val_acc: 0.8053
Epoch 23/250
 - 26s - loss: 1.2199 - acc: 0.7757 - val_loss: 1.1164 - val_acc: 0.8076
Epoch 24/250
 - 26s - loss: 1.2170 - acc: 0.7747 - val_loss: 1.2335 - val_acc: 0.7720
Epoch 25/250
 - 26s - loss: 1.2014 - acc: 0.7827 - val_loss: 1.1221 - val_acc: 0.8073
Epoch 26/250
 - 26s - loss: 1.2125 - acc: 0.7801 - val_loss: 1.1337 - val_acc: 0.8107
Epoch 27/250
 - 26s - loss: 1.2075 - acc: 0.7859 - val_loss: 1.3345 - val_acc: 0.7494
Epoch 28/250
 - 26s - loss: 1.2113 - acc: 0.7860 - val_loss: 1.0902 - val_acc: 0.8245
Epoch 29/250
 - 26s - loss: 1.2193 - acc: 0.7895 - val_loss: 1.2040 - val_acc: 0.7898
Epoch 30/250
 - 26s - loss: 1.2219 - acc: 0.7897 - val_loss: 1.1523 - val_acc: 0.8075
Epoch 31/250
 - 26s - loss: 1.2264 - acc: 0.7921 - val_loss: 1.1140 - val_acc: 0.8289
Epoch 32/250
 - 26s - loss: 1.2302 - acc: 0.7915 - val_loss: 1.1519 - val_acc: 0.8213
Epoch 33/250
 - 26s - loss: 1.2333 - acc: 0.7936 - val_loss: 1.2256 - val_acc: 0.7942
Epoch 34/250
 - 26s - loss: 1.2299 - acc: 0.7962 - val_loss: 1.2050 - val_acc: 0.8071
Epoch 35/250
 - 26s - loss: 1.2319 - acc: 0.7961 - val_loss: 1.1674 - val_acc: 0.8164
Epoch 36/250
 - 26s - loss: 1.2352 - acc: 0.7979 - val_loss: 1.2697 - val_acc: 0.7917
Epoch 37/250
 - 26s - loss: 1.2325 - acc: 0.7996 - val_loss: 1.1997 - val_acc: 0.8044
Epoch 38/250
 - 26s - loss: 1.2316 - acc: 0.8006 - val_loss: 1.3241 - val_acc: 0.7739
Epoch 39/250
 - 26s - loss: 1.2484 - acc: 0.7980 - val_loss: 1.2515 - val_acc: 0.7996
Epoch 40/250
 - 26s - loss: 1.2393 - acc: 0.7986 - val_loss: 1.2109 - val_acc: 0.8139
Epoch 41/250
 - 26s - loss: 1.1157 - acc: 0.8336 - val_loss: 0.9886 - val_acc: 0.8619
Epoch 42/250
 - 26s - loss: 1.0401 - acc: 0.8434 - val_loss: 0.9573 - val_acc: 0.8616
Epoch 43/250
 - 26s - loss: 1.0015 - acc: 0.8440 - val_loss: 0.9486 - val_acc: 0.8586
Epoch 44/250
```

Machine Learning Project Report

```
 - 26s - loss: 0.9900 - acc: 0.8423 - val_loss: 0.9344 - val_acc: 0.8599
Epoch 45/250
 - 26s - loss: 0.9716 - acc: 0.8453 - val_loss: 0.9060 - val_acc: 0.8627
Epoch 46/250
 - 26s - loss: 0.9686 - acc: 0.8424 - val_loss: 0.9383 - val_acc: 0.8555
Epoch 47/250
 - 26s - loss: 0.9704 - acc: 0.8420 - val_loss: 1.0192 - val_acc: 0.8267
Epoch 48/250
 - 27s - loss: 0.9670 - acc: 0.8406 - val_loss: 0.9301 - val_acc: 0.8570
Epoch 49/250
 - 26s - loss: 0.9607 - acc: 0.8439 - val_loss: 0.9553 - val_acc: 0.8505
Epoch 50/250
 - 26s - loss: 0.9667 - acc: 0.8451 - val_loss: 0.9154 - val_acc: 0.8599
Epoch 51/250
 - 26s - loss: 0.9719 - acc: 0.8429 - val_loss: 0.9046 - val_acc: 0.8654
Epoch 52/250
 - 26s - loss: 0.9627 - acc: 0.8474 - val_loss: 0.9515 - val_acc: 0.8478
Epoch 53/250
 - 26s - loss: 0.9765 - acc: 0.8415 - val_loss: 0.9314 - val_acc: 0.8606
Epoch 54/250
 - 26s - loss: 0.9711 - acc: 0.8463 - val_loss: 0.9683 - val_acc: 0.8473
Epoch 55/250
 - 26s - loss: 0.9656 - acc: 0.8481 - val_loss: 0.9260 - val_acc: 0.8636
Epoch 56/250
 - 26s - loss: 0.9782 - acc: 0.8457 - val_loss: 1.0713 - val_acc: 0.8203
Epoch 57/250
 - 26s - loss: 0.9768 - acc: 0.8472 - val_loss: 0.9433 - val_acc: 0.8618
Epoch 58/250
 - 26s - loss: 0.9708 - acc: 0.8502 - val_loss: 0.9161 - val_acc: 0.8663
Epoch 59/250
 - 26s - loss: 0.9766 - acc: 0.8516 - val_loss: 0.9366 - val_acc: 0.8618
Epoch 60/250
 - 26s - loss: 0.9737 - acc: 0.8495 - val_loss: 0.9541 - val_acc: 0.8545
Epoch 61/250
 - 26s - loss: 0.8840 - acc: 0.8747 - val_loss: 0.8103 - val_acc: 0.8949
Epoch 62/250
 - 26s - loss: 0.8353 - acc: 0.8841 - val_loss: 0.8033 - val_acc: 0.8909
Epoch 63/250
 - 26s - loss: 0.8157 - acc: 0.8828 - val_loss: 0.7751 - val_acc: 0.8915
Epoch 64/250
 - 26s - loss: 0.7914 - acc: 0.8866 - val_loss: 0.8417 - val_acc: 0.8669
Epoch 65/250
 - 26s - loss: 0.7836 - acc: 0.8851 - val_loss: 0.7633 - val_acc: 0.8927
Epoch 66/250
 - 26s - loss: 0.7726 - acc: 0.8850 - val_loss: 0.7650 - val_acc: 0.8898
Epoch 67/250
 - 26s - loss: 0.7679 - acc: 0.8854 - val_loss: 0.7404 - val_acc: 0.8919
Epoch 68/250
 - 26s - loss: 0.7622 - acc: 0.8839 - val_loss: 0.7063 - val_acc: 0.9002
Epoch 69/250
 - 26s - loss: 0.7564 - acc: 0.8853 - val_loss: 0.7528 - val_acc: 0.8868
Epoch 70/250
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 - 26s - loss: 0.7533 - acc: 0.8842 - val_loss: 0.7876 - val_acc: 0.8793
Epoch 71/250
 - 26s - loss: 0.7518 - acc: 0.8841 - val_loss: 0.7208 - val_acc: 0.8962
Epoch 72/250
 - 26s - loss: 0.7549 - acc: 0.8834 - val_loss: 0.7602 - val_acc: 0.8821
Epoch 73/250
 - 26s - loss: 0.7470 - acc: 0.8849 - val_loss: 0.7281 - val_acc: 0.8913
Epoch 74/250
 - 26s - loss: 0.7501 - acc: 0.8847 - val_loss: 0.7463 - val_acc: 0.8854
Epoch 75/250
 - 26s - loss: 0.7521 - acc: 0.8853 - val_loss: 0.7446 - val_acc: 0.8905
Epoch 76/250
 - 26s - loss: 0.7499 - acc: 0.8836 - val_loss: 0.7261 - val_acc: 0.8946
Epoch 77/250
 - 26s - loss: 0.7513 - acc: 0.8842 - val_loss: 0.7320 - val_acc: 0.8907
Epoch 78/250
 - 26s - loss: 0.7417 - acc: 0.8888 - val_loss: 0.7554 - val_acc: 0.8899
Epoch 79/250
 - 26s - loss: 0.7454 - acc: 0.8872 - val_loss: 0.7454 - val_acc: 0.8896
Epoch 80/250
 - 26s - loss: 0.7472 - acc: 0.8857 - val_loss: 0.7414 - val_acc: 0.8911
Epoch 81/250
 - 26s - loss: 0.6916 - acc: 0.9028 - val_loss: 0.6760 - val_acc: 0.9094
Epoch 82/250
 - 26s - loss: 0.6534 - acc: 0.9129 - val_loss: 0.6549 - val_acc: 0.9113
Epoch 83/250
 - 26s - loss: 0.6351 - acc: 0.9159 - val_loss: 0.6543 - val_acc: 0.9103
Epoch 84/250
 - 26s - loss: 0.6276 - acc: 0.9162 - val_loss: 0.6619 - val_acc: 0.9070
Epoch 85/250
 - 26s - loss: 0.6126 - acc: 0.9171 - val_loss: 0.6453 - val_acc: 0.9106
Epoch 86/250
 - 26s - loss: 0.6166 - acc: 0.9150 - val_loss: 0.6259 - val_acc: 0.9149
Epoch 87/250
 - 26s - loss: 0.6057 - acc: 0.9169 - val_loss: 0.6698 - val_acc: 0.8995
Epoch 88/250
 - 25s - loss: 0.5998 - acc: 0.9164 - val_loss: 0.6395 - val_acc: 0.9073
Epoch 89/250
 - 26s - loss: 0.5921 - acc: 0.9175 - val_loss: 0.6370 - val_acc: 0.9021
Epoch 90/250
 - 26s - loss: 0.5936 - acc: 0.9165 - val_loss: 0.6307 - val_acc: 0.9075
Epoch 91/250
 - 26s - loss: 0.5875 - acc: 0.9186 - val_loss: 0.6376 - val_acc: 0.9033
Epoch 92/250
 - 26s - loss: 0.5807 - acc: 0.9177 - val_loss: 0.6141 - val_acc: 0.9131
Epoch 93/250
 - 26s - loss: 0.5762 - acc: 0.9191 - val_loss: 0.6566 - val_acc: 0.9023
Epoch 94/250
 - 26s - loss: 0.5692 - acc: 0.9214 - val_loss: 0.6255 - val_acc: 0.9070
Epoch 95/250
 - 26s - loss: 0.5778 - acc: 0.9176 - val_loss: 0.5972 - val_acc: 0.9147
Epoch 96/250
```

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 - 26s - loss: 0.5755 - acc: 0.9164 - val_loss: 0.6188 - val_acc: 0.9069
Epoch 97/250
 - 26s - loss: 0.5769 - acc: 0.9150 - val_loss: 0.6653 - val_acc: 0.8957
Epoch 98/250
 - 26s - loss: 0.5716 - acc: 0.9177 - val_loss: 0.6448 - val_acc: 0.9003
Epoch 99/250
 - 26s - loss: 0.5717 - acc: 0.9178 - val_loss: 0.6104 - val_acc: 0.9102
Epoch 100/250
 - 26s - loss: 0.5681 - acc: 0.9169 - val_loss: 0.6218 - val_acc: 0.9035
Epoch 101/250
 - 26s - loss: 0.5340 - acc: 0.9287 - val_loss: 0.6074 - val_acc: 0.9098
Epoch 102/250
 - 26s - loss: 0.5060 - acc: 0.9377 - val_loss: 0.5766 - val_acc: 0.9188
Epoch 103/250
 - 26s - loss: 0.4995 - acc: 0.9377 - val_loss: 0.5781 - val_acc: 0.9185
Epoch 104/250
 - 26s - loss: 0.4929 - acc: 0.9390 - val_loss: 0.5655 - val_acc: 0.9209
Epoch 105/250
 - 26s - loss: 0.4867 - acc: 0.9402 - val_loss: 0.5773 - val_acc: 0.9163
Epoch 106/250
 - 26s - loss: 0.4805 - acc: 0.9387 - val_loss: 0.5697 - val_acc: 0.9177
Epoch 107/250
 - 26s - loss: 0.4763 - acc: 0.9409 - val_loss: 0.5657 - val_acc: 0.9176
Epoch 108/250
 - 26s - loss: 0.4736 - acc: 0.9396 - val_loss: 0.5695 - val_acc: 0.9180
Epoch 109/250
 - 26s - loss: 0.4666 - acc: 0.9428 - val_loss: 0.5516 - val_acc: 0.9192
Epoch 110/250
 - 26s - loss: 0.4623 - acc: 0.9428 - val_loss: 0.5606 - val_acc: 0.9170
Epoch 111/250
 - 26s - loss: 0.4584 - acc: 0.9435 - val_loss: 0.5482 - val_acc: 0.9231
Epoch 112/250
 - 26s - loss: 0.4586 - acc: 0.9423 - val_loss: 0.5682 - val_acc: 0.9157
Epoch 113/250
 - 26s - loss: 0.4494 - acc: 0.9452 - val_loss: 0.5403 - val_acc: 0.9234
Epoch 114/250
 - 26s - loss: 0.4478 - acc: 0.9439 - val_loss: 0.5379 - val_acc: 0.9236
Epoch 115/250
 - 26s - loss: 0.4459 - acc: 0.9440 - val_loss: 0.5756 - val_acc: 0.9123
Epoch 116/250
 - 26s - loss: 0.4459 - acc: 0.9435 - val_loss: 0.5547 - val_acc: 0.9160
Epoch 117/250
 - 26s - loss: 0.4441 - acc: 0.9428 - val_loss: 0.5339 - val_acc: 0.9215
Epoch 118/250
 - 26s - loss: 0.4402 - acc: 0.9452 - val_loss: 0.5268 - val_acc: 0.9238
Epoch 119/250
 - 26s - loss: 0.4357 - acc: 0.9444 - val_loss: 0.5484 - val_acc: 0.9199
Epoch 120/250
 - 26s - loss: 0.4397 - acc: 0.9430 - val_loss: 0.5544 - val_acc: 0.9166
Epoch 121/250
 - 26s - loss: 0.4164 - acc: 0.9501 - val_loss: 0.5400 - val_acc: 0.9182
Epoch 122/250
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 - 26s - loss: 0.4009 - acc: 0.9545 - val_loss: 0.5308 - val_acc: 0.9226
Epoch 123/250
 - 26s - loss: 0.3954 - acc: 0.9562 - val_loss: 0.5214 - val_acc: 0.9256
Epoch 124/250
 - 26s - loss: 0.3903 - acc: 0.9556 - val_loss: 0.5198 - val_acc: 0.9278
Epoch 125/250
 - 25s - loss: 0.3876 - acc: 0.9572 - val_loss: 0.5141 - val_acc: 0.9265
Epoch 126/250
 - 26s - loss: 0.3848 - acc: 0.9570 - val_loss: 0.5209 - val_acc: 0.9272
Epoch 127/250
 - 26s - loss: 0.3806 - acc: 0.9598 - val_loss: 0.5275 - val_acc: 0.9230
Epoch 128/250
 - 26s - loss: 0.3768 - acc: 0.9579 - val_loss: 0.5334 - val_acc: 0.9206
Epoch 129/250
 - 26s - loss: 0.3748 - acc: 0.9590 - val_loss: 0.5072 - val_acc: 0.9279
Epoch 130/250
 - 26s - loss: 0.3701 - acc: 0.9596 - val_loss: 0.5136 - val_acc: 0.9254
Epoch 131/250
 - 26s - loss: 0.3667 - acc: 0.9609 - val_loss: 0.5071 - val_acc: 0.9281
Epoch 132/250
 - 26s - loss: 0.3690 - acc: 0.9591 - val_loss: 0.5158 - val_acc: 0.9250
Epoch 133/250
 - 26s - loss: 0.3628 - acc: 0.9612 - val_loss: 0.5124 - val_acc: 0.9287
Epoch 134/250
 - 26s - loss: 0.3612 - acc: 0.9607 - val_loss: 0.5144 - val_acc: 0.9254
Epoch 135/250
 - 26s - loss: 0.3584 - acc: 0.9613 - val_loss: 0.5078 - val_acc: 0.9273
Epoch 136/250
 - 26s - loss: 0.3586 - acc: 0.9601 - val_loss: 0.5084 - val_acc: 0.9264
Epoch 137/250
 - 25s - loss: 0.3571 - acc: 0.9611 - val_loss: 0.4916 - val_acc: 0.9285
Epoch 138/250
 - 25s - loss: 0.3558 - acc: 0.9611 - val_loss: 0.5088 - val_acc: 0.9271
Epoch 139/250
 - 26s - loss: 0.3503 - acc: 0.9624 - val_loss: 0.5015 - val_acc: 0.9267
Epoch 140/250
 - 25s - loss: 0.3511 - acc: 0.9602 - val_loss: 0.4979 - val_acc: 0.9292
Epoch 141/250
 - 26s - loss: 0.3373 - acc: 0.9660 - val_loss: 0.5021 - val_acc: 0.9281
Epoch 142/250
 - 26s - loss: 0.3326 - acc: 0.9668 - val_loss: 0.4942 - val_acc: 0.9310
Epoch 143/250
 - 25s - loss: 0.3267 - acc: 0.9683 - val_loss: 0.4920 - val_acc: 0.9330
Epoch 144/250
 - 26s - loss: 0.3257 - acc: 0.9691 - val_loss: 0.4956 - val_acc: 0.9304
Epoch 145/250
 - 25s - loss: 0.3228 - acc: 0.9695 - val_loss: 0.5083 - val_acc: 0.9276
Epoch 146/250
 - 26s - loss: 0.3220 - acc: 0.9699 - val_loss: 0.4970 - val_acc: 0.9301
Epoch 147/250
 - 25s - loss: 0.3195 - acc: 0.9699 - val_loss: 0.5012 - val_acc: 0.9296
Epoch 148/250
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 - 25s - loss: 0.3184 - acc: 0.9698 - val_loss: 0.4989 - val_acc: 0.9283
Epoch 149/250
 - 26s - loss: 0.3179 - acc: 0.9691 - val_loss: 0.4889 - val_acc: 0.9291
Epoch 150/250
 - 25s - loss: 0.3139 - acc: 0.9706 - val_loss: 0.4979 - val_acc: 0.9274
Epoch 151/250
 - 26s - loss: 0.3108 - acc: 0.9708 - val_loss: 0.5048 - val_acc: 0.9269
Epoch 152/250
 - 26s - loss: 0.3095 - acc: 0.9715 - val_loss: 0.4918 - val_acc: 0.9310
Epoch 153/250
 - 26s - loss: 0.3094 - acc: 0.9709 - val_loss: 0.5001 - val_acc: 0.9284
Epoch 154/250
 - 25s - loss: 0.3042 - acc: 0.9724 - val_loss: 0.4878 - val_acc: 0.9293
Epoch 155/250
 - 26s - loss: 0.3078 - acc: 0.9706 - val_loss: 0.4882 - val_acc: 0.9317
Epoch 156/250
 - 26s - loss: 0.3078 - acc: 0.9712 - val_loss: 0.4879 - val_acc: 0.9307
Epoch 157/250
 - 26s - loss: 0.3078 - acc: 0.9710 - val_loss: 0.4811 - val_acc: 0.9322
Epoch 158/250
 - 26s - loss: 0.3005 - acc: 0.9720 - val_loss: 0.4889 - val_acc: 0.9299
Epoch 159/250
 - 26s - loss: 0.3000 - acc: 0.9719 - val_loss: 0.4740 - val_acc: 0.9344
Epoch 160/250
 - 26s - loss: 0.2971 - acc: 0.9725 - val_loss: 0.4790 - val_acc: 0.9317
Epoch 161/250
 - 26s - loss: 0.2930 - acc: 0.9739 - val_loss: 0.4819 - val_acc: 0.9330
Epoch 162/250
 - 26s - loss: 0.2915 - acc: 0.9739 - val_loss: 0.4751 - val_acc: 0.9341
Epoch 163/250
 - 26s - loss: 0.2895 - acc: 0.9752 - val_loss: 0.4809 - val_acc: 0.9325
Epoch 164/250
 - 26s - loss: 0.2848 - acc: 0.9768 - val_loss: 0.4778 - val_acc: 0.9335
Epoch 165/250
 - 26s - loss: 0.2857 - acc: 0.9758 - val_loss: 0.4805 - val_acc: 0.9331
Epoch 166/250
 - 26s - loss: 0.2845 - acc: 0.9766 - val_loss: 0.4818 - val_acc: 0.9335
Epoch 167/250
 - 26s - loss: 0.2812 - acc: 0.9779 - val_loss: 0.4763 - val_acc: 0.9350
Epoch 168/250
 - 25s - loss: 0.2799 - acc: 0.9777 - val_loss: 0.4867 - val_acc: 0.9312
Epoch 169/250
 - 26s - loss: 0.2845 - acc: 0.9754 - val_loss: 0.4861 - val_acc: 0.9318
Epoch 170/250
 - 26s - loss: 0.2824 - acc: 0.9757 - val_loss: 0.4772 - val_acc: 0.9332
Epoch 171/250
 - 25s - loss: 0.2783 - acc: 0.9775 - val_loss: 0.4743 - val_acc: 0.9324
Epoch 172/250
 - 26s - loss: 0.2775 - acc: 0.9767 - val_loss: 0.4778 - val_acc: 0.9323
Epoch 173/250
 - 25s - loss: 0.2787 - acc: 0.9767 - val_loss: 0.4816 - val_acc: 0.9309
Epoch 174/250
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 - 26s - loss: 0.2760 - acc: 0.9779 - val_loss: 0.4824 - val_acc: 0.9312
Epoch 175/250
 - 25s - loss: 0.2757 - acc: 0.9773 - val_loss: 0.4823 - val_acc: 0.9319
Epoch 176/250
 - 25s - loss: 0.2757 - acc: 0.9773 - val_loss: 0.4814 - val_acc: 0.9318
Epoch 177/250
 - 26s - loss: 0.2773 - acc: 0.9765 - val_loss: 0.4815 - val_acc: 0.9330
Epoch 178/250
 - 26s - loss: 0.2731 - acc: 0.9779 - val_loss: 0.4794 - val_acc: 0.9321
Epoch 179/250
 - 26s - loss: 0.2706 - acc: 0.9786 - val_loss: 0.4787 - val_acc: 0.9322
Epoch 180/250
 - 26s - loss: 0.2712 - acc: 0.9782 - val_loss: 0.4835 - val_acc: 0.9309
Epoch 181/250
 - 26s - loss: 0.2692 - acc: 0.9795 - val_loss: 0.4797 - val_acc: 0.9322
Epoch 182/250
 - 26s - loss: 0.2715 - acc: 0.9786 - val_loss: 0.4800 - val_acc: 0.9318
Epoch 183/250
 - 26s - loss: 0.2666 - acc: 0.9795 - val_loss: 0.4783 - val_acc: 0.9333
Epoch 184/250
 - 26s - loss: 0.2673 - acc: 0.9794 - val_loss: 0.4770 - val_acc: 0.9325
Epoch 185/250
 - 26s - loss: 0.2629 - acc: 0.9810 - val_loss: 0.4771 - val_acc: 0.9334
Epoch 186/250
 - 26s - loss: 0.2693 - acc: 0.9784 - val_loss: 0.4766 - val_acc: 0.9335
Epoch 187/250
 - 26s - loss: 0.2629 - acc: 0.9807 - val_loss: 0.4762 - val_acc: 0.9334
Epoch 188/250
 - 26s - loss: 0.2667 - acc: 0.9799 - val_loss: 0.4785 - val_acc: 0.9329
Epoch 189/250
 - 26s - loss: 0.2617 - acc: 0.9808 - val_loss: 0.4751 - val_acc: 0.9321
Epoch 190/250
 - 26s - loss: 0.2655 - acc: 0.9789 - val_loss: 0.4757 - val_acc: 0.9320
Epoch 191/250
 - 26s - loss: 0.2616 - acc: 0.9803 - val_loss: 0.4793 - val_acc: 0.9324
Epoch 192/250
 - 25s - loss: 0.2632 - acc: 0.9802 - val_loss: 0.4782 - val_acc: 0.9333
Epoch 193/250
 - 26s - loss: 0.2624 - acc: 0.9805 - val_loss: 0.4781 - val_acc: 0.9320
Epoch 194/250
 - 26s - loss: 0.2588 - acc: 0.9811 - val_loss: 0.4754 - val_acc: 0.9337
Epoch 195/250
 - 26s - loss: 0.2623 - acc: 0.9799 - val_loss: 0.4716 - val_acc: 0.9336
Epoch 196/250
 - 26s - loss: 0.2616 - acc: 0.9798 - val_loss: 0.4738 - val_acc: 0.9334
Epoch 197/250
 - 25s - loss: 0.2618 - acc: 0.9802 - val_loss: 0.4746 - val_acc: 0.9334
Epoch 198/250
 - 26s - loss: 0.2592 - acc: 0.9810 - val_loss: 0.4781 - val_acc: 0.9319
Epoch 199/250
 - 26s - loss: 0.2568 - acc: 0.9817 - val_loss: 0.4780 - val_acc: 0.9318
Epoch 200/250
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 - 26s - loss: 0.2614 - acc: 0.9800 - val_loss: 0.4802 - val_acc: 0.9320
Epoch 201/250
 - 25s - loss: 0.2575 - acc: 0.9814 - val_loss: 0.4789 - val_acc: 0.9325
Epoch 202/250
 - 26s - loss: 0.2560 - acc: 0.9818 - val_loss: 0.4760 - val_acc: 0.9318
Epoch 203/250
 - 25s - loss: 0.2551 - acc: 0.9816 - val_loss: 0.4750 - val_acc: 0.9333
Epoch 204/250
 - 26s - loss: 0.2553 - acc: 0.9822 - val_loss: 0.4739 - val_acc: 0.9333
Epoch 205/250
 - 26s - loss: 0.2577 - acc: 0.9809 - val_loss: 0.4752 - val_acc: 0.9326
Epoch 206/250
 - 25s - loss: 0.2551 - acc: 0.9812 - val_loss: 0.4726 - val_acc: 0.9340
Epoch 207/250
 - 26s - loss: 0.2559 - acc: 0.9818 - val_loss: 0.4736 - val_acc: 0.9327
Epoch 208/250
 - 26s - loss: 0.2550 - acc: 0.9809 - val_loss: 0.4754 - val_acc: 0.9318
Epoch 209/250
 - 26s - loss: 0.2528 - acc: 0.9825 - val_loss: 0.4747 - val_acc: 0.9330
Epoch 210/250
 - 26s - loss: 0.2555 - acc: 0.9814 - val_loss: 0.4726 - val_acc: 0.9330
Epoch 211/250
 - 26s - loss: 0.2537 - acc: 0.9813 - val_loss: 0.4722 - val_acc: 0.9333
Epoch 212/250
 - 26s - loss: 0.2539 - acc: 0.9819 - val_loss: 0.4745 - val_acc: 0.9330
Epoch 213/250
 - 25s - loss: 0.2525 - acc: 0.9822 - val_loss: 0.4732 - val_acc: 0.9329
Epoch 214/250
 - 26s - loss: 0.2531 - acc: 0.9815 - val_loss: 0.4739 - val_acc: 0.9329
Epoch 215/250
 - 26s - loss: 0.2503 - acc: 0.9826 - val_loss: 0.4736 - val_acc: 0.9333
Epoch 216/250
 - 26s - loss: 0.2517 - acc: 0.9820 - val_loss: 0.4738 - val_acc: 0.9331
Epoch 217/250
 - 26s - loss: 0.2521 - acc: 0.9821 - val_loss: 0.4726 - val_acc: 0.9329
Epoch 218/250
 - 26s - loss: 0.2535 - acc: 0.9815 - val_loss: 0.4741 - val_acc: 0.9333
Epoch 219/250
 - 26s - loss: 0.2519 - acc: 0.9820 - val_loss: 0.4740 - val_acc: 0.9330
Epoch 220/250
 - 26s - loss: 0.2521 - acc: 0.9824 - val_loss: 0.4780 - val_acc: 0.9318
Epoch 221/250
 - 26s - loss: 0.2512 - acc: 0.9826 - val_loss: 0.4780 - val_acc: 0.9317
Epoch 222/250
 - 26s - loss: 0.2541 - acc: 0.9809 - val_loss: 0.4776 - val_acc: 0.9315
Epoch 223/250
 - 26s - loss: 0.2491 - acc: 0.9834 - val_loss: 0.4756 - val_acc: 0.9323
Epoch 224/250
 - 26s - loss: 0.2488 - acc: 0.9835 - val_loss: 0.4765 - val_acc: 0.9326
Epoch 225/250
 - 26s - loss: 0.2538 - acc: 0.9810 - val_loss: 0.4763 - val_acc: 0.9332
Epoch 226/250
```

Machine Learning Project Report

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 - 26s - loss: 0.2484 - acc: 0.9832 - val_loss: 0.4757 - val_acc: 0.9328
Epoch 227/250
 - 26s - loss: 0.2482 - acc: 0.9832 - val_loss: 0.4736 - val_acc: 0.9333
Epoch 228/250
 - 26s - loss: 0.2509 - acc: 0.9826 - val_loss: 0.4726 - val_acc: 0.9329
Epoch 229/250
 - 26s - loss: 0.2515 - acc: 0.9818 - val_loss: 0.4748 - val_acc: 0.9326
Epoch 230/250
 - 26s - loss: 0.2500 - acc: 0.9826 - val_loss: 0.4751 - val_acc: 0.9327
Epoch 231/250
 - 25s - loss: 0.2505 - acc: 0.9821 - val_loss: 0.4728 - val_acc: 0.9334
Epoch 232/250
 - 26s - loss: 0.2505 - acc: 0.9828 - val_loss: 0.4746 - val_acc: 0.9339
Epoch 233/250
 - 26s - loss: 0.2492 - acc: 0.9827 - val_loss: 0.4743 - val_acc: 0.9338
Epoch 234/250
 - 26s - loss: 0.2497 - acc: 0.9832 - val_loss: 0.4725 - val_acc: 0.9342
Epoch 235/250
 - 25s - loss: 0.2479 - acc: 0.9830 - val_loss: 0.4741 - val_acc: 0.9332
Epoch 236/250
 - 26s - loss: 0.2498 - acc: 0.9827 - val_loss: 0.4740 - val_acc: 0.9327
Epoch 237/250
 - 26s - loss: 0.2484 - acc: 0.9830 - val_loss: 0.4755 - val_acc: 0.9333
Epoch 238/250
 - 26s - loss: 0.2492 - acc: 0.9825 - val_loss: 0.4746 - val_acc: 0.9331
Epoch 239/250
 - 26s - loss: 0.2478 - acc: 0.9837 - val_loss: 0.4751 - val_acc: 0.9323
Epoch 240/250
 - 26s - loss: 0.2483 - acc: 0.9822 - val_loss: 0.4748 - val_acc: 0.9338
Epoch 241/250
 - 25s - loss: 0.2462 - acc: 0.9833 - val_loss: 0.4755 - val_acc: 0.9337
Epoch 242/250
 - 26s - loss: 0.2503 - acc: 0.9821 - val_loss: 0.4744 - val_acc: 0.9331
Epoch 243/250
 - 26s - loss: 0.2448 - acc: 0.9839 - val_loss: 0.4749 - val_acc: 0.9330
Epoch 244/250
 - 25s - loss: 0.2497 - acc: 0.9825 - val_loss: 0.4748 - val_acc: 0.9334
Epoch 245/250
 - 26s - loss: 0.2490 - acc: 0.9832 - val_loss: 0.4741 - val_acc: 0.9339
Epoch 246/250
 - 26s - loss: 0.2478 - acc: 0.9830 - val_loss: 0.4749 - val_acc: 0.9336
Epoch 247/250
 - 26s - loss: 0.2507 - acc: 0.9821 - val_loss: 0.4748 - val_acc: 0.9341
Epoch 248/250
 - 26s - loss: 0.2467 - acc: 0.9831 - val_loss: 0.4733 - val_acc: 0.9335
Epoch 249/250
 - 26s - loss: 0.2440 - acc: 0.9844 - val_loss: 0.4730 - val_acc: 0.9341
Epoch 250/250
 - 26s - loss: 0.2469 - acc: 0.9841 - val_loss: 0.4756 - val_acc: 0.9339
Training Time:  6461.9510769844055
Accuracy:  93.39 %
```

Machine Learning Project Report

Third Run

```
Epoch 1/250
 - 31s - loss: 21.9502 - acc: 0.2262 - val_loss: 24.6493 - val_acc: 0.0951
Epoch 2/250
 - 27s - loss: 11.4498 - acc: 0.3245 - val_loss: 10.7797 - val_acc: 0.1102
Epoch 3/250
 - 27s - loss: 6.5736 - acc: 0.3558 - val_loss: 18.1988 - val_acc: 0.1023
Epoch 4/250
 - 27s - loss: 5.3329 - acc: 0.2797 - val_loss: 4.5784 - val_acc: 0.2320
Epoch 5/250
 - 26s - loss: 4.2790 - acc: 0.2733 - val_loss: 4.6100 - val_acc: 0.1474
Epoch 6/250
 - 26s - loss: 3.2948 - acc: 0.3369 - val_loss: 3.1202 - val_acc: 0.2552
Epoch 7/250
 - 27s - loss: 2.3483 - acc: 0.4322 - val_loss: 2.1629 - val_acc: 0.4201
Epoch 8/250
 - 26s - loss: 1.9024 - acc: 0.5010 - val_loss: 1.8787 - val_acc: 0.4677
Epoch 9/250
 - 27s - loss: 1.7048 - acc: 0.5511 - val_loss: 1.7039 - val_acc: 0.5599
Epoch 10/250
 - 26s - loss: 1.6062 - acc: 0.5883 - val_loss: 1.4815 - val_acc: 0.6374
Epoch 11/250
 - 26s - loss: 1.5467 - acc: 0.6235 - val_loss: 1.4711 - val_acc: 0.6394
Epoch 12/250
 - 26s - loss: 1.4935 - acc: 0.6551 - val_loss: 1.6533 - val_acc: 0.6205
Epoch 13/250
 - 26s - loss: 1.4751 - acc: 0.6752 - val_loss: 1.4192 - val_acc: 0.6989
Epoch 14/250
 - 26s - loss: 1.4693 - acc: 0.6867 - val_loss: 1.6493 - val_acc: 0.6345
Epoch 15/250
 - 26s - loss: 1.4591 - acc: 0.6997 - val_loss: 1.4682 - val_acc: 0.6948
Epoch 16/250
 - 27s - loss: 1.4573 - acc: 0.7063 - val_loss: 1.4564 - val_acc: 0.7139
Epoch 17/250
 - 26s - loss: 1.4622 - acc: 0.7141 - val_loss: 1.4293 - val_acc: 0.7227
Epoch 18/250
 - 26s - loss: 1.4641 - acc: 0.7179 - val_loss: 1.4165 - val_acc: 0.7321
Epoch 19/250
 - 26s - loss: 1.4757 - acc: 0.7219 - val_loss: 1.6612 - val_acc: 0.6853
Epoch 20/250
 - 26s - loss: 1.4755 - acc: 0.7274 - val_loss: 1.4602 - val_acc: 0.7316
Epoch 21/250
 - 26s - loss: 1.3157 - acc: 0.7658 - val_loss: 1.1901 - val_acc: 0.7829
Epoch 22/250
 - 26s - loss: 1.2159 - acc: 0.7765 - val_loss: 1.1474 - val_acc: 0.7971
Epoch 23/250
 - 26s - loss: 1.1991 - acc: 0.7766 - val_loss: 1.1631 - val_acc: 0.7841
Epoch 24/250
 - 26s - loss: 1.1872 - acc: 0.7771 - val_loss: 1.0820 - val_acc: 0.8136
Epoch 25/250
```

Machine Learning Project Report

```
 - 26s - loss: 1.1886 - acc: 0.7782 - val_loss: 1.1479 - val_acc: 0.7958
Epoch 26/250
 - 26s - loss: 1.1877 - acc: 0.7813 - val_loss: 1.2066 - val_acc: 0.7766
Epoch 27/250
 - 26s - loss: 1.1925 - acc: 0.7854 - val_loss: 1.1859 - val_acc: 0.7888
Epoch 28/250
 - 26s - loss: 1.1938 - acc: 0.7870 - val_loss: 1.1842 - val_acc: 0.7909
Epoch 29/250
 - 26s - loss: 1.1972 - acc: 0.7896 - val_loss: 1.0930 - val_acc: 0.8227
Epoch 30/250
 - 26s - loss: 1.2036 - acc: 0.7893 - val_loss: 1.1792 - val_acc: 0.8000
Epoch 31/250
 - 26s - loss: 1.2029 - acc: 0.7925 - val_loss: 1.1930 - val_acc: 0.7982
Epoch 32/250
 - 26s - loss: 1.2071 - acc: 0.7922 - val_loss: 1.1346 - val_acc: 0.8185
Epoch 33/250
 - 26s - loss: 1.2075 - acc: 0.7950 - val_loss: 1.2183 - val_acc: 0.7907
Epoch 34/250
 - 26s - loss: 1.2136 - acc: 0.7939 - val_loss: 1.1572 - val_acc: 0.8140
Epoch 35/250
 - 26s - loss: 1.2058 - acc: 0.7994 - val_loss: 1.1263 - val_acc: 0.8224
Epoch 36/250
 - 26s - loss: 1.2163 - acc: 0.7957 - val_loss: 1.1311 - val_acc: 0.8267
Epoch 37/250
 - 26s - loss: 1.2169 - acc: 0.7999 - val_loss: 1.1166 - val_acc: 0.8332
Epoch 38/250
 - 26s - loss: 1.2242 - acc: 0.7986 - val_loss: 1.1439 - val_acc: 0.8246
Epoch 39/250
 - 26s - loss: 1.2172 - acc: 0.8029 - val_loss: 1.1134 - val_acc: 0.8355
Epoch 40/250
 - 26s - loss: 1.2181 - acc: 0.8017 - val_loss: 1.1796 - val_acc: 0.8109
Epoch 41/250
 - 26s - loss: 1.0991 - acc: 0.8307 - val_loss: 0.9634 - val_acc: 0.8690
Epoch 42/250
 - 26s - loss: 1.0205 - acc: 0.8417 - val_loss: 0.9860 - val_acc: 0.8466
Epoch 43/250
 - 26s - loss: 0.9932 - acc: 0.8432 - val_loss: 0.9213 - val_acc: 0.8605
Epoch 44/250
 - 26s - loss: 0.9761 - acc: 0.8407 - val_loss: 0.9348 - val_acc: 0.8510
Epoch 45/250
 - 26s - loss: 0.9658 - acc: 0.8406 - val_loss: 0.9890 - val_acc: 0.8326
Epoch 46/250
 - 26s - loss: 0.9614 - acc: 0.8424 - val_loss: 0.8941 - val_acc: 0.8578
Epoch 47/250
 - 26s - loss: 0.9559 - acc: 0.8443 - val_loss: 0.9385 - val_acc: 0.8482
Epoch 48/250
 - 26s - loss: 0.9570 - acc: 0.8441 - val_loss: 0.9702 - val_acc: 0.8452
Epoch 49/250
 - 26s - loss: 0.9452 - acc: 0.8446 - val_loss: 0.9311 - val_acc: 0.8490
Epoch 50/250
 - 26s - loss: 0.9513 - acc: 0.8436 - val_loss: 0.9148 - val_acc: 0.8550
Epoch 51/250
```

Machine Learning Project Report

```
 - 26s - loss: 0.9561 - acc: 0.8442 - val_loss: 0.9155 - val_acc: 0.8574
Epoch 52/250
 - 26s - loss: 0.9556 - acc: 0.8446 - val_loss: 0.9564 - val_acc: 0.8438
Epoch 53/250
 - 26s - loss: 0.9588 - acc: 0.8438 - val_loss: 0.8678 - val_acc: 0.8723
Epoch 54/250
 - 26s - loss: 0.9589 - acc: 0.8454 - val_loss: 0.9817 - val_acc: 0.8374
Epoch 55/250
 - 26s - loss: 0.9590 - acc: 0.8466 - val_loss: 0.9094 - val_acc: 0.8619
Epoch 56/250
 - 26s - loss: 0.9592 - acc: 0.8472 - val_loss: 0.9251 - val_acc: 0.8592
Epoch 57/250
 - 26s - loss: 0.9626 - acc: 0.8481 - val_loss: 0.9012 - val_acc: 0.8669
Epoch 58/250
 - 26s - loss: 0.9597 - acc: 0.8478 - val_loss: 0.8887 - val_acc: 0.8699
Epoch 59/250
 - 26s - loss: 0.9560 - acc: 0.8523 - val_loss: 0.9056 - val_acc: 0.8677
Epoch 60/250
 - 26s - loss: 0.9598 - acc: 0.8492 - val_loss: 0.9048 - val_acc: 0.8687
Epoch 61/250
 - 26s - loss: 0.8739 - acc: 0.8751 - val_loss: 0.8284 - val_acc: 0.8850
Epoch 62/250
 - 26s - loss: 0.8310 - acc: 0.8822 - val_loss: 0.8066 - val_acc: 0.8829
Epoch 63/250
 - 26s - loss: 0.8025 - acc: 0.8849 - val_loss: 0.7702 - val_acc: 0.8929
Epoch 64/250
 - 26s - loss: 0.7830 - acc: 0.8845 - val_loss: 0.7729 - val_acc: 0.8890
Epoch 65/250
 - 26s - loss: 0.7756 - acc: 0.8849 - val_loss: 0.7411 - val_acc: 0.8935
Epoch 66/250
 - 26s - loss: 0.7595 - acc: 0.8860 - val_loss: 0.7638 - val_acc: 0.8868
Epoch 67/250
 - 26s - loss: 0.7591 - acc: 0.8839 - val_loss: 0.7345 - val_acc: 0.8933
Epoch 68/250
 - 26s - loss: 0.7485 - acc: 0.8879 - val_loss: 0.7308 - val_acc: 0.8892
Epoch 69/250
 - 26s - loss: 0.7517 - acc: 0.8845 - val_loss: 0.7407 - val_acc: 0.8885
Epoch 70/250
 - 26s - loss: 0.7443 - acc: 0.8846 - val_loss: 0.7480 - val_acc: 0.8860
Epoch 71/250
 - 26s - loss: 0.7345 - acc: 0.8873 - val_loss: 0.7673 - val_acc: 0.8779
Epoch 72/250
 - 26s - loss: 0.7430 - acc: 0.8860 - val_loss: 0.7799 - val_acc: 0.8739
Epoch 73/250
 - 26s - loss: 0.7358 - acc: 0.8873 - val_loss: 0.7470 - val_acc: 0.8825
Epoch 74/250
 - 26s - loss: 0.7410 - acc: 0.8857 - val_loss: 0.7092 - val_acc: 0.8940
Epoch 75/250
 - 26s - loss: 0.7389 - acc: 0.8866 - val_loss: 0.7369 - val_acc: 0.8905
Epoch 76/250
 - 26s - loss: 0.7382 - acc: 0.8867 - val_loss: 0.7498 - val_acc: 0.8844
Epoch 77/250
```

```
 - 26s - loss: 0.7419 - acc: 0.8864 - val_loss: 0.7584 - val_acc: 0.8821
Epoch 78/250
 - 26s - loss: 0.7332 - acc: 0.8890 - val_loss: 0.7181 - val_acc: 0.8953
Epoch 79/250
 - 26s - loss: 0.7356 - acc: 0.8889 - val_loss: 0.7487 - val_acc: 0.8846
Epoch 80/250
 - 26s - loss: 0.7384 - acc: 0.8881 - val_loss: 0.7537 - val_acc: 0.8851
Epoch 81/250
 - 26s - loss: 0.6792 - acc: 0.9047 - val_loss: 0.6754 - val_acc: 0.9056
Epoch 82/250
 - 26s - loss: 0.6455 - acc: 0.9132 - val_loss: 0.6638 - val_acc: 0.9086
Epoch 83/250
 - 26s - loss: 0.6316 - acc: 0.9150 - val_loss: 0.6499 - val_acc: 0.9096
Epoch 84/250
 - 26s - loss: 0.6243 - acc: 0.9150 - val_loss: 0.6323 - val_acc: 0.9134
Epoch 85/250
 - 26s - loss: 0.6093 - acc: 0.9169 - val_loss: 0.6313 - val_acc: 0.9133
Epoch 86/250
 - 26s - loss: 0.6055 - acc: 0.9163 - val_loss: 0.6460 - val_acc: 0.9086
Epoch 87/250
 - 26s - loss: 0.6030 - acc: 0.9150 - val_loss: 0.6247 - val_acc: 0.9089
Epoch 88/250
 - 26s - loss: 0.5855 - acc: 0.9195 - val_loss: 0.6268 - val_acc: 0.9111
Epoch 89/250
 - 26s - loss: 0.5852 - acc: 0.9186 - val_loss: 0.6223 - val_acc: 0.9076
Epoch 90/250
 - 26s - loss: 0.5804 - acc: 0.9174 - val_loss: 0.6642 - val_acc: 0.8978
Epoch 91/250
 - 26s - loss: 0.5832 - acc: 0.9171 - val_loss: 0.6142 - val_acc: 0.9093
Epoch 92/250
 - 26s - loss: 0.5738 - acc: 0.9176 - val_loss: 0.6241 - val_acc: 0.9070
Epoch 93/250
 - 26s - loss: 0.5723 - acc: 0.9179 - val_loss: 0.6050 - val_acc: 0.9091
Epoch 94/250
 - 26s - loss: 0.5742 - acc: 0.9174 - val_loss: 0.6202 - val_acc: 0.9058
Epoch 95/250
 - 26s - loss: 0.5702 - acc: 0.9183 - val_loss: 0.6323 - val_acc: 0.9023
Epoch 96/250
 - 26s - loss: 0.5688 - acc: 0.9186 - val_loss: 0.6241 - val_acc: 0.9046
Epoch 97/250
 - 26s - loss: 0.5666 - acc: 0.9174 - val_loss: 0.5909 - val_acc: 0.9154
Epoch 98/250
 - 26s - loss: 0.5681 - acc: 0.9175 - val_loss: 0.6100 - val_acc: 0.9058
Epoch 99/250
 - 26s - loss: 0.5606 - acc: 0.9193 - val_loss: 0.6055 - val_acc: 0.9065
Epoch 100/250
 - 26s - loss: 0.5577 - acc: 0.9209 - val_loss: 0.6004 - val_acc: 0.9106
Epoch 101/250
 - 26s - loss: 0.5217 - acc: 0.9297 - val_loss: 0.5757 - val_acc: 0.9169
Epoch 102/250
 - 26s - loss: 0.5017 - acc: 0.9369 - val_loss: 0.5882 - val_acc: 0.9104
Epoch 103/250
```

Machine Learning Project Report

```
 - 26s - loss: 0.4963 - acc: 0.9373 - val_loss: 0.5784 - val_acc: 0.9124
Epoch 104/250
 - 26s - loss: 0.4829 - acc: 0.9406 - val_loss: 0.5842 - val_acc: 0.9151
Epoch 105/250
 - 26s - loss: 0.4776 - acc: 0.9394 - val_loss: 0.5693 - val_acc: 0.9154
Epoch 106/250
 - 26s - loss: 0.4728 - acc: 0.9421 - val_loss: 0.5490 - val_acc: 0.9232
Epoch 107/250
 - 26s - loss: 0.4682 - acc: 0.9411 - val_loss: 0.5459 - val_acc: 0.9204
Epoch 108/250
 - 26s - loss: 0.4622 - acc: 0.9423 - val_loss: 0.5458 - val_acc: 0.9204
Epoch 109/250
 - 26s - loss: 0.4637 - acc: 0.9417 - val_loss: 0.5413 - val_acc: 0.9196
Epoch 110/250
 - 26s - loss: 0.4598 - acc: 0.9415 - val_loss: 0.5578 - val_acc: 0.9139
Epoch 111/250
 - 27s - loss: 0.4526 - acc: 0.9438 - val_loss: 0.5497 - val_acc: 0.9196
Epoch 112/250
 - 26s - loss: 0.4453 - acc: 0.9452 - val_loss: 0.5519 - val_acc: 0.9150
Epoch 113/250
 - 26s - loss: 0.4492 - acc: 0.9426 - val_loss: 0.5556 - val_acc: 0.9141
Epoch 114/250
 - 26s - loss: 0.4477 - acc: 0.9405 - val_loss: 0.5426 - val_acc: 0.9184
Epoch 115/250
 - 26s - loss: 0.4418 - acc: 0.9424 - val_loss: 0.5350 - val_acc: 0.9190
Epoch 116/250
 - 26s - loss: 0.4414 - acc: 0.9432 - val_loss: 0.5468 - val_acc: 0.9162
Epoch 117/250
 - 26s - loss: 0.4427 - acc: 0.9414 - val_loss: 0.5426 - val_acc: 0.9155
Epoch 118/250
 - 26s - loss: 0.4344 - acc: 0.9438 - val_loss: 0.5377 - val_acc: 0.9180
Epoch 119/250
 - 26s - loss: 0.4280 - acc: 0.9441 - val_loss: 0.5402 - val_acc: 0.9172
Epoch 120/250
 - 26s - loss: 0.4319 - acc: 0.9447 - val_loss: 0.5374 - val_acc: 0.9182
Epoch 121/250
 - 26s - loss: 0.4080 - acc: 0.9504 - val_loss: 0.5124 - val_acc: 0.9256
Epoch 122/250
 - 26s - loss: 0.3958 - acc: 0.9541 - val_loss: 0.5183 - val_acc: 0.9246
Epoch 123/250
 - 26s - loss: 0.3875 - acc: 0.9558 - val_loss: 0.5254 - val_acc: 0.9235
Epoch 124/250
 - 26s - loss: 0.3874 - acc: 0.9562 - val_loss: 0.5024 - val_acc: 0.9261
Epoch 125/250
 - 26s - loss: 0.3815 - acc: 0.9574 - val_loss: 0.5141 - val_acc: 0.9252
Epoch 126/250
 - 26s - loss: 0.3778 - acc: 0.9581 - val_loss: 0.5122 - val_acc: 0.9245
Epoch 127/250
 - 26s - loss: 0.3724 - acc: 0.9603 - val_loss: 0.5085 - val_acc: 0.9256
Epoch 128/250
 - 26s - loss: 0.3711 - acc: 0.9582 - val_loss: 0.5044 - val_acc: 0.9245
Epoch 129/250
```

```
 - 26s - loss: 0.3666 - acc: 0.9607 - val_loss: 0.4982 - val_acc: 0.9260
Epoch 130/250
 - 26s - loss: 0.3669 - acc: 0.9590 - val_loss: 0.5059 - val_acc: 0.9239
Epoch 131/250
 - 26s - loss: 0.3661 - acc: 0.9588 - val_loss: 0.5074 - val_acc: 0.9240
Epoch 132/250
 - 26s - loss: 0.3631 - acc: 0.9595 - val_loss: 0.5060 - val_acc: 0.9249
Epoch 133/250
 - 26s - loss: 0.3630 - acc: 0.9588 - val_loss: 0.5017 - val_acc: 0.9250
Epoch 134/250
 - 26s - loss: 0.3572 - acc: 0.9604 - val_loss: 0.5019 - val_acc: 0.9237
Epoch 135/250
 - 26s - loss: 0.3532 - acc: 0.9616 - val_loss: 0.5029 - val_acc: 0.9251
Epoch 136/250
 - 26s - loss: 0.3536 - acc: 0.9612 - val_loss: 0.4877 - val_acc: 0.9264
Epoch 137/250
 - 26s - loss: 0.3538 - acc: 0.9597 - val_loss: 0.4914 - val_acc: 0.9260
Epoch 138/250
 - 26s - loss: 0.3498 - acc: 0.9608 - val_loss: 0.4873 - val_acc: 0.9269
Epoch 139/250
 - 26s - loss: 0.3477 - acc: 0.9618 - val_loss: 0.4887 - val_acc: 0.9253
Epoch 140/250
 - 26s - loss: 0.3470 - acc: 0.9609 - val_loss: 0.5015 - val_acc: 0.9217
Epoch 141/250
 - 26s - loss: 0.3347 - acc: 0.9653 - val_loss: 0.4817 - val_acc: 0.9299
Epoch 142/250
 - 26s - loss: 0.3253 - acc: 0.9684 - val_loss: 0.4792 - val_acc: 0.9301
Epoch 143/250
 - 26s - loss: 0.3270 - acc: 0.9668 - val_loss: 0.4919 - val_acc: 0.9240
Epoch 144/250
 - 26s - loss: 0.3213 - acc: 0.9686 - val_loss: 0.4777 - val_acc: 0.9294
Epoch 145/250
 - 26s - loss: 0.3184 - acc: 0.9694 - val_loss: 0.4803 - val_acc: 0.9300
Epoch 146/250
 - 26s - loss: 0.3170 - acc: 0.9694 - val_loss: 0.4840 - val_acc: 0.9291
Epoch 147/250
 - 26s - loss: 0.3135 - acc: 0.9707 - val_loss: 0.4815 - val_acc: 0.9293
Epoch 148/250
 - 26s - loss: 0.3116 - acc: 0.9702 - val_loss: 0.4794 - val_acc: 0.9302
Epoch 149/250
 - 26s - loss: 0.3105 - acc: 0.9706 - val_loss: 0.4845 - val_acc: 0.9293
Epoch 150/250
 - 26s - loss: 0.3089 - acc: 0.9702 - val_loss: 0.4786 - val_acc: 0.9308
Epoch 151/250
 - 26s - loss: 0.3080 - acc: 0.9710 - val_loss: 0.4831 - val_acc: 0.9295
Epoch 152/250
 - 26s - loss: 0.3030 - acc: 0.9719 - val_loss: 0.4794 - val_acc: 0.9286
Epoch 153/250
 - 26s - loss: 0.3060 - acc: 0.9716 - val_loss: 0.4799 - val_acc: 0.9315
Epoch 154/250
 - 26s - loss: 0.3003 - acc: 0.9725 - val_loss: 0.4857 - val_acc: 0.9288
Epoch 155/250
```

```
 - 26s - loss: 0.3030 - acc: 0.9700 - val_loss: 0.4744 - val_acc: 0.9304
Epoch 156/250
 - 26s - loss: 0.2965 - acc: 0.9724 - val_loss: 0.4893 - val_acc: 0.9262
Epoch 157/250
 - 26s - loss: 0.2953 - acc: 0.9726 - val_loss: 0.4737 - val_acc: 0.9326
Epoch 158/250
 - 26s - loss: 0.2992 - acc: 0.9712 - val_loss: 0.4759 - val_acc: 0.9304
Epoch 159/250
 - 26s - loss: 0.2960 - acc: 0.9719 - val_loss: 0.4885 - val_acc: 0.9277
Epoch 160/250
 - 26s - loss: 0.2938 - acc: 0.9720 - val_loss: 0.4736 - val_acc: 0.9331
Epoch 161/250
 - 26s - loss: 0.2884 - acc: 0.9741 - val_loss: 0.4747 - val_acc: 0.9299
Epoch 162/250
 - 26s - loss: 0.2848 - acc: 0.9752 - val_loss: 0.4747 - val_acc: 0.9311
Epoch 163/250
 - 26s - loss: 0.2886 - acc: 0.9740 - val_loss: 0.4661 - val_acc: 0.9320
Epoch 164/250
 - 26s - loss: 0.2837 - acc: 0.9751 - val_loss: 0.4655 - val_acc: 0.9317
Epoch 165/250
 - 26s - loss: 0.2818 - acc: 0.9759 - val_loss: 0.4660 - val_acc: 0.9333
Epoch 166/250
 - 26s - loss: 0.2837 - acc: 0.9750 - val_loss: 0.4678 - val_acc: 0.9321
Epoch 167/250
 - 26s - loss: 0.2765 - acc: 0.9769 - val_loss: 0.4735 - val_acc: 0.9282
Epoch 168/250
 - 26s - loss: 0.2828 - acc: 0.9754 - val_loss: 0.4643 - val_acc: 0.9311
Epoch 169/250
 - 26s - loss: 0.2765 - acc: 0.9770 - val_loss: 0.4705 - val_acc: 0.9306
Epoch 170/250
 - 26s - loss: 0.2757 - acc: 0.9768 - val_loss: 0.4621 - val_acc: 0.9345
Epoch 171/250
 - 26s - loss: 0.2757 - acc: 0.9771 - val_loss: 0.4673 - val_acc: 0.9327
Epoch 172/250
 - 26s - loss: 0.2730 - acc: 0.9778 - val_loss: 0.4667 - val_acc: 0.9328
Epoch 173/250
 - 26s - loss: 0.2721 - acc: 0.9782 - val_loss: 0.4651 - val_acc: 0.9333
Epoch 174/250
 - 26s - loss: 0.2726 - acc: 0.9779 - val_loss: 0.4714 - val_acc: 0.9315
Epoch 175/250
 - 26s - loss: 0.2730 - acc: 0.9772 - val_loss: 0.4692 - val_acc: 0.9321
Epoch 176/250
 - 26s - loss: 0.2711 - acc: 0.9776 - val_loss: 0.4684 - val_acc: 0.9316
Epoch 177/250
 - 26s - loss: 0.2723 - acc: 0.9777 - val_loss: 0.4680 - val_acc: 0.9326
Epoch 178/250
 - 26s - loss: 0.2675 - acc: 0.9784 - val_loss: 0.4645 - val_acc: 0.9335
Epoch 179/250
 - 26s - loss: 0.2676 - acc: 0.9787 - val_loss: 0.4612 - val_acc: 0.9345
Epoch 180/250
 - 26s - loss: 0.2682 - acc: 0.9778 - val_loss: 0.4720 - val_acc: 0.9307
Epoch 181/250
```

```
 - 26s - loss: 0.2658 - acc: 0.9790 - val_loss: 0.4620 - val_acc: 0.9325
Epoch 182/250
 - 26s - loss: 0.2669 - acc: 0.9784 - val_loss: 0.4617 - val_acc: 0.9333
Epoch 183/250
 - 26s - loss: 0.2640 - acc: 0.9793 - val_loss: 0.4618 - val_acc: 0.9322
Epoch 184/250
 - 26s - loss: 0.2593 - acc: 0.9809 - val_loss: 0.4593 - val_acc: 0.9333
Epoch 185/250
 - 26s - loss: 0.2582 - acc: 0.9810 - val_loss: 0.4601 - val_acc: 0.9338
Epoch 186/250
 - 26s - loss: 0.2598 - acc: 0.9802 - val_loss: 0.4632 - val_acc: 0.9335
Epoch 187/250
 - 26s - loss: 0.2582 - acc: 0.9806 - val_loss: 0.4628 - val_acc: 0.9340
Epoch 188/250
 - 26s - loss: 0.2614 - acc: 0.9801 - val_loss: 0.4650 - val_acc: 0.9330
Epoch 189/250
 - 26s - loss: 0.2591 - acc: 0.9805 - val_loss: 0.4688 - val_acc: 0.9327
Epoch 190/250
 - 26s - loss: 0.2577 - acc: 0.9804 - val_loss: 0.4659 - val_acc: 0.9319
Epoch 191/250
 - 26s - loss: 0.2585 - acc: 0.9803 - val_loss: 0.4653 - val_acc: 0.9335
Epoch 192/250
 - 26s - loss: 0.2598 - acc: 0.9805 - val_loss: 0.4704 - val_acc: 0.9316
Epoch 193/250
 - 26s - loss: 0.2583 - acc: 0.9803 - val_loss: 0.4676 - val_acc: 0.9335
Epoch 194/250
 - 26s - loss: 0.2558 - acc: 0.9815 - val_loss: 0.4631 - val_acc: 0.9334
Epoch 195/250
 - 26s - loss: 0.2577 - acc: 0.9797 - val_loss: 0.4654 - val_acc: 0.9332
Epoch 196/250
 - 26s - loss: 0.2568 - acc: 0.9800 - val_loss: 0.4697 - val_acc: 0.9316
Epoch 197/250
 - 26s - loss: 0.2558 - acc: 0.9805 - val_loss: 0.4634 - val_acc: 0.9335
Epoch 198/250
 - 26s - loss: 0.2552 - acc: 0.9806 - val_loss: 0.4664 - val_acc: 0.9333
Epoch 199/250
 - 26s - loss: 0.2539 - acc: 0.9807 - val_loss: 0.4616 - val_acc: 0.9341
Epoch 200/250
 - 26s - loss: 0.2559 - acc: 0.9802 - val_loss: 0.4631 - val_acc: 0.9330
Epoch 201/250
 - 26s - loss: 0.2544 - acc: 0.9810 - val_loss: 0.4630 - val_acc: 0.9328
Epoch 202/250
 - 26s - loss: 0.2506 - acc: 0.9819 - val_loss: 0.4606 - val_acc: 0.9342
Epoch 203/250
 - 26s - loss: 0.2531 - acc: 0.9810 - val_loss: 0.4617 - val_acc: 0.9333
Epoch 204/250
 - 26s - loss: 0.2505 - acc: 0.9813 - val_loss: 0.4619 - val_acc: 0.9341
Epoch 205/250
 - 26s - loss: 0.2512 - acc: 0.9824 - val_loss: 0.4631 - val_acc: 0.9342
Epoch 206/250
 - 26s - loss: 0.2513 - acc: 0.9816 - val_loss: 0.4615 - val_acc: 0.9341
Epoch 207/250
```

```
 - 26s - loss: 0.2509 - acc: 0.9819 - val_loss: 0.4622 - val_acc: 0.9338
Epoch 208/250
 - 26s - loss: 0.2500 - acc: 0.9818 - val_loss: 0.4621 - val_acc: 0.9340
Epoch 209/250
 - 26s - loss: 0.2519 - acc: 0.9809 - val_loss: 0.4637 - val_acc: 0.9336
Epoch 210/250
 - 26s - loss: 0.2500 - acc: 0.9819 - val_loss: 0.4621 - val_acc: 0.9337
Epoch 211/250
 - 26s - loss: 0.2504 - acc: 0.9821 - val_loss: 0.4597 - val_acc: 0.9338
Epoch 212/250
 - 26s - loss: 0.2506 - acc: 0.9819 - val_loss: 0.4622 - val_acc: 0.9339
Epoch 213/250
 - 26s - loss: 0.2491 - acc: 0.9820 - val_loss: 0.4631 - val_acc: 0.9338
Epoch 214/250
 - 26s - loss: 0.2488 - acc: 0.9824 - val_loss: 0.4632 - val_acc: 0.9330
Epoch 215/250
 - 26s - loss: 0.2477 - acc: 0.9822 - val_loss: 0.4616 - val_acc: 0.9342
Epoch 216/250
 - 26s - loss: 0.2451 - acc: 0.9831 - val_loss: 0.4620 - val_acc: 0.9334
Epoch 217/250
 - 26s - loss: 0.2473 - acc: 0.9829 - val_loss: 0.4661 - val_acc: 0.9329
Epoch 218/250
 - 26s - loss: 0.2461 - acc: 0.9828 - val_loss: 0.4623 - val_acc: 0.9338
Epoch 219/250
 - 26s - loss: 0.2481 - acc: 0.9823 - val_loss: 0.4605 - val_acc: 0.9339
Epoch 220/250
 - 26s - loss: 0.2480 - acc: 0.9821 - val_loss: 0.4618 - val_acc: 0.9331
Epoch 221/250
 - 26s - loss: 0.2485 - acc: 0.9825 - val_loss: 0.4626 - val_acc: 0.9338
Epoch 222/250
 - 26s - loss: 0.2459 - acc: 0.9830 - val_loss: 0.4603 - val_acc: 0.9348
Epoch 223/250
 - 26s - loss: 0.2478 - acc: 0.9822 - val_loss: 0.4609 - val_acc: 0.9343
Epoch 224/250
 - 26s - loss: 0.2465 - acc: 0.9817 - val_loss: 0.4611 - val_acc: 0.9341
Epoch 225/250
 - 26s - loss: 0.2444 - acc: 0.9825 - val_loss: 0.4623 - val_acc: 0.9338
Epoch 226/250
 - 26s - loss: 0.2441 - acc: 0.9837 - val_loss: 0.4605 - val_acc: 0.9345
Epoch 227/250
 - 26s - loss: 0.2457 - acc: 0.9827 - val_loss: 0.4618 - val_acc: 0.9352
Epoch 228/250
 - 26s - loss: 0.2457 - acc: 0.9826 - val_loss: 0.4592 - val_acc: 0.9344
Epoch 229/250
 - 26s - loss: 0.2434 - acc: 0.9837 - val_loss: 0.4601 - val_acc: 0.9342
Epoch 230/250
 - 26s - loss: 0.2483 - acc: 0.9817 - val_loss: 0.4604 - val_acc: 0.9341
Epoch 231/250
 - 26s - loss: 0.2464 - acc: 0.9822 - val_loss: 0.4594 - val_acc: 0.9343
Epoch 232/250
 - 26s - loss: 0.2453 - acc: 0.9827 - val_loss: 0.4586 - val_acc: 0.9338
Epoch 233/250
```

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```
 - 26s - loss: 0.2487 - acc: 0.9823 - val_loss: 0.4605 - val_acc: 0.9341
Epoch 234/250
 - 26s - loss: 0.2446 - acc: 0.9832 - val_loss: 0.4601 - val_acc: 0.9342
Epoch 235/250
 - 26s - loss: 0.2450 - acc: 0.9828 - val_loss: 0.4607 - val_acc: 0.9334
Epoch 236/250
 - 26s - loss: 0.2441 - acc: 0.9835 - val_loss: 0.4593 - val_acc: 0.9342
Epoch 237/250
 - 26s - loss: 0.2468 - acc: 0.9823 - val_loss: 0.4593 - val_acc: 0.9336
Epoch 238/250
 - 26s - loss: 0.2454 - acc: 0.9829 - val_loss: 0.4611 - val_acc: 0.9338
Epoch 239/250
 - 26s - loss: 0.2455 - acc: 0.9829 - val_loss: 0.4597 - val_acc: 0.9337
Epoch 240/250
 - 26s - loss: 0.2452 - acc: 0.9827 - val_loss: 0.4609 - val_acc: 0.9330
Epoch 241/250
 - 26s - loss: 0.2422 - acc: 0.9833 - val_loss: 0.4603 - val_acc: 0.9334
Epoch 242/250
 - 26s - loss: 0.2459 - acc: 0.9830 - val_loss: 0.4613 - val_acc: 0.9334
Epoch 243/250
 - 26s - loss: 0.2441 - acc: 0.9829 - val_loss: 0.4624 - val_acc: 0.9333
Epoch 244/250
 - 26s - loss: 0.2446 - acc: 0.9828 - val_loss: 0.4618 - val_acc: 0.9333
Epoch 245/250
 - 26s - loss: 0.2430 - acc: 0.9835 - val_loss: 0.4608 - val_acc: 0.9330
Epoch 246/250
 - 26s - loss: 0.2420 - acc: 0.9840 - val_loss: 0.4614 - val_acc: 0.9332
Epoch 247/250
 - 26s - loss: 0.2395 - acc: 0.9843 - val_loss: 0.4616 - val_acc: 0.9335
Epoch 248/250
 - 26s - loss: 0.2445 - acc: 0.9828 - val_loss: 0.4626 - val_acc: 0.9326
Epoch 249/250
 - 26s - loss: 0.2454 - acc: 0.9820 - val_loss: 0.4628 - val_acc: 0.9331
Epoch 250/250
 - 26s - loss: 0.2426 - acc: 0.9836 - val_loss: 0.4616 - val_acc: 0.9331
Training Time:  6523.386714935303
Accuracy:  93.31 %
```

Result:

	First Run	Second Run	Third Run	Average
Accuracy	93.45%	93.39%	93.31%	93.38%
Training Time	6452.848s	6461.951s	6523.386s	6479.939s

Machine Learning Project Report

CIFAR-100

Introduction:

This dataset is just like the CIFAR-10, except it has 100 classes containing 600 images each. There are 500 training images and 100 testing images per class. The 100 classes in the CIFAR-100 are grouped into 20 superclasses. Each image comes with a "fine" label (the class to which it belongs) and a "coarse" label (the superclass to which it belongs).

Dataset Link: https://www.cs.toronto.edu/~kriz/cifar-100-python.tar.gz

Model:

We have used Keras model based on VGG16 architecture for CIFAR-100 dataset.

VGG16 Architecture:

This network is characterized by its simplicity, using only *3×3* convolutional layers stacked on top of each other in increasing depth. Reducing volume size is handled by max pooling. Two fully-connected layers, each with 4,096 nodes are then followed by a softmax classifier

Source Code:

```
from __future__ import print_function
import keras
from keras.datasets import cifar100
from keras.preprocessing.image import ImageDataGenerator
from keras.models import Sequential
from keras.layers import Dense, Dropout, Activation, Flatten
from keras.layers import Conv2D, MaxPooling2D, BatchNormalization
from keras import optimizers
import numpy as np
from keras.layers.core import Lambda
from keras import backend as K
from keras import regularizers
import time
from sklearn.metrics import accuracy_score

class cifar100vgg:
    def __init__(self,train=True):
        self.num_classes = 100
        self.weight_decay = 0.0005
        self.x_shape = [32,32,3]

        self.model = self.build_model()
        if train:
            self.model = self.train(self.model)
        else:
```

```
        self.model.load_weights('cifar100vgg.h5')

    def build_model(self):
        # Build the network of vgg for 10 classes with massive dropout and weight decay as described in the pap
er.

        model = Sequential()
        weight_decay = self.weight_decay

        model.add(Conv2D(64, (3, 3), padding='same',
                         input_shape=self.x_shape,kernel_regularizer=regularizers.l2(weight_decay)))
        model.add(Activation('relu'))
        model.add(BatchNormalization())
        model.add(Dropout(0.3))

        model.add(Conv2D(64, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
        model.add(Activation('relu'))
        model.add(BatchNormalization())

        model.add(MaxPooling2D(pool_size=(2, 2)))

        model.add(Conv2D(128, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
        model.add(Activation('relu'))
        model.add(BatchNormalization())
        model.add(Dropout(0.4))

        model.add(Conv2D(128, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
        model.add(Activation('relu'))
        model.add(BatchNormalization())

        model.add(MaxPooling2D(pool_size=(2, 2)))

        model.add(Conv2D(256, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
        model.add(Activation('relu'))
        model.add(BatchNormalization())
        model.add(Dropout(0.4))

        model.add(Conv2D(256, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
        model.add(Activation('relu'))
        model.add(BatchNormalization())
        model.add(Dropout(0.4))

        model.add(Conv2D(256, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
        model.add(Activation('relu'))
        model.add(BatchNormalization())

        model.add(MaxPooling2D(pool_size=(2, 2)))
```

```
    model.add(Conv2D(512, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
    model.add(Activation('relu'))
    model.add(BatchNormalization())
    model.add(Dropout(0.4))

    model.add(Conv2D(512, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
    model.add(Activation('relu'))
    model.add(BatchNormalization())
    model.add(Dropout(0.4))

    model.add(Conv2D(512, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
    model.add(Activation('relu'))
    model.add(BatchNormalization())

    model.add(MaxPooling2D(pool_size=(2, 2)))

    model.add(Conv2D(512, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
    model.add(Activation('relu'))
    model.add(BatchNormalization())
    model.add(Dropout(0.4))

    model.add(Conv2D(512, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
    model.add(Activation('relu'))
    model.add(BatchNormalization())
    model.add(Dropout(0.4))

    model.add(Conv2D(512, (3, 3), padding='same',kernel_regularizer=regularizers.l2(weight_decay)))
    model.add(Activation('relu'))
    model.add(BatchNormalization())

    model.add(MaxPooling2D(pool_size=(2, 2)))
    model.add(Dropout(0.5))

    model.add(Flatten())
    model.add(Dense(512,kernel_regularizer=regularizers.l2(weight_decay)))
    model.add(Activation('relu'))
    model.add(BatchNormalization())

    model.add(Dropout(0.5))
    model.add(Dense(self.num_classes))
    model.add(Activation('softmax'))
    return model

def normalize(self,X_train,X_test):
    #this function normalize inputs for zero mean and unit variance
    # it is used when training a model.
```

```
        # Input: training set and test set
        # Output: normalized training set and test set according to the trianing set statistics.
        mean = np.mean(X_train,axis=(0,1,2,3))
        std = np.std(X_train, axis=(0, 1, 2, 3))
        print(mean)
        print(std)
        X_train = (X_train-mean)/(std+1e-7)
        X_test = (X_test-mean)/(std+1e-7)
        return X_train, X_test

    def normalize_production(self,x):
        #this function is used to normalize instances in production according to saved training set statistics
        # Input: X - a training set
        # Output X - a normalized training set according to normalization constants.

        #these values produced during first training and are general for the standard cifar10 training set normaliz
ation
        mean = 121.936
        std = 68.389
        return (x-mean)/(std+1e-7)

    def predict(self,x,normalize=True,batch_size=50):
        if normalize:
            x = self.normalize_production(x)
        return self.model.predict(x,batch_size)

    def train(self,model):

        #training parameters
        batch_size = 128
        maxepoches = 250
        learning_rate = 0.1
        lr_decay = 1e-6
        lr_drop = 20

        # The data, shuffled and split between train and test sets:
        (x_train, y_train), (x_test, y_test) = cifar100.load_data()
        x_train = x_train.astype('float32')
        x_test = x_test.astype('float32')
        x_train, x_test = self.normalize(x_train, x_test)

        y_train = keras.utils.to_categorical(y_train, self.num_classes)
        y_test = keras.utils.to_categorical(y_test, self.num_classes)

        def lr_scheduler(epoch):
            return learning_rate * (0.5 ** (epoch // lr_drop))
        reduce_lr = keras.callbacks.LearningRateScheduler(lr_scheduler)
```

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```
    #data augmentation
    datagen = ImageDataGenerator(
      featurewise_center=False,  # set input mean to 0 over the dataset
      samplewise_center=False,  # set each sample mean to 0
      featurewise_std_normalization=False,  # divide inputs by std of the dataset
      samplewise_std_normalization=False,  # divide each input by its std
      zca_whitening=False,  # apply ZCA whitening
      rotation_range=15,  # randomly rotate images in the range (degrees, 0 to 180)
      width_shift_range=0.1,  # randomly shift images horizontally (fraction of total width)
      height_shift_range=0.1,  # randomly shift images vertically (fraction of total height)
      horizontal_flip=True,  # randomly flip images
      vertical_flip=False)  # randomly flip images
    # (std, mean, and principal components if ZCA whitening is applied).
    start = time.time()
    datagen.fit(x_train)



    #optimization details
    sgd = optimizers.SGD(lr=learning_rate, decay=lr_decay, momentum=0.9, nesterov=True)
    model.compile(loss='categorical_crossentropy', optimizer=sgd,metrics=['accuracy'])

    # training process in a for loop with learning rate drop every 25 epoches.

    historytemp = model.fit_generator(datagen.flow(x_train, y_train,
                                     batch_size=batch_size),
                        steps_per_epoch=x_train.shape[0] // batch_size,
                        epochs=maxepoches,
                        validation_data=(x_test, y_test),callbacks=[reduce_lr],verbose=2)
    model.save_weights('cifar100vgg.h5')
    end = time.time()
    print("Training Time :",(end-start))
    return model

if __name__ == '__main__':
  (x_train, y_train), (x_test, y_test) = cifar100.load_data()
  x_train = x_train.astype('float32')
  x_test = x_test.astype('float32')

  y_train = keras.utils.to_categorical(y_train, 100)
  y_test = keras.utils.to_categorical(y_test, 100)

  model = cifar100vgg()

  predicted_x = model.predict(x_test)
  accuracy = accuracy_score(np.argmax(predicted_x,1) , np.argmax(y_test,1))
```

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```
print("Accuracy: ",accuracy*100,"%" )
```

Output:

Run 1:

```
Using TensorFlow backend.
The default version of TensorFlow in Colab will soon switch to TensorFlow 2.x.
We recommend you upgrade now or ensure your notebook will continue to use TensorFlow 1.x via the %tensorflow_version 1.x magic: more info.
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-100-python.tar.gz
169009152/169001437 [==============================] - 6s 0us/step
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:66: The name tf.get_default_graph is deprecated. Please use tf.compat.v1.get_default_graph instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:541: The name tf.placeholder is deprecated. Please use tf.compat.v1.placeholder instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4432: The name tf.random_uniform is deprecated. Please use tf.random.uniform instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:190: The name tf.get_default_session is deprecated. Please use tf.compat.v1.get_default_session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:197: The name tf.ConfigProto is deprecated. Please use tf.compat.v1.ConfigProto instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:203: The name tf.Session is deprecated. Please use tf.compat.v1.Session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:207: The name tf.global_variables is deprecated. Please use tf.compat.v1.global_variables instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:216: The name tf.is_variable_initialized is deprecated. Please use tf.compat.v1.is_variable_initialized instead.
```

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```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:223: The name
tf.variables_initializer is deprecated. Please use
tf.compat.v1.variables_initializer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:2041: The name
tf.nn.fused_batch_norm is deprecated. Please use
tf.compat.v1.nn.fused_batch_norm instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:148: The name
tf.placeholder_with_default is deprecated. Please use
tf.compat.v1.placeholder_with_default instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:3733: calling dropout (from
tensorflow.python.ops.nn_ops) with keep_prob is deprecated and will be
removed in a future version.
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 -
keep_prob`.
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:4267: The name tf.nn.max_pool is
deprecated. Please use tf.nn.max_pool2d instead.

121.93584
68.38902
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/optimizers.py:793: The name tf.train.Optimizer is deprecated.
Please use tf.compat.v1.train.Optimizer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:3576: The name tf.log is
deprecated. Please use tf.math.log instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/tensorflow_core/python/ops/math_grad.py:1424: where (from
tensorflow.python.ops.array_ops) is deprecated and will be removed in a
future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:1033: The name tf.assign_add is
deprecated. Please use tf.compat.v1.assign_add instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:1020: The name tf.assign is
deprecated. Please use tf.compat.v1.assign instead.

Epoch 1/250
 - 84s - loss: 20.6756 - acc: 0.0282 - val_loss: 16.4382 - val_acc: 0.0145
Epoch 2/250
```

Machine Learning Project Report

```
 - 73s - loss: 12.2054 - acc: 0.0417 - val_loss: 14.0973 - val_acc: 0.0138
Epoch 3/250
 - 73s - loss: 8.2737 - acc: 0.0460 - val_loss: 11.3437 - val_acc: 0.0075
Epoch 4/250
 - 73s - loss: 6.9882 - acc: 0.0422 - val_loss: 6.3838 - val_acc: 0.0446
Epoch 5/250
 - 73s - loss: 6.1584 - acc: 0.0506 - val_loss: 5.8782 - val_acc: 0.0310
Epoch 6/250
 - 73s - loss: 5.3622 - acc: 0.0641 - val_loss: 5.7121 - val_acc: 0.0223
Epoch 7/250
 - 73s - loss: 4.6940 - acc: 0.0828 - val_loss: 4.7939 - val_acc: 0.0576
Epoch 8/250
 - 73s - loss: 4.3459 - acc: 0.1007 - val_loss: 4.4188 - val_acc: 0.0803
Epoch 9/250
 - 73s - loss: 4.1645 - acc: 0.1140 - val_loss: 4.0707 - val_acc: 0.1247
Epoch 10/250
 - 73s - loss: 4.0467 - acc: 0.1274 - val_loss: 4.0644 - val_acc: 0.1303
Epoch 11/250
 - 73s - loss: 3.9725 - acc: 0.1430 - val_loss: 4.1975 - val_acc: 0.1344
Epoch 12/250
 - 73s - loss: 3.9167 - acc: 0.1597 - val_loss: 3.8333 - val_acc: 0.1840
Epoch 13/250
 - 73s - loss: 3.8582 - acc: 0.1800 - val_loss: 3.7158 - val_acc: 0.2114
Epoch 14/250
 - 73s - loss: 3.8033 - acc: 0.1985 - val_loss: 3.6846 - val_acc: 0.2296
Epoch 15/250
 - 73s - loss: 3.7770 - acc: 0.2207 - val_loss: 3.7565 - val_acc: 0.2406
Epoch 16/250
 - 73s - loss: 3.7441 - acc: 0.2416 - val_loss: 3.6451 - val_acc: 0.2672
Epoch 17/250
 - 74s - loss: 3.7394 - acc: 0.2618 - val_loss: 3.8330 - val_acc: 0.2626
Epoch 18/250
 - 73s - loss: 3.7516 - acc: 0.2750 - val_loss: 4.0233 - val_acc: 0.2538
Epoch 19/250
 - 74s - loss: 3.7650 - acc: 0.2882 - val_loss: 3.7117 - val_acc: 0.3134
Epoch 20/250
 - 73s - loss: 3.7587 - acc: 0.3033 - val_loss: 3.5769 - val_acc: 0.3408
Epoch 21/250
 - 73s - loss: 3.4489 - acc: 0.3568 - val_loss: 3.1665 - val_acc: 0.4040
Epoch 22/250
 - 73s - loss: 3.3070 - acc: 0.3729 - val_loss: 3.2326 - val_acc: 0.3806
Epoch 23/250
 - 73s - loss: 3.2784 - acc: 0.3772 - val_loss: 3.2470 - val_acc: 0.3956
Epoch 24/250
 - 73s - loss: 3.2619 - acc: 0.3846 - val_loss: 3.2542 - val_acc: 0.3960
Epoch 25/250
 - 73s - loss: 3.2498 - acc: 0.3921 - val_loss: 3.1304 - val_acc: 0.4146
Epoch 26/250
 - 73s - loss: 3.2601 - acc: 0.3981 - val_loss: 3.2662 - val_acc: 0.4084
Epoch 27/250
 - 73s - loss: 3.2591 - acc: 0.4040 - val_loss: 3.2157 - val_acc: 0.4259
Epoch 28/250
 - 73s - loss: 3.2684 - acc: 0.4112 - val_loss: 3.2219 - val_acc: 0.4337
Epoch 29/250
 - 73s - loss: 3.2704 - acc: 0.4167 - val_loss: 3.0671 - val_acc: 0.4620
```

Machine Learning Project Report

```
Epoch 30/250
 - 74s - loss: 3.2665 - acc: 0.4218 - val_loss: 3.2299 - val_acc: 0.4368
Epoch 31/250
 - 73s - loss: 3.2959 - acc: 0.4193 - val_loss: 3.4639 - val_acc: 0.4091
Epoch 32/250
 - 73s - loss: 3.2896 - acc: 0.4276 - val_loss: 3.1511 - val_acc: 0.4592
Epoch 33/250
 - 73s - loss: 3.3003 - acc: 0.4325 - val_loss: 3.2044 - val_acc: 0.4548
Epoch 34/250
 - 74s - loss: 3.3017 - acc: 0.4349 - val_loss: 3.3354 - val_acc: 0.4356
Epoch 35/250
 - 74s - loss: 3.2970 - acc: 0.4390 - val_loss: 3.3408 - val_acc: 0.4384
Epoch 36/250
 - 73s - loss: 3.3114 - acc: 0.4416 - val_loss: 3.0754 - val_acc: 0.4999
Epoch 37/250
 - 73s - loss: 3.3192 - acc: 0.4452 - val_loss: 3.1470 - val_acc: 0.4805
Epoch 38/250
 - 73s - loss: 3.3101 - acc: 0.4482 - val_loss: 3.3261 - val_acc: 0.4564
Epoch 39/250
 - 73s - loss: 3.3244 - acc: 0.4500 - val_loss: 3.4501 - val_acc: 0.4480
Epoch 40/250
 - 73s - loss: 3.3403 - acc: 0.4505 - val_loss: 3.2798 - val_acc: 0.4652
Epoch 41/250
 - 73s - loss: 3.0713 - acc: 0.5010 - val_loss: 2.9705 - val_acc: 0.5149
Epoch 42/250
 - 73s - loss: 2.9162 - acc: 0.5179 - val_loss: 2.8526 - val_acc: 0.5327
Epoch 43/250
 - 73s - loss: 2.8495 - acc: 0.5211 - val_loss: 2.9520 - val_acc: 0.5133
Epoch 44/250
 - 73s - loss: 2.8191 - acc: 0.5236 - val_loss: 2.8670 - val_acc: 0.5208
Epoch 45/250
 - 73s - loss: 2.7979 - acc: 0.5268 - val_loss: 2.8340 - val_acc: 0.5234
Epoch 46/250
 - 73s - loss: 2.7886 - acc: 0.5246 - val_loss: 2.8433 - val_acc: 0.5189
Epoch 47/250
 - 73s - loss: 2.7797 - acc: 0.5278 - val_loss: 2.8080 - val_acc: 0.5303
Epoch 48/250
 - 73s - loss: 2.7754 - acc: 0.5323 - val_loss: 2.9752 - val_acc: 0.5147
Epoch 49/250
 - 73s - loss: 2.7869 - acc: 0.5325 - val_loss: 3.0404 - val_acc: 0.5049
Epoch 50/250
 - 73s - loss: 2.7783 - acc: 0.5335 - val_loss: 2.7255 - val_acc: 0.5532
Epoch 51/250
 - 73s - loss: 2.7931 - acc: 0.5367 - val_loss: 2.9087 - val_acc: 0.5200
Epoch 52/250
 - 73s - loss: 2.7913 - acc: 0.5372 - val_loss: 2.7988 - val_acc: 0.5467
Epoch 53/250
 - 73s - loss: 2.8003 - acc: 0.5372 - val_loss: 2.7715 - val_acc: 0.5470
Epoch 54/250
 - 73s - loss: 2.7951 - acc: 0.5438 - val_loss: 2.7716 - val_acc: 0.5554
Epoch 55/250
 - 73s - loss: 2.7870 - acc: 0.5477 - val_loss: 2.7653 - val_acc: 0.5580
Epoch 56/250
 - 73s - loss: 2.7956 - acc: 0.5457 - val_loss: 2.8150 - val_acc: 0.5511
Epoch 57/250
```

Machine Learning Project Report

```
 - 73s - loss: 2.7982 - acc: 0.5450 - val_loss: 2.7758 - val_acc: 0.5561
Epoch 58/250
 - 73s - loss: 2.8016 - acc: 0.5493 - val_loss: 2.8002 - val_acc: 0.5613
Epoch 59/250
 - 73s - loss: 2.8088 - acc: 0.5479 - val_loss: 2.8056 - val_acc: 0.5558
Epoch 60/250
 - 73s - loss: 2.7991 - acc: 0.5548 - val_loss: 2.8858 - val_acc: 0.5451
Epoch 61/250
 - 73s - loss: 2.5989 - acc: 0.5985 - val_loss: 2.5901 - val_acc: 0.5985
Epoch 62/250
 - 73s - loss: 2.4865 - acc: 0.6109 - val_loss: 2.4905 - val_acc: 0.6169
Epoch 63/250
 - 73s - loss: 2.4425 - acc: 0.6173 - val_loss: 2.4787 - val_acc: 0.6115
Epoch 64/250
 - 73s - loss: 2.3959 - acc: 0.6200 - val_loss: 2.5190 - val_acc: 0.5951
Epoch 65/250
 - 73s - loss: 2.3715 - acc: 0.6222 - val_loss: 2.4943 - val_acc: 0.5986
Epoch 66/250
 - 73s - loss: 2.3595 - acc: 0.6208 - val_loss: 2.4443 - val_acc: 0.6034
Epoch 67/250
 - 73s - loss: 2.3313 - acc: 0.6250 - val_loss: 2.5064 - val_acc: 0.5917
Epoch 68/250
 - 73s - loss: 2.3354 - acc: 0.6216 - val_loss: 2.4027 - val_acc: 0.6106
Epoch 69/250
 - 73s - loss: 2.3271 - acc: 0.6238 - val_loss: 2.4977 - val_acc: 0.5942
Epoch 70/250
 - 73s - loss: 2.3222 - acc: 0.6241 - val_loss: 2.6475 - val_acc: 0.5763
Epoch 71/250
 - 73s - loss: 2.3147 - acc: 0.6260 - val_loss: 2.5133 - val_acc: 0.5994
Epoch 72/250
 - 74s - loss: 2.3097 - acc: 0.6267 - val_loss: 2.4364 - val_acc: 0.6057
Epoch 73/250
 - 73s - loss: 2.3119 - acc: 0.6225 - val_loss: 2.4700 - val_acc: 0.6061
Epoch 74/250
 - 73s - loss: 2.3128 - acc: 0.6267 - val_loss: 2.5312 - val_acc: 0.5994
Epoch 75/250
 - 73s - loss: 2.3132 - acc: 0.6291 - val_loss: 2.6506 - val_acc: 0.5652
Epoch 76/250
 - 73s - loss: 2.3169 - acc: 0.6287 - val_loss: 2.5014 - val_acc: 0.5954
Epoch 77/250
 - 73s - loss: 2.3172 - acc: 0.6297 - val_loss: 2.5622 - val_acc: 0.5902
Epoch 78/250
 - 73s - loss: 2.3083 - acc: 0.6334 - val_loss: 2.5386 - val_acc: 0.5934
Epoch 79/250
 - 73s - loss: 2.3084 - acc: 0.6328 - val_loss: 2.5255 - val_acc: 0.6009
Epoch 80/250
 - 73s - loss: 2.3118 - acc: 0.6344 - val_loss: 2.5547 - val_acc: 0.5937
Epoch 81/250
 - 73s - loss: 2.1604 - acc: 0.6699 - val_loss: 2.4328 - val_acc: 0.6218
Epoch 82/250
 - 73s - loss: 2.0735 - acc: 0.6849 - val_loss: 2.3229 - val_acc: 0.6355
Epoch 83/250
 - 73s - loss: 2.0313 - acc: 0.6904 - val_loss: 2.3480 - val_acc: 0.6333
Epoch 84/250
 - 73s - loss: 1.9983 - acc: 0.6979 - val_loss: 2.2584 - val_acc: 0.6497
```

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```
Epoch 85/250
 - 73s - loss: 1.9711 - acc: 0.6975 - val_loss: 2.3124 - val_acc: 0.6397
Epoch 86/250
 - 73s - loss: 1.9632 - acc: 0.6962 - val_loss: 2.2306 - val_acc: 0.6476
Epoch 87/250
 - 73s - loss: 1.9546 - acc: 0.6973 - val_loss: 2.3628 - val_acc: 0.6294
Epoch 88/250
 - 73s - loss: 1.9313 - acc: 0.7009 - val_loss: 2.2666 - val_acc: 0.6441
Epoch 89/250
 - 73s - loss: 1.9256 - acc: 0.6995 - val_loss: 2.2452 - val_acc: 0.6386
Epoch 90/250
 - 73s - loss: 1.9063 - acc: 0.7011 - val_loss: 2.2394 - val_acc: 0.6416
Epoch 91/250
 - 73s - loss: 1.9031 - acc: 0.7024 - val_loss: 2.3344 - val_acc: 0.6254
Epoch 92/250
 - 73s - loss: 1.9011 - acc: 0.7022 - val_loss: 2.2714 - val_acc: 0.6357
Epoch 93/250
 - 73s - loss: 1.8995 - acc: 0.7032 - val_loss: 2.1884 - val_acc: 0.6479
Epoch 94/250
 - 73s - loss: 1.8854 - acc: 0.7027 - val_loss: 2.2678 - val_acc: 0.6275
Epoch 95/250
 - 73s - loss: 1.8807 - acc: 0.7071 - val_loss: 2.2454 - val_acc: 0.6316
Epoch 96/250
 - 73s - loss: 1.8867 - acc: 0.7032 - val_loss: 2.2106 - val_acc: 0.6476
Epoch 97/250
 - 73s - loss: 1.8607 - acc: 0.7105 - val_loss: 2.2614 - val_acc: 0.6425
Epoch 98/250
 - 73s - loss: 1.8807 - acc: 0.7037 - val_loss: 2.3134 - val_acc: 0.6326
Epoch 99/250
 - 73s - loss: 1.8754 - acc: 0.7070 - val_loss: 2.1912 - val_acc: 0.6494
Epoch 100/250
 - 73s - loss: 1.8787 - acc: 0.7048 - val_loss: 2.2177 - val_acc: 0.6452
Epoch 101/250
 - 73s - loss: 1.7557 - acc: 0.7363 - val_loss: 2.1566 - val_acc: 0.6594
Epoch 102/250
 - 73s - loss: 1.6833 - acc: 0.7535 - val_loss: 2.1369 - val_acc: 0.6666
Epoch 103/250
 - 73s - loss: 1.6808 - acc: 0.7510 - val_loss: 2.0935 - val_acc: 0.6723
Epoch 104/250
 - 73s - loss: 1.6459 - acc: 0.7574 - val_loss: 2.1751 - val_acc: 0.6586
Epoch 105/250
 - 73s - loss: 1.6317 - acc: 0.7587 - val_loss: 2.1415 - val_acc: 0.6631
Epoch 106/250
 - 73s - loss: 1.6106 - acc: 0.7617 - val_loss: 2.0827 - val_acc: 0.6772
Epoch 107/250
 - 73s - loss: 1.5922 - acc: 0.7649 - val_loss: 2.1169 - val_acc: 0.6669
Epoch 108/250
 - 73s - loss: 1.5760 - acc: 0.7653 - val_loss: 2.1186 - val_acc: 0.6724
Epoch 109/250
 - 73s - loss: 1.5822 - acc: 0.7660 - val_loss: 2.0705 - val_acc: 0.6755
Epoch 110/250
 - 73s - loss: 1.5715 - acc: 0.7637 - val_loss: 2.1859 - val_acc: 0.6564
Epoch 111/250
 - 73s - loss: 1.5594 - acc: 0.7686 - val_loss: 2.1140 - val_acc: 0.6670
Epoch 112/250
```

Machine Learning Project Report

```
 - 73s - loss: 1.5567 - acc: 0.7684 - val_loss: 2.0638 - val_acc: 0.6737
Epoch 113/250
 - 73s - loss: 1.5445 - acc: 0.7692 - val_loss: 2.1003 - val_acc: 0.6718
Epoch 114/250
 - 73s - loss: 1.5482 - acc: 0.7685 - val_loss: 2.0253 - val_acc: 0.6802
Epoch 115/250
 - 73s - loss: 1.5348 - acc: 0.7716 - val_loss: 2.0756 - val_acc: 0.6733
Epoch 116/250
 - 73s - loss: 1.5350 - acc: 0.7684 - val_loss: 2.0520 - val_acc: 0.6721
Epoch 117/250
 - 73s - loss: 1.5145 - acc: 0.7742 - val_loss: 2.1025 - val_acc: 0.6659
Epoch 118/250
 - 73s - loss: 1.5180 - acc: 0.7712 - val_loss: 2.0321 - val_acc: 0.6779
Epoch 119/250
 - 73s - loss: 1.5132 - acc: 0.7734 - val_loss: 2.0939 - val_acc: 0.6685
Epoch 120/250
 - 73s - loss: 1.5153 - acc: 0.7724 - val_loss: 2.0729 - val_acc: 0.6669
Epoch 121/250
 - 73s - loss: 1.4355 - acc: 0.7935 - val_loss: 2.0412 - val_acc: 0.6778
Epoch 122/250
 - 73s - loss: 1.3951 - acc: 0.8011 - val_loss: 2.0376 - val_acc: 0.6803
Epoch 123/250
 - 73s - loss: 1.3620 - acc: 0.8098 - val_loss: 2.0401 - val_acc: 0.6809
Epoch 124/250
 - 73s - loss: 1.3548 - acc: 0.8108 - val_loss: 2.0352 - val_acc: 0.6819
Epoch 125/250
 - 73s - loss: 1.3386 - acc: 0.8119 - val_loss: 2.0281 - val_acc: 0.6830
Epoch 126/250
 - 73s - loss: 1.3282 - acc: 0.8145 - val_loss: 2.0856 - val_acc: 0.6759
Epoch 127/250
 - 73s - loss: 1.3227 - acc: 0.8154 - val_loss: 2.0566 - val_acc: 0.6814
Epoch 128/250
 - 73s - loss: 1.3068 - acc: 0.8177 - val_loss: 2.0759 - val_acc: 0.6772
Epoch 129/250
 - 73s - loss: 1.3063 - acc: 0.8181 - val_loss: 2.0966 - val_acc: 0.6778
Epoch 130/250
 - 73s - loss: 1.2926 - acc: 0.8203 - val_loss: 2.0357 - val_acc: 0.6882
Epoch 131/250
 - 73s - loss: 1.2872 - acc: 0.8182 - val_loss: 2.0345 - val_acc: 0.6822
Epoch 132/250
 - 73s - loss: 1.2785 - acc: 0.8219 - val_loss: 2.0800 - val_acc: 0.6795
Epoch 133/250
 - 73s - loss: 1.2691 - acc: 0.8228 - val_loss: 2.0819 - val_acc: 0.6753
Epoch 134/250
 - 73s - loss: 1.2635 - acc: 0.8214 - val_loss: 2.0667 - val_acc: 0.6798
Epoch 135/250
 - 73s - loss: 1.2646 - acc: 0.8235 - val_loss: 2.0518 - val_acc: 0.6799
Epoch 136/250
 - 73s - loss: 1.2592 - acc: 0.8226 - val_loss: 2.0559 - val_acc: 0.6846
Epoch 137/250
 - 73s - loss: 1.2488 - acc: 0.8251 - val_loss: 2.1136 - val_acc: 0.6710
Epoch 138/250
 - 73s - loss: 1.2429 - acc: 0.8283 - val_loss: 2.1088 - val_acc: 0.6720
Epoch 139/250
 - 73s - loss: 1.2355 - acc: 0.8265 - val_loss: 2.0294 - val_acc: 0.6889
```

Machine Learning Project Report

```
Epoch 140/250
 - 73s - loss: 1.2234 - acc: 0.8292 - val_loss: 2.0956 - val_acc: 0.6744
Epoch 141/250
 - 73s - loss: 1.1887 - acc: 0.8408 - val_loss: 2.0380 - val_acc: 0.6887
Epoch 142/250
 - 73s - loss: 1.1542 - acc: 0.8477 - val_loss: 2.0185 - val_acc: 0.6891
Epoch 143/250
 - 73s - loss: 1.1408 - acc: 0.8509 - val_loss: 2.0109 - val_acc: 0.6901
Epoch 144/250
 - 73s - loss: 1.1384 - acc: 0.8512 - val_loss: 2.0416 - val_acc: 0.6872
Epoch 145/250
 - 73s - loss: 1.1208 - acc: 0.8545 - val_loss: 2.0410 - val_acc: 0.6871
Epoch 146/250
 - 73s - loss: 1.1176 - acc: 0.8569 - val_loss: 2.0464 - val_acc: 0.6859
Epoch 147/250
 - 73s - loss: 1.1197 - acc: 0.8551 - val_loss: 2.0523 - val_acc: 0.6852
Epoch 148/250
 - 73s - loss: 1.1083 - acc: 0.8582 - val_loss: 2.0826 - val_acc: 0.6821
Epoch 149/250
 - 73s - loss: 1.0997 - acc: 0.8586 - val_loss: 2.1030 - val_acc: 0.6778
Epoch 150/250
 - 73s - loss: 1.0972 - acc: 0.8603 - val_loss: 2.0389 - val_acc: 0.6916
Epoch 151/250
 - 73s - loss: 1.0853 - acc: 0.8623 - val_loss: 2.0502 - val_acc: 0.6891
Epoch 152/250
 - 73s - loss: 1.0853 - acc: 0.8593 - val_loss: 2.0763 - val_acc: 0.6856
Epoch 153/250
 - 73s - loss: 1.0818 - acc: 0.8614 - val_loss: 2.0555 - val_acc: 0.6889
Epoch 154/250
 - 73s - loss: 1.0752 - acc: 0.8626 - val_loss: 2.0450 - val_acc: 0.6897
Epoch 155/250
 - 73s - loss: 1.0665 - acc: 0.8637 - val_loss: 2.0505 - val_acc: 0.6876
Epoch 156/250
 - 73s - loss: 1.0677 - acc: 0.8623 - val_loss: 2.0334 - val_acc: 0.6909
Epoch 157/250
 - 73s - loss: 1.0617 - acc: 0.8625 - val_loss: 2.0517 - val_acc: 0.6906
Epoch 158/250
 - 73s - loss: 1.0479 - acc: 0.8696 - val_loss: 2.0689 - val_acc: 0.6903
Epoch 159/250
 - 73s - loss: 1.0501 - acc: 0.8669 - val_loss: 2.0759 - val_acc: 0.6834
Epoch 160/250
 - 73s - loss: 1.0438 - acc: 0.8664 - val_loss: 2.0530 - val_acc: 0.6874
Epoch 161/250
 - 73s - loss: 1.0284 - acc: 0.8714 - val_loss: 2.0446 - val_acc: 0.6909
Epoch 162/250
 - 73s - loss: 1.0062 - acc: 0.8782 - val_loss: 2.0319 - val_acc: 0.6908
Epoch 163/250
 - 74s - loss: 0.9989 - acc: 0.8793 - val_loss: 2.0566 - val_acc: 0.6890
Epoch 164/250
 - 73s - loss: 0.9990 - acc: 0.8783 - val_loss: 2.0409 - val_acc: 0.6952
Epoch 165/250
 - 73s - loss: 0.9926 - acc: 0.8806 - val_loss: 2.0428 - val_acc: 0.6915
Epoch 166/250
 - 73s - loss: 0.9866 - acc: 0.8817 - val_loss: 2.0332 - val_acc: 0.6942
Epoch 167/250
```

Machine Learning Project Report

```
 - 73s - loss: 0.9874 - acc: 0.8813 - val_loss: 2.0519 - val_acc: 0.6927
Epoch 168/250
 - 73s - loss: 0.9714 - acc: 0.8846 - val_loss: 2.0595 - val_acc: 0.6881
Epoch 169/250
 - 73s - loss: 0.9745 - acc: 0.8823 - val_loss: 2.0393 - val_acc: 0.6941
Epoch 170/250
 - 73s - loss: 0.9666 - acc: 0.8872 - val_loss: 2.0530 - val_acc: 0.6920
Epoch 171/250
 - 73s - loss: 0.9605 - acc: 0.8877 - val_loss: 2.0461 - val_acc: 0.6921
Epoch 172/250
 - 73s - loss: 0.9627 - acc: 0.8845 - val_loss: 2.0504 - val_acc: 0.6938
Epoch 173/250
 - 73s - loss: 0.9614 - acc: 0.8862 - val_loss: 2.0626 - val_acc: 0.6900
Epoch 174/250
 - 73s - loss: 0.9511 - acc: 0.8900 - val_loss: 2.0691 - val_acc: 0.6925
Epoch 175/250
 - 73s - loss: 0.9515 - acc: 0.8878 - val_loss: 2.0751 - val_acc: 0.6906
Epoch 176/250
 - 73s - loss: 0.9496 - acc: 0.8900 - val_loss: 2.0552 - val_acc: 0.6939
Epoch 177/250
 - 73s - loss: 0.9542 - acc: 0.8865 - val_loss: 2.0670 - val_acc: 0.6943
Epoch 178/250
 - 73s - loss: 0.9369 - acc: 0.8921 - val_loss: 2.0627 - val_acc: 0.6932
Epoch 179/250
 - 73s - loss: 0.9461 - acc: 0.8881 - val_loss: 2.0726 - val_acc: 0.6866
Epoch 180/250
 - 73s - loss: 0.9398 - acc: 0.8903 - val_loss: 2.0425 - val_acc: 0.6942
Epoch 181/250
 - 73s - loss: 0.9235 - acc: 0.8941 - val_loss: 2.0549 - val_acc: 0.6923
Epoch 182/250
 - 73s - loss: 0.9316 - acc: 0.8914 - val_loss: 2.0492 - val_acc: 0.6921
Epoch 183/250
 - 73s - loss: 0.9168 - acc: 0.8949 - val_loss: 2.0620 - val_acc: 0.6923
Epoch 184/250
 - 73s - loss: 0.9110 - acc: 0.8979 - val_loss: 2.0660 - val_acc: 0.6901
Epoch 185/250
 - 73s - loss: 0.9201 - acc: 0.8960 - val_loss: 2.0621 - val_acc: 0.6942
Epoch 186/250
 - 73s - loss: 0.9083 - acc: 0.8978 - val_loss: 2.0575 - val_acc: 0.6922
Epoch 187/250
 - 73s - loss: 0.9029 - acc: 0.8997 - val_loss: 2.0565 - val_acc: 0.6929
Epoch 188/250
 - 73s - loss: 0.9040 - acc: 0.8993 - val_loss: 2.0582 - val_acc: 0.6923
Epoch 189/250
 - 73s - loss: 0.9057 - acc: 0.8977 - val_loss: 2.0653 - val_acc: 0.6896
Epoch 190/250
 - 73s - loss: 0.9043 - acc: 0.8978 - val_loss: 2.0591 - val_acc: 0.6922
Epoch 191/250
 - 73s - loss: 0.8897 - acc: 0.9026 - val_loss: 2.0576 - val_acc: 0.6940
Epoch 192/250
 - 73s - loss: 0.8946 - acc: 0.8996 - val_loss: 2.0679 - val_acc: 0.6921
Epoch 193/250
 - 73s - loss: 0.9027 - acc: 0.8987 - val_loss: 2.0553 - val_acc: 0.6944
Epoch 194/250
 - 73s - loss: 0.8950 - acc: 0.9011 - val_loss: 2.0702 - val_acc: 0.6924
```

Machine Learning Project Report

```
Epoch 195/250
 - 73s - loss: 0.8905 - acc: 0.9019 - val_loss: 2.0743 - val_acc: 0.6921
Epoch 196/250
 - 73s - loss: 0.8875 - acc: 0.9016 - val_loss: 2.0507 - val_acc: 0.6933
Epoch 197/250
 - 73s - loss: 0.8897 - acc: 0.9006 - val_loss: 2.0591 - val_acc: 0.6935
Epoch 198/250
 - 73s - loss: 0.8825 - acc: 0.9030 - val_loss: 2.0673 - val_acc: 0.6926
Epoch 199/250
 - 73s - loss: 0.8834 - acc: 0.9036 - val_loss: 2.0717 - val_acc: 0.6921
Epoch 200/250
 - 73s - loss: 0.8822 - acc: 0.9024 - val_loss: 2.0756 - val_acc: 0.6916
Epoch 201/250
 - 73s - loss: 0.8742 - acc: 0.9036 - val_loss: 2.0609 - val_acc: 0.6944
Epoch 202/250
 - 73s - loss: 0.8804 - acc: 0.9025 - val_loss: 2.0607 - val_acc: 0.6940
Epoch 203/250
 - 73s - loss: 0.8745 - acc: 0.9049 - val_loss: 2.0608 - val_acc: 0.6949
Epoch 204/250
 - 73s - loss: 0.8723 - acc: 0.9044 - val_loss: 2.0632 - val_acc: 0.6926
Epoch 205/250
 - 73s - loss: 0.8644 - acc: 0.9077 - val_loss: 2.0600 - val_acc: 0.6944
Epoch 206/250
 - 73s - loss: 0.8625 - acc: 0.9077 - val_loss: 2.0795 - val_acc: 0.6918
Epoch 207/250
 - 74s - loss: 0.8642 - acc: 0.9071 - val_loss: 2.0698 - val_acc: 0.6941
Epoch 208/250
 - 73s - loss: 0.8649 - acc: 0.9065 - val_loss: 2.0664 - val_acc: 0.6942
Epoch 209/250
 - 73s - loss: 0.8636 - acc: 0.9071 - val_loss: 2.0661 - val_acc: 0.6937
Epoch 210/250
 - 73s - loss: 0.8586 - acc: 0.9078 - val_loss: 2.0681 - val_acc: 0.6941
Epoch 211/250
 - 73s - loss: 0.8586 - acc: 0.9078 - val_loss: 2.0738 - val_acc: 0.6935
Epoch 212/250
 - 73s - loss: 0.8573 - acc: 0.9096 - val_loss: 2.0687 - val_acc: 0.6934
Epoch 213/250
 - 73s - loss: 0.8570 - acc: 0.9086 - val_loss: 2.0746 - val_acc: 0.6942
Epoch 214/250
 - 73s - loss: 0.8608 - acc: 0.9077 - val_loss: 2.0659 - val_acc: 0.6956
Epoch 215/250
 - 73s - loss: 0.8508 - acc: 0.9100 - val_loss: 2.0703 - val_acc: 0.6950
Epoch 216/250
 - 73s - loss: 0.8513 - acc: 0.9117 - val_loss: 2.0774 - val_acc: 0.6947
Epoch 217/250
 - 73s - loss: 0.8537 - acc: 0.9089 - val_loss: 2.0736 - val_acc: 0.6938
Epoch 218/250
 - 73s - loss: 0.8532 - acc: 0.9088 - val_loss: 2.0682 - val_acc: 0.6958
Epoch 219/250
 - 73s - loss: 0.8481 - acc: 0.9124 - val_loss: 2.0846 - val_acc: 0.6945
Epoch 220/250
 - 73s - loss: 0.8549 - acc: 0.9069 - val_loss: 2.0746 - val_acc: 0.6938
Epoch 221/250
 - 73s - loss: 0.8531 - acc: 0.9086 - val_loss: 2.0784 - val_acc: 0.6931
Epoch 222/250
```

Machine Learning Project Report

```
 - 73s - loss: 0.8440 - acc: 0.9113 - val_loss: 2.0791 - val_acc: 0.6928
Epoch 223/250
 - 73s - loss: 0.8486 - acc: 0.9102 - val_loss: 2.0762 - val_acc: 0.6929
Epoch 224/250
 - 73s - loss: 0.8518 - acc: 0.9097 - val_loss: 2.0737 - val_acc: 0.6955
Epoch 225/250
 - 73s - loss: 0.8480 - acc: 0.9109 - val_loss: 2.0711 - val_acc: 0.6952
Epoch 226/250
 - 73s - loss: 0.8508 - acc: 0.9091 - val_loss: 2.0730 - val_acc: 0.6951
Epoch 227/250
 - 73s - loss: 0.8401 - acc: 0.9124 - val_loss: 2.0784 - val_acc: 0.6934
Epoch 228/250
 - 73s - loss: 0.8425 - acc: 0.9111 - val_loss: 2.0667 - val_acc: 0.6944
Epoch 229/250
 - 73s - loss: 0.8495 - acc: 0.9098 - val_loss: 2.0741 - val_acc: 0.6941
Epoch 230/250
 - 73s - loss: 0.8408 - acc: 0.9130 - val_loss: 2.0675 - val_acc: 0.6950
Epoch 231/250
 - 73s - loss: 0.8484 - acc: 0.9099 - val_loss: 2.0703 - val_acc: 0.6946
Epoch 232/250
 - 73s - loss: 0.8401 - acc: 0.9122 - val_loss: 2.0664 - val_acc: 0.6942
Epoch 233/250
 - 73s - loss: 0.8380 - acc: 0.9136 - val_loss: 2.0768 - val_acc: 0.6922
Epoch 234/250
 - 73s - loss: 0.8482 - acc: 0.9086 - val_loss: 2.0791 - val_acc: 0.6914
Epoch 235/250
 - 73s - loss: 0.8383 - acc: 0.9128 - val_loss: 2.0788 - val_acc: 0.6931
Epoch 236/250
 - 73s - loss: 0.8426 - acc: 0.9116 - val_loss: 2.0740 - val_acc: 0.6937
Epoch 237/250
 - 73s - loss: 0.8394 - acc: 0.9108 - val_loss: 2.0802 - val_acc: 0.6935
Epoch 238/250
 - 73s - loss: 0.8446 - acc: 0.9108 - val_loss: 2.0764 - val_acc: 0.6938
Epoch 239/250
 - 73s - loss: 0.8419 - acc: 0.9108 - val_loss: 2.0730 - val_acc: 0.6938
Epoch 240/250
 - 73s - loss: 0.8418 - acc: 0.9104 - val_loss: 2.0760 - val_acc: 0.6944
Epoch 241/250
 - 73s - loss: 0.8368 - acc: 0.9131 - val_loss: 2.0734 - val_acc: 0.6937
Epoch 242/250
 - 73s - loss: 0.8344 - acc: 0.9134 - val_loss: 2.0655 - val_acc: 0.6953
Epoch 243/250
 - 73s - loss: 0.8363 - acc: 0.9139 - val_loss: 2.0730 - val_acc: 0.6936
Epoch 244/250
 - 73s - loss: 0.8360 - acc: 0.9122 - val_loss: 2.0668 - val_acc: 0.6948
Epoch 245/250
 - 73s - loss: 0.8318 - acc: 0.9128 - val_loss: 2.0664 - val_acc: 0.6987
Epoch 246/250
 - 73s - loss: 0.8331 - acc: 0.9136 - val_loss: 2.0699 - val_acc: 0.7009
Epoch 247/250
 - 73s - loss: 0.8328 - acc: 0.9134 - val_loss: 2.0686 - val_acc: 0.7021
Epoch 248/250
 - 73s - loss: 0.8311 - acc: 0.9133 - val_loss: 2.0716 - val_acc: 0.7045
Epoch 249/250
 - 73s - loss: 0.8356 - acc: 0.9131 - val_loss: 2.0731 - val_acc: 0.7065
```

Machine Learning Project Report

```
Epoch 250/250
 - 73s - loss: 0.8291 - acc: 0.9137 - val_loss: 2.0754 - val_acc: 0.7088
Training Time : 18284.95653295517
Accuracy:  70.88 %
```

Run 2:

```
Using TensorFlow backend.
```
The default version of TensorFlow in Colab will soon switch to TensorFlow 2.x.
We recommend you upgrade now or ensure your notebook will continue to use TensorFlow 1.x via the `%tensorflow_version 1.x` magic: more info.
```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-100-python.tar.gz
169009152/169001437 [==============================] - 11s 0us/step
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:66: The name tf.get_default_graph is deprecated. Please use tf.compat.v1.get_default_graph instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:541: The name tf.placeholder is deprecated. Please use tf.compat.v1.placeholder instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:4432: The name tf.random_uniform is deprecated. Please use tf.random.uniform instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:190: The name tf.get_default_session is deprecated. Please use tf.compat.v1.get_default_session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:197: The name tf.ConfigProto is deprecated. Please use tf.compat.v1.ConfigProto instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:203: The name tf.Session is deprecated. Please use tf.compat.v1.Session instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:207: The name tf.global_variables is deprecated. Please use tf.compat.v1.global_variables instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:216: The name tf.is_variable_initialized is deprecated. Please use tf.compat.v1.is_variable_initialized instead.
```

Machine Learning Project Report

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:223: The name
tf.variables_initializer is deprecated. Please use
tf.compat.v1.variables_initializer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:2041: The name
tf.nn.fused_batch_norm is deprecated. Please use
tf.compat.v1.nn.fused_batch_norm instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:148: The name
tf.placeholder_with_default is deprecated. Please use
tf.compat.v1.placeholder_with_default instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:3733: calling dropout (from
tensorflow.python.ops.nn_ops) with keep_prob is deprecated and will be
removed in a future version.
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 -
keep_prob`.
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:4267: The name tf.nn.max_pool is
deprecated. Please use tf.nn.max_pool2d instead.

121.93584
68.38902
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/optimizers.py:793: The name tf.train.Optimizer is deprecated.
Please use tf.compat.v1.train.Optimizer instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:3576: The name tf.log is
deprecated. Please use tf.math.log instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/tensorflow_core/python/ops/math_grad.py:1424: where (from
tensorflow.python.ops.array_ops) is deprecated and will be removed in a
future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:1033: The name tf.assign_add is
deprecated. Please use tf.compat.v1.assign_add instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-
packages/keras/backend/tensorflow_backend.py:1020: The name tf.assign is
deprecated. Please use tf.compat.v1.assign instead.

Epoch 1/250
 - 34s - loss: 19.7685 - acc: 0.0266 - val_loss: 24.3936 - val_acc: 0.0053
```

Machine Learning Project Report

```
Epoch 2/250
 - 26s - loss: 11.7540 - acc: 0.0481 - val_loss: 12.9683 - val_acc: 0.0157
Epoch 3/250
 - 26s - loss: 8.5206 - acc: 0.0419 - val_loss: 7.5412 - val_acc: 0.0343
Epoch 4/250
 - 26s - loss: 6.7142 - acc: 0.0549 - val_loss: 6.5740 - val_acc: 0.0369
Epoch 5/250
 - 26s - loss: 5.7953 - acc: 0.0580 - val_loss: 6.0052 - val_acc: 0.0393
Epoch 6/250
 - 26s - loss: 5.1539 - acc: 0.0710 - val_loss: 5.3819 - val_acc: 0.0266
Epoch 7/250
 - 26s - loss: 4.5888 - acc: 0.0855 - val_loss: 4.9524 - val_acc: 0.0399
Epoch 8/250
 - 26s - loss: 4.3123 - acc: 0.0993 - val_loss: 4.8184 - val_acc: 0.0689
Epoch 9/250
 - 26s - loss: 4.1317 - acc: 0.1112 - val_loss: 4.2757 - val_acc: 0.0939
Epoch 10/250
 - 26s - loss: 4.0376 - acc: 0.1270 - val_loss: 4.1955 - val_acc: 0.1098
Epoch 11/250
 - 26s - loss: 3.9728 - acc: 0.1426 - val_loss: 3.9241 - val_acc: 0.1540
Epoch 12/250
 - 26s - loss: 3.9039 - acc: 0.1607 - val_loss: 3.8912 - val_acc: 0.1668
Epoch 13/250
 - 26s - loss: 3.8229 - acc: 0.1861 - val_loss: 3.7463 - val_acc: 0.2150
Epoch 14/250
 - 26s - loss: 3.7817 - acc: 0.2100 - val_loss: 3.6448 - val_acc: 0.2423
Epoch 15/250
 - 26s - loss: 3.7583 - acc: 0.2297 - val_loss: 4.1827 - val_acc: 0.1991
Epoch 16/250
 - 26s - loss: 3.7360 - acc: 0.2463 - val_loss: 3.6596 - val_acc: 0.2682
Epoch 17/250
 - 26s - loss: 3.7420 - acc: 0.2628 - val_loss: 3.8115 - val_acc: 0.2696
Epoch 18/250
 - 26s - loss: 3.7506 - acc: 0.2726 - val_loss: 3.8232 - val_acc: 0.2718
Epoch 19/250
 - 26s - loss: 3.7495 - acc: 0.2869 - val_loss: 3.5881 - val_acc: 0.3313
Epoch 20/250
 - 26s - loss: 3.7644 - acc: 0.2955 - val_loss: 4.1675 - val_acc: 0.2638
Epoch 21/250
 - 26s - loss: 3.4662 - acc: 0.3480 - val_loss: 3.3955 - val_acc: 0.3623
Epoch 22/250
 - 26s - loss: 3.3145 - acc: 0.3679 - val_loss: 3.0883 - val_acc: 0.4198
Epoch 23/250
 - 26s - loss: 3.2904 - acc: 0.3740 - val_loss: 3.3546 - val_acc: 0.3677
Epoch 24/250
 - 26s - loss: 3.2593 - acc: 0.3794 - val_loss: 3.2644 - val_acc: 0.3910
Epoch 25/250
 - 26s - loss: 3.2598 - acc: 0.3870 - val_loss: 3.2654 - val_acc: 0.3933
Epoch 26/250
 - 26s - loss: 3.2654 - acc: 0.3947 - val_loss: 3.2257 - val_acc: 0.4112
Epoch 27/250
 - 26s - loss: 3.2796 - acc: 0.3992 - val_loss: 3.3614 - val_acc: 0.3934
Epoch 28/250
 - 26s - loss: 3.2714 - acc: 0.4037 - val_loss: 3.3750 - val_acc: 0.3975
Epoch 29/250
```

Machine Learning Project Report

```
 - 26s - loss: 3.2946 - acc: 0.4073 - val_loss: 3.1965 - val_acc: 0.4336
Epoch 30/250
 - 26s - loss: 3.2907 - acc: 0.4124 - val_loss: 3.1605 - val_acc: 0.4409
Epoch 31/250
 - 26s - loss: 3.3008 - acc: 0.4182 - val_loss: 3.2512 - val_acc: 0.4366
Epoch 32/250
 - 26s - loss: 3.3084 - acc: 0.4189 - val_loss: 3.4488 - val_acc: 0.4140
Epoch 33/250
 - 26s - loss: 3.3174 - acc: 0.4248 - val_loss: 3.3692 - val_acc: 0.4319
Epoch 34/250
 - 26s - loss: 3.3198 - acc: 0.4294 - val_loss: 3.6615 - val_acc: 0.4013
Epoch 35/250
 - 26s - loss: 3.3179 - acc: 0.4349 - val_loss: 3.4176 - val_acc: 0.4288
Epoch 36/250
 - 26s - loss: 3.3196 - acc: 0.4375 - val_loss: 3.4943 - val_acc: 0.4339
Epoch 37/250
 - 26s - loss: 3.3264 - acc: 0.4382 - val_loss: 3.4441 - val_acc: 0.4196
Epoch 38/250
 - 25s - loss: 3.3328 - acc: 0.4439 - val_loss: 3.5274 - val_acc: 0.4168
Epoch 39/250
 - 26s - loss: 3.3257 - acc: 0.4471 - val_loss: 3.3270 - val_acc: 0.4529
Epoch 40/250
 - 26s - loss: 3.3427 - acc: 0.4459 - val_loss: 3.1870 - val_acc: 0.4799
Epoch 41/250
 - 25s - loss: 3.0762 - acc: 0.4987 - val_loss: 2.9643 - val_acc: 0.5275
Epoch 42/250
 - 25s - loss: 2.9258 - acc: 0.5156 - val_loss: 2.9333 - val_acc: 0.5139
Epoch 43/250
 - 26s - loss: 2.8772 - acc: 0.5155 - val_loss: 2.7859 - val_acc: 0.5362
Epoch 44/250
 - 26s - loss: 2.8330 - acc: 0.5196 - val_loss: 2.8306 - val_acc: 0.5273
Epoch 45/250
 - 26s - loss: 2.8133 - acc: 0.5236 - val_loss: 2.8843 - val_acc: 0.5184
Epoch 46/250
 - 26s - loss: 2.8164 - acc: 0.5222 - val_loss: 2.8089 - val_acc: 0.5270
Epoch 47/250
 - 26s - loss: 2.7995 - acc: 0.5238 - val_loss: 2.8081 - val_acc: 0.5272
Epoch 48/250
 - 26s - loss: 2.8107 - acc: 0.5248 - val_loss: 2.9375 - val_acc: 0.5152
Epoch 49/250
 - 26s - loss: 2.8005 - acc: 0.5300 - val_loss: 2.8647 - val_acc: 0.5354
Epoch 50/250
 - 26s - loss: 2.8189 - acc: 0.5260 - val_loss: 2.9271 - val_acc: 0.5229
Epoch 51/250
 - 26s - loss: 2.7965 - acc: 0.5364 - val_loss: 2.7683 - val_acc: 0.5571
Epoch 52/250
 - 26s - loss: 2.8131 - acc: 0.5347 - val_loss: 2.8927 - val_acc: 0.5246
Epoch 53/250
 - 26s - loss: 2.8005 - acc: 0.5389 - val_loss: 2.9677 - val_acc: 0.5149
Epoch 54/250
 - 26s - loss: 2.8205 - acc: 0.5361 - val_loss: 2.7071 - val_acc: 0.5595
Epoch 55/250
 - 26s - loss: 2.8157 - acc: 0.5389 - val_loss: 2.8835 - val_acc: 0.5416
Epoch 56/250
 - 26s - loss: 2.8162 - acc: 0.5390 - val_loss: 2.9346 - val_acc: 0.5237
```

Machine Learning Project Report

```
Epoch 57/250
 - 26s - loss: 2.8272 - acc: 0.5425 - val_loss: 2.8332 - val_acc: 0.5476
Epoch 58/250
 - 26s - loss: 2.8194 - acc: 0.5466 - val_loss: 2.9615 - val_acc: 0.5290
Epoch 59/250
 - 26s - loss: 2.8302 - acc: 0.5458 - val_loss: 2.8825 - val_acc: 0.5415
Epoch 60/250
 - 26s - loss: 2.8270 - acc: 0.5505 - val_loss: 2.7677 - val_acc: 0.5652
Epoch 61/250
 - 26s - loss: 2.6185 - acc: 0.5891 - val_loss: 2.6056 - val_acc: 0.5962
Epoch 62/250
 - 26s - loss: 2.4968 - acc: 0.6113 - val_loss: 2.5813 - val_acc: 0.5952
Epoch 63/250
 - 26s - loss: 2.4497 - acc: 0.6149 - val_loss: 2.7964 - val_acc: 0.5559
Epoch 64/250
 - 26s - loss: 2.4200 - acc: 0.6161 - val_loss: 2.5451 - val_acc: 0.5910
Epoch 65/250
 - 25s - loss: 2.3868 - acc: 0.6176 - val_loss: 2.5715 - val_acc: 0.5837
Epoch 66/250
 - 26s - loss: 2.3881 - acc: 0.6149 - val_loss: 2.4482 - val_acc: 0.6113
Epoch 67/250
 - 26s - loss: 2.3585 - acc: 0.6209 - val_loss: 2.4967 - val_acc: 0.5942
Epoch 68/250
 - 26s - loss: 2.3543 - acc: 0.6212 - val_loss: 2.5385 - val_acc: 0.5908
Epoch 69/250
 - 26s - loss: 2.3480 - acc: 0.6215 - val_loss: 2.4505 - val_acc: 0.6024
Epoch 70/250
 - 26s - loss: 2.3402 - acc: 0.6206 - val_loss: 2.4691 - val_acc: 0.6005
Epoch 71/250
 - 26s - loss: 2.3278 - acc: 0.6227 - val_loss: 2.4997 - val_acc: 0.5976
Epoch 72/250
 - 26s - loss: 2.3301 - acc: 0.6240 - val_loss: 2.4299 - val_acc: 0.6007
Epoch 73/250
 - 26s - loss: 2.3259 - acc: 0.6239 - val_loss: 2.4850 - val_acc: 0.6004
Epoch 74/250
 - 25s - loss: 2.3172 - acc: 0.6274 - val_loss: 2.4108 - val_acc: 0.6162
Epoch 75/250
 - 25s - loss: 2.3247 - acc: 0.6278 - val_loss: 2.5810 - val_acc: 0.5856
Epoch 76/250
 - 25s - loss: 2.3332 - acc: 0.6259 - val_loss: 2.4518 - val_acc: 0.6105
Epoch 77/250
 - 25s - loss: 2.3224 - acc: 0.6296 - val_loss: 2.5016 - val_acc: 0.5983
Epoch 78/250
 - 25s - loss: 2.3216 - acc: 0.6297 - val_loss: 2.5045 - val_acc: 0.6040
Epoch 79/250
 - 26s - loss: 2.3214 - acc: 0.6320 - val_loss: 2.4495 - val_acc: 0.6124
Epoch 80/250
 - 26s - loss: 2.3335 - acc: 0.6307 - val_loss: 2.5088 - val_acc: 0.6119
Epoch 81/250
 - 26s - loss: 2.1692 - acc: 0.6688 - val_loss: 2.3187 - val_acc: 0.6439
Epoch 82/250
 - 26s - loss: 2.0821 - acc: 0.6862 - val_loss: 2.3215 - val_acc: 0.6422
Epoch 83/250
 - 26s - loss: 2.0432 - acc: 0.6886 - val_loss: 2.2495 - val_acc: 0.6539
Epoch 84/250
```

Machine Learning Project Report

```
 - 26s - loss: 2.0206 - acc: 0.6913 - val_loss: 2.3052 - val_acc: 0.6432
Epoch 85/250
 - 26s - loss: 1.9951 - acc: 0.6948 - val_loss: 2.2957 - val_acc: 0.6416
Epoch 86/250
 - 26s - loss: 1.9730 - acc: 0.6978 - val_loss: 2.2026 - val_acc: 0.6552
Epoch 87/250
 - 25s - loss: 1.9527 - acc: 0.6985 - val_loss: 2.2139 - val_acc: 0.6511
Epoch 88/250
 - 26s - loss: 1.9510 - acc: 0.6997 - val_loss: 2.2681 - val_acc: 0.6418
Epoch 89/250
 - 26s - loss: 1.9494 - acc: 0.6981 - val_loss: 2.3120 - val_acc: 0.6386
Epoch 90/250
 - 26s - loss: 1.9250 - acc: 0.7034 - val_loss: 2.2982 - val_acc: 0.6321
Epoch 91/250
 - 26s - loss: 1.9273 - acc: 0.6991 - val_loss: 2.2410 - val_acc: 0.6443
Epoch 92/250
 - 26s - loss: 1.9171 - acc: 0.7028 - val_loss: 2.3104 - val_acc: 0.6331
Epoch 93/250
 - 26s - loss: 1.9102 - acc: 0.6997 - val_loss: 2.2510 - val_acc: 0.6430
Epoch 94/250
 - 26s - loss: 1.9022 - acc: 0.7026 - val_loss: 2.2786 - val_acc: 0.6373
Epoch 95/250
 - 26s - loss: 1.9005 - acc: 0.7047 - val_loss: 2.3490 - val_acc: 0.6245
Epoch 96/250
 - 26s - loss: 1.9048 - acc: 0.7024 - val_loss: 2.2359 - val_acc: 0.6434
Epoch 97/250
 - 26s - loss: 1.8975 - acc: 0.7045 - val_loss: 2.2191 - val_acc: 0.6447
Epoch 98/250
 - 26s - loss: 1.8920 - acc: 0.7056 - val_loss: 2.3646 - val_acc: 0.6225
Epoch 99/250
 - 26s - loss: 1.8960 - acc: 0.7058 - val_loss: 2.2042 - val_acc: 0.6525
Epoch 100/250
 - 26s - loss: 1.8878 - acc: 0.7085 - val_loss: 2.2993 - val_acc: 0.6300
Epoch 101/250
 - 26s - loss: 1.7692 - acc: 0.7371 - val_loss: 2.1028 - val_acc: 0.6725
Epoch 102/250
 - 26s - loss: 1.7086 - acc: 0.7499 - val_loss: 2.1832 - val_acc: 0.6588
Epoch 103/250
 - 26s - loss: 1.6819 - acc: 0.7527 - val_loss: 2.1714 - val_acc: 0.6562
Epoch 104/250
 - 26s - loss: 1.6548 - acc: 0.7592 - val_loss: 2.0992 - val_acc: 0.6725
Epoch 105/250
 - 26s - loss: 1.6415 - acc: 0.7588 - val_loss: 2.1263 - val_acc: 0.6678
Epoch 106/250
 - 26s - loss: 1.6227 - acc: 0.7637 - val_loss: 2.2212 - val_acc: 0.6532
Epoch 107/250
 - 26s - loss: 1.6175 - acc: 0.7608 - val_loss: 2.1423 - val_acc: 0.6622
Epoch 108/250
 - 26s - loss: 1.5959 - acc: 0.7678 - val_loss: 2.0881 - val_acc: 0.6730
Epoch 109/250
 - 26s - loss: 1.6026 - acc: 0.7640 - val_loss: 2.0944 - val_acc: 0.6713
Epoch 110/250
 - 26s - loss: 1.5787 - acc: 0.7678 - val_loss: 2.0417 - val_acc: 0.6832
Epoch 111/250
 - 26s - loss: 1.5838 - acc: 0.7665 - val_loss: 2.1493 - val_acc: 0.6603
```

Machine Learning Project Report

```
Epoch 112/250
 - 26s - loss: 1.5726 - acc: 0.7692 - val_loss: 2.1042 - val_acc: 0.6695
Epoch 113/250
 - 26s - loss: 1.5567 - acc: 0.7716 - val_loss: 2.1922 - val_acc: 0.6540
Epoch 114/250
 - 26s - loss: 1.5532 - acc: 0.7704 - val_loss: 2.1597 - val_acc: 0.6565
Epoch 115/250
 - 26s - loss: 1.5354 - acc: 0.7753 - val_loss: 2.1220 - val_acc: 0.6668
Epoch 116/250
 - 26s - loss: 1.5399 - acc: 0.7708 - val_loss: 2.1141 - val_acc: 0.6687
Epoch 117/250
 - 26s - loss: 1.5247 - acc: 0.7740 - val_loss: 2.1849 - val_acc: 0.6578
Epoch 118/250
 - 26s - loss: 1.5224 - acc: 0.7759 - val_loss: 2.1530 - val_acc: 0.6622
Epoch 119/250
 - 26s - loss: 1.5246 - acc: 0.7741 - val_loss: 2.0905 - val_acc: 0.6726
Epoch 120/250
 - 26s - loss: 1.5159 - acc: 0.7736 - val_loss: 2.1328 - val_acc: 0.6599
Epoch 121/250
 - 26s - loss: 1.4384 - acc: 0.7954 - val_loss: 2.0659 - val_acc: 0.6777
Epoch 122/250
 - 26s - loss: 1.3982 - acc: 0.8056 - val_loss: 2.1013 - val_acc: 0.6732
Epoch 123/250
 - 26s - loss: 1.3799 - acc: 0.8071 - val_loss: 2.0523 - val_acc: 0.6806
Epoch 124/250
 - 26s - loss: 1.3617 - acc: 0.8120 - val_loss: 2.0836 - val_acc: 0.6779
Epoch 125/250
 - 26s - loss: 1.3541 - acc: 0.8147 - val_loss: 2.1260 - val_acc: 0.6739
Epoch 126/250
 - 26s - loss: 1.3319 - acc: 0.8165 - val_loss: 2.1047 - val_acc: 0.6755
Epoch 127/250
 - 26s - loss: 1.3152 - acc: 0.8201 - val_loss: 2.0933 - val_acc: 0.6798
Epoch 128/250
 - 26s - loss: 1.3189 - acc: 0.8200 - val_loss: 2.0582 - val_acc: 0.6851
Epoch 129/250
 - 26s - loss: 1.3052 - acc: 0.8225 - val_loss: 2.0383 - val_acc: 0.6863
Epoch 130/250
 - 26s - loss: 1.3029 - acc: 0.8208 - val_loss: 2.1430 - val_acc: 0.6745
Epoch 131/250
 - 26s - loss: 1.2852 - acc: 0.8258 - val_loss: 2.2152 - val_acc: 0.6627
Epoch 132/250
 - 26s - loss: 1.2797 - acc: 0.8259 - val_loss: 2.0992 - val_acc: 0.6740
Epoch 133/250
 - 26s - loss: 1.2750 - acc: 0.8253 - val_loss: 2.0821 - val_acc: 0.6768
Epoch 134/250
 - 26s - loss: 1.2671 - acc: 0.8261 - val_loss: 2.0845 - val_acc: 0.6749
Epoch 135/250
 - 26s - loss: 1.2611 - acc: 0.8275 - val_loss: 2.0680 - val_acc: 0.6794
Epoch 136/250
 - 26s - loss: 1.2502 - acc: 0.8298 - val_loss: 2.1274 - val_acc: 0.6677
Epoch 137/250
 - 26s - loss: 1.2645 - acc: 0.8263 - val_loss: 2.0627 - val_acc: 0.6811
Epoch 138/250
 - 26s - loss: 1.2414 - acc: 0.8296 - val_loss: 2.0861 - val_acc: 0.6740
Epoch 139/250
```

Machine Learning Project Report

```
 - 26s - loss: 1.2390 - acc: 0.8315 - val_loss: 2.0939 - val_acc: 0.6775
Epoch 140/250
 - 26s - loss: 1.2405 - acc: 0.8298 - val_loss: 2.1165 - val_acc: 0.6765
Epoch 141/250
 - 26s - loss: 1.1938 - acc: 0.8433 - val_loss: 2.0326 - val_acc: 0.6886
Epoch 142/250
 - 26s - loss: 1.1699 - acc: 0.8490 - val_loss: 2.0844 - val_acc: 0.6800
Epoch 143/250
 - 26s - loss: 1.1508 - acc: 0.8523 - val_loss: 2.1215 - val_acc: 0.6756
Epoch 144/250
 - 26s - loss: 1.1405 - acc: 0.8547 - val_loss: 2.0349 - val_acc: 0.6882
Epoch 145/250
 - 26s - loss: 1.1256 - acc: 0.8593 - val_loss: 2.0729 - val_acc: 0.6848
Epoch 146/250
 - 26s - loss: 1.1101 - acc: 0.8612 - val_loss: 2.0838 - val_acc: 0.6804
Epoch 147/250
 - 26s - loss: 1.1211 - acc: 0.8579 - val_loss: 2.0592 - val_acc: 0.6858
Epoch 148/250
 - 26s - loss: 1.1110 - acc: 0.8599 - val_loss: 2.1277 - val_acc: 0.6726
Epoch 149/250
 - 26s - loss: 1.1057 - acc: 0.8607 - val_loss: 2.0784 - val_acc: 0.6813
Epoch 150/250
 - 26s - loss: 1.0929 - acc: 0.8635 - val_loss: 2.1237 - val_acc: 0.6786
Epoch 151/250
 - 26s - loss: 1.0930 - acc: 0.8644 - val_loss: 2.0612 - val_acc: 0.6876
Epoch 152/250
 - 26s - loss: 1.0757 - acc: 0.8679 - val_loss: 2.0844 - val_acc: 0.6840
Epoch 153/250
 - 26s - loss: 1.0878 - acc: 0.8623 - val_loss: 2.0860 - val_acc: 0.6819
Epoch 154/250
 - 26s - loss: 1.0880 - acc: 0.8621 - val_loss: 2.1512 - val_acc: 0.6772
Epoch 155/250
 - 26s - loss: 1.0690 - acc: 0.8681 - val_loss: 2.1552 - val_acc: 0.6720
Epoch 156/250
 - 26s - loss: 1.0627 - acc: 0.8682 - val_loss: 2.1125 - val_acc: 0.6806
Epoch 157/250
 - 26s - loss: 1.0570 - acc: 0.8701 - val_loss: 2.0952 - val_acc: 0.6854
Epoch 158/250
 - 26s - loss: 1.0545 - acc: 0.8712 - val_loss: 2.0950 - val_acc: 0.6832
Epoch 159/250
 - 26s - loss: 1.0550 - acc: 0.8699 - val_loss: 2.0751 - val_acc: 0.6843
Epoch 160/250
 - 26s - loss: 1.0451 - acc: 0.8711 - val_loss: 2.0752 - val_acc: 0.6853
Epoch 161/250
 - 26s - loss: 1.0288 - acc: 0.8751 - val_loss: 2.0755 - val_acc: 0.6858
Epoch 162/250
 - 26s - loss: 1.0048 - acc: 0.8813 - val_loss: 2.0842 - val_acc: 0.6882
Epoch 163/250
 - 26s - loss: 1.0056 - acc: 0.8820 - val_loss: 2.0820 - val_acc: 0.6882
Epoch 164/250
 - 26s - loss: 0.9977 - acc: 0.8840 - val_loss: 2.1042 - val_acc: 0.6854
Epoch 165/250
 - 26s - loss: 0.9901 - acc: 0.8861 - val_loss: 2.0950 - val_acc: 0.6870
Epoch 166/250
 - 26s - loss: 0.9775 - acc: 0.8899 - val_loss: 2.0625 - val_acc: 0.6909
```

Machine Learning Project Report

```
Epoch 167/250
 - 26s - loss: 0.9818 - acc: 0.8869 - val_loss: 2.1022 - val_acc: 0.6862
Epoch 168/250
 - 26s - loss: 0.9828 - acc: 0.8856 - val_loss: 2.1117 - val_acc: 0.6839
Epoch 169/250
 - 26s - loss: 0.9703 - acc: 0.8901 - val_loss: 2.1006 - val_acc: 0.6867
Epoch 170/250
 - 26s - loss: 0.9687 - acc: 0.8897 - val_loss: 2.0830 - val_acc: 0.6905
Epoch 171/250
 - 26s - loss: 0.9674 - acc: 0.8886 - val_loss: 2.0941 - val_acc: 0.6865
Epoch 172/250
 - 26s - loss: 0.9627 - acc: 0.8919 - val_loss: 2.1281 - val_acc: 0.6813
Epoch 173/250
 - 26s - loss: 0.9497 - acc: 0.8939 - val_loss: 2.0903 - val_acc: 0.6880
Epoch 174/250
 - 26s - loss: 0.9525 - acc: 0.8949 - val_loss: 2.1049 - val_acc: 0.6865
Epoch 175/250
 - 26s - loss: 0.9587 - acc: 0.8914 - val_loss: 2.0926 - val_acc: 0.6858
Epoch 176/250
 - 26s - loss: 0.9492 - acc: 0.8922 - val_loss: 2.0985 - val_acc: 0.6852
Epoch 177/250
 - 26s - loss: 0.9490 - acc: 0.8925 - val_loss: 2.1051 - val_acc: 0.6851
Epoch 178/250
 - 26s - loss: 0.9344 - acc: 0.8960 - val_loss: 2.1334 - val_acc: 0.6851
Epoch 179/250
 - 26s - loss: 0.9501 - acc: 0.8906 - val_loss: 2.1180 - val_acc: 0.6871
Epoch 180/250
 - 26s - loss: 0.9386 - acc: 0.8946 - val_loss: 2.1169 - val_acc: 0.6840
Epoch 181/250
 - 26s - loss: 0.9347 - acc: 0.8951 - val_loss: 2.1136 - val_acc: 0.6859
Epoch 182/250
 - 26s - loss: 0.9201 - acc: 0.8999 - val_loss: 2.0911 - val_acc: 0.6879
Epoch 183/250
 - 26s - loss: 0.9136 - acc: 0.9003 - val_loss: 2.1020 - val_acc: 0.6866
Epoch 184/250
 - 26s - loss: 0.9188 - acc: 0.8987 - val_loss: 2.0981 - val_acc: 0.6880
Epoch 185/250
 - 26s - loss: 0.9166 - acc: 0.9010 - val_loss: 2.1189 - val_acc: 0.6846
Epoch 186/250
 - 26s - loss: 0.9161 - acc: 0.9018 - val_loss: 2.1113 - val_acc: 0.6857
Epoch 187/250
 - 26s - loss: 0.9076 - acc: 0.9019 - val_loss: 2.1191 - val_acc: 0.6844
Epoch 188/250
 - 26s - loss: 0.9050 - acc: 0.9020 - val_loss: 2.1009 - val_acc: 0.6881
Epoch 189/250
 - 26s - loss: 0.9028 - acc: 0.9044 - val_loss: 2.1037 - val_acc: 0.6880
Epoch 190/250
 - 26s - loss: 0.8945 - acc: 0.9044 - val_loss: 2.1015 - val_acc: 0.6888
Epoch 191/250
 - 26s - loss: 0.8985 - acc: 0.9046 - val_loss: 2.1237 - val_acc: 0.6850
Epoch 192/250
 - 26s - loss: 0.8992 - acc: 0.9028 - val_loss: 2.1044 - val_acc: 0.6874
Epoch 193/250
 - 26s - loss: 0.8917 - acc: 0.9053 - val_loss: 2.1046 - val_acc: 0.6875
Epoch 194/250
```

```
 - 26s - loss: 0.8976 - acc: 0.9047 - val_loss: 2.0956 - val_acc: 0.6921
Epoch 195/250
 - 26s - loss: 0.8882 - acc: 0.9058 - val_loss: 2.1317 - val_acc: 0.6874
Epoch 196/250
 - 26s - loss: 0.8934 - acc: 0.9050 - val_loss: 2.1004 - val_acc: 0.6914
Epoch 197/250
 - 26s - loss: 0.8866 - acc: 0.9066 - val_loss: 2.1143 - val_acc: 0.6890
Epoch 198/250
 - 26s - loss: 0.8908 - acc: 0.9039 - val_loss: 2.1179 - val_acc: 0.6896
Epoch 199/250
 - 26s - loss: 0.8849 - acc: 0.9065 - val_loss: 2.1083 - val_acc: 0.6913
Epoch 200/250
 - 26s - loss: 0.8768 - acc: 0.9092 - val_loss: 2.1075 - val_acc: 0.6875
Epoch 201/250
 - 26s - loss: 0.8697 - acc: 0.9108 - val_loss: 2.0998 - val_acc: 0.6898
Epoch 202/250
 - 26s - loss: 0.8736 - acc: 0.9091 - val_loss: 2.1054 - val_acc: 0.6875
Epoch 203/250
 - 26s - loss: 0.8736 - acc: 0.9092 - val_loss: 2.1071 - val_acc: 0.6880
Epoch 204/250
 - 26s - loss: 0.8712 - acc: 0.9101 - val_loss: 2.1118 - val_acc: 0.6887
Epoch 205/250
 - 26s - loss: 0.8745 - acc: 0.9093 - val_loss: 2.1012 - val_acc: 0.6896
Epoch 206/250
 - 26s - loss: 0.8622 - acc: 0.9120 - val_loss: 2.1030 - val_acc: 0.6907
Epoch 207/250
 - 26s - loss: 0.8660 - acc: 0.9112 - val_loss: 2.1078 - val_acc: 0.6876
Epoch 208/250
 - 26s - loss: 0.8660 - acc: 0.9114 - val_loss: 2.1000 - val_acc: 0.6891
Epoch 209/250
 - 26s - loss: 0.8654 - acc: 0.9102 - val_loss: 2.1071 - val_acc: 0.6874
Epoch 210/250
 - 26s - loss: 0.8632 - acc: 0.9112 - val_loss: 2.0927 - val_acc: 0.6915
Epoch 211/250
 - 26s - loss: 0.8607 - acc: 0.9131 - val_loss: 2.1102 - val_acc: 0.6885
Epoch 212/250
 - 26s - loss: 0.8579 - acc: 0.9130 - val_loss: 2.1067 - val_acc: 0.6904
Epoch 213/250
 - 26s - loss: 0.8586 - acc: 0.9139 - val_loss: 2.0984 - val_acc: 0.6913
Epoch 214/250
 - 26s - loss: 0.8651 - acc: 0.9112 - val_loss: 2.1113 - val_acc: 0.6898
Epoch 215/250
 - 26s - loss: 0.8612 - acc: 0.9121 - val_loss: 2.1016 - val_acc: 0.6888
Epoch 216/250
 - 25s - loss: 0.8590 - acc: 0.9141 - val_loss: 2.0915 - val_acc: 0.6923
Epoch 217/250
 - 26s - loss: 0.8576 - acc: 0.9111 - val_loss: 2.1094 - val_acc: 0.6877
Epoch 218/250
 - 26s - loss: 0.8511 - acc: 0.9144 - val_loss: 2.1187 - val_acc: 0.6878
Epoch 219/250
 - 25s - loss: 0.8594 - acc: 0.9108 - val_loss: 2.1124 - val_acc: 0.6880
Epoch 220/250
 - 25s - loss: 0.8548 - acc: 0.9127 - val_loss: 2.1165 - val_acc: 0.6888
Epoch 221/250
 - 25s - loss: 0.8490 - acc: 0.9142 - val_loss: 2.1217 - val_acc: 0.6890
```

Machine Learning Project Report

```
Epoch 222/250
 - 26s - loss: 0.8496 - acc: 0.9147 - val_loss: 2.1120 - val_acc: 0.6890
Epoch 223/250
 - 26s - loss: 0.8483 - acc: 0.9139 - val_loss: 2.1117 - val_acc: 0.6912
Epoch 224/250
 - 26s - loss: 0.8452 - acc: 0.9155 - val_loss: 2.1121 - val_acc: 0.6897
Epoch 225/250
 - 26s - loss: 0.8501 - acc: 0.9146 - val_loss: 2.1169 - val_acc: 0.6887
Epoch 226/250
 - 26s - loss: 0.8510 - acc: 0.9146 - val_loss: 2.1184 - val_acc: 0.6888
Epoch 227/250
 - 26s - loss: 0.8443 - acc: 0.9165 - val_loss: 2.1152 - val_acc: 0.6901
Epoch 228/250
 - 26s - loss: 0.8450 - acc: 0.9158 - val_loss: 2.1082 - val_acc: 0.6903
Epoch 229/250
 - 27s - loss: 0.8445 - acc: 0.9157 - val_loss: 2.1134 - val_acc: 0.6895
Epoch 230/250
 - 26s - loss: 0.8441 - acc: 0.9152 - val_loss: 2.1112 - val_acc: 0.6889
Epoch 231/250
 - 26s - loss: 0.8444 - acc: 0.9144 - val_loss: 2.1102 - val_acc: 0.6904
Epoch 232/250
 - 26s - loss: 0.8491 - acc: 0.9137 - val_loss: 2.1135 - val_acc: 0.6901
Epoch 233/250
 - 26s - loss: 0.8458 - acc: 0.9148 - val_loss: 2.1136 - val_acc: 0.6903
Epoch 234/250
 - 26s - loss: 0.8380 - acc: 0.9171 - val_loss: 2.1115 - val_acc: 0.6903
Epoch 235/250
 - 26s - loss: 0.8396 - acc: 0.9171 - val_loss: 2.1068 - val_acc: 0.6901
Epoch 236/250
 - 26s - loss: 0.8457 - acc: 0.9151 - val_loss: 2.1118 - val_acc: 0.6883
Epoch 237/250
 - 26s - loss: 0.8442 - acc: 0.9156 - val_loss: 2.1038 - val_acc: 0.6919
Epoch 238/250
 - 26s - loss: 0.8452 - acc: 0.9144 - val_loss: 2.1092 - val_acc: 0.6903
Epoch 239/250
 - 26s - loss: 0.8399 - acc: 0.9155 - val_loss: 2.1039 - val_acc: 0.6909
Epoch 240/250
 - 26s - loss: 0.8401 - acc: 0.9170 - val_loss: 2.1130 - val_acc: 0.6911
Epoch 241/250
 - 26s - loss: 0.8355 - acc: 0.9181 - val_loss: 2.1085 - val_acc: 0.6896
Epoch 242/250
 - 26s - loss: 0.8355 - acc: 0.9179 - val_loss: 2.1142 - val_acc: 0.6891
Epoch 243/250
 - 26s - loss: 0.8374 - acc: 0.9174 - val_loss: 2.1143 - val_acc: 0.6954
Epoch 244/250
 - 26s - loss: 0.8294 - acc: 0.9190 - val_loss: 2.1124 - val_acc: 0.6991
Epoch 245/250
 - 26s - loss: 0.8310 - acc: 0.9192 - val_loss: 2.0991 - val_acc: 0.7034
Epoch 246/250
 - 26s - loss: 0.8367 - acc: 0.9163 - val_loss: 2.1037 - val_acc: 0.7056
Epoch 247/250
 - 26s - loss: 0.8393 - acc: 0.9170 - val_loss: 2.1076 - val_acc: 0.7089
Epoch 248/250
 - 26s - loss: 0.8365 - acc: 0.9182 - val_loss: 2.1078 - val_acc: 0.7101
Epoch 249/250
```

Machine Learning Project Report

```
 - 26s - loss: 0.8260 - acc: 0.9201 - val_loss: 2.1024 - val_acc: 0.7121
Epoch 250/250
 - 26s - loss: 0.8319 - acc: 0.9193 - val_loss: 2.1072 - val_acc: 0.7143
Training Time : 6461.053843021393
Accuracy:  71.43 %
```

Run 3:

```
121.93584
68.38902
Epoch 1/250
 - 30s - loss: 18.7502 - acc: 0.0239 - val_loss: 14.6522 - val_acc: 0.0163
Epoch 2/250
 - 26s - loss: 11.4647 - acc: 0.0439 - val_loss: 9.4003 - val_acc: 0.0218
Epoch 3/250
 - 26s - loss: 8.5017 - acc: 0.0394 - val_loss: 7.8104 - val_acc: 0.0445
Epoch 4/250
 - 26s - loss: 7.0439 - acc: 0.0468 - val_loss: 6.3975 - val_acc: 0.0336
Epoch 5/250
 - 26s - loss: 5.5937 - acc: 0.0657 - val_loss: 5.6558 - val_acc: 0.0202
Epoch 6/250
 - 26s - loss: 4.7609 - acc: 0.0842 - val_loss: 4.9156 - val_acc: 0.0449
Epoch 7/250
 - 26s - loss: 4.3819 - acc: 0.0957 - val_loss: 4.5202 - val_acc: 0.0738
Epoch 8/250
 - 26s - loss: 4.1964 - acc: 0.1127 - val_loss: 4.2389 - val_acc: 0.1076
Epoch 9/250
 - 26s - loss: 4.0565 - acc: 0.1296 - val_loss: 3.9747 - val_acc: 0.1556
Epoch 10/250
 - 26s - loss: 3.9777 - acc: 0.1447 - val_loss: 3.8448 - val_acc: 0.1701
Epoch 11/250
 - 26s - loss: 3.9027 - acc: 0.1598 - val_loss: 3.9674 - val_acc: 0.1752
Epoch 12/250
 - 26s - loss: 3.8708 - acc: 0.1702 - val_loss: 3.7472 - val_acc: 0.1995
Epoch 13/250
 - 26s - loss: 3.8097 - acc: 0.1989 - val_loss: 3.6767 - val_acc: 0.2364
Epoch 14/250
 - 26s - loss: 3.7564 - acc: 0.2171 - val_loss: 3.6926 - val_acc: 0.2432
Epoch 15/250
 - 26s - loss: 3.7363 - acc: 0.2364 - val_loss: 3.6505 - val_acc: 0.2561
Epoch 16/250
 - 26s - loss: 3.7241 - acc: 0.2543 - val_loss: 3.6460 - val_acc: 0.2812
Epoch 17/250
 - 26s - loss: 3.7397 - acc: 0.2694 - val_loss: 3.8514 - val_acc: 0.2640
Epoch 18/250
 - 26s - loss: 3.7257 - acc: 0.2822 - val_loss: 3.6232 - val_acc: 0.3153
Epoch 19/250
 - 26s - loss: 3.7412 - acc: 0.2949 - val_loss: 3.5996 - val_acc: 0.3222
Epoch 20/250
```

Machine Learning Project Report

```
 - 26s - loss: 3.7478 - acc: 0.3044 - val_loss: 3.8868 - val_acc: 0.2966
Epoch 21/250
 - 26s - loss: 3.4332 - acc: 0.3616 - val_loss: 3.3439 - val_acc: 0.3855
Epoch 22/250
 - 26s - loss: 3.2927 - acc: 0.3756 - val_loss: 3.3064 - val_acc: 0.3900
Epoch 23/250
 - 26s - loss: 3.2552 - acc: 0.3831 - val_loss: 3.2420 - val_acc: 0.3918
Epoch 24/250
 - 26s - loss: 3.2453 - acc: 0.3893 - val_loss: 3.3796 - val_acc: 0.3756
Epoch 25/250
 - 26s - loss: 3.2437 - acc: 0.3984 - val_loss: 3.4726 - val_acc: 0.3756
Epoch 26/250
 - 26s - loss: 3.2474 - acc: 0.4043 - val_loss: 3.2384 - val_acc: 0.4103
Epoch 27/250
 - 26s - loss: 3.2552 - acc: 0.4106 - val_loss: 3.2692 - val_acc: 0.4261
Epoch 28/250
 - 26s - loss: 3.2485 - acc: 0.4178 - val_loss: 3.1857 - val_acc: 0.4476
Epoch 29/250
 - 26s - loss: 3.2623 - acc: 0.4196 - val_loss: 3.2810 - val_acc: 0.4322
Epoch 30/250
 - 26s - loss: 3.2725 - acc: 0.4271 - val_loss: 3.4296 - val_acc: 0.4036
Epoch 31/250
 - 26s - loss: 3.2937 - acc: 0.4279 - val_loss: 3.2417 - val_acc: 0.4453
Epoch 32/250
 - 26s - loss: 3.2858 - acc: 0.4350 - val_loss: 3.2418 - val_acc: 0.4514
Epoch 33/250
 - 26s - loss: 3.2899 - acc: 0.4369 - val_loss: 3.2702 - val_acc: 0.4470
Epoch 34/250
 - 26s - loss: 3.2852 - acc: 0.4416 - val_loss: 3.4443 - val_acc: 0.4305
Epoch 35/250
 - 26s - loss: 3.3034 - acc: 0.4431 - val_loss: 3.1901 - val_acc: 0.4729
Epoch 36/250
 - 26s - loss: 3.3096 - acc: 0.4445 - val_loss: 3.2266 - val_acc: 0.4733
Epoch 37/250
 - 26s - loss: 3.3132 - acc: 0.4490 - val_loss: 3.3243 - val_acc: 0.4543
Epoch 38/250
 - 26s - loss: 3.2977 - acc: 0.4539 - val_loss: 3.2419 - val_acc: 0.4777
Epoch 39/250
 - 25s - loss: 3.3201 - acc: 0.4546 - val_loss: 3.2470 - val_acc: 0.4721
Epoch 40/250
 - 26s - loss: 3.3196 - acc: 0.4579 - val_loss: 3.5200 - val_acc: 0.4310
Epoch 41/250
 - 25s - loss: 3.0563 - acc: 0.5077 - val_loss: 2.8816 - val_acc: 0.5386
Epoch 42/250
 - 26s - loss: 2.9137 - acc: 0.5225 - val_loss: 2.9258 - val_acc: 0.5148
Epoch 43/250
 - 26s - loss: 2.8375 - acc: 0.5288 - val_loss: 2.8640 - val_acc: 0.5211
Epoch 44/250
 - 26s - loss: 2.8149 - acc: 0.5281 - val_loss: 3.0841 - val_acc: 0.4838
Epoch 45/250
 - 26s - loss: 2.7931 - acc: 0.5290 - val_loss: 2.7688 - val_acc: 0.5437
Epoch 46/250
```

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 - 26s - loss: 2.7877 - acc: 0.5310 - val_loss: 2.8550 - val_acc: 0.5248
Epoch 47/250
 - 25s - loss: 2.7745 - acc: 0.5318 - val_loss: 2.7962 - val_acc: 0.5419
Epoch 48/250
 - 26s - loss: 2.7858 - acc: 0.5319 - val_loss: 2.9742 - val_acc: 0.5090
Epoch 49/250
 - 26s - loss: 2.7763 - acc: 0.5360 - val_loss: 3.0202 - val_acc: 0.5059
Epoch 50/250
 - 26s - loss: 2.7913 - acc: 0.5366 - val_loss: 2.7573 - val_acc: 0.5519
Epoch 51/250
 - 26s - loss: 2.7821 - acc: 0.5400 - val_loss: 3.0113 - val_acc: 0.5130
Epoch 52/250
 - 26s - loss: 2.7840 - acc: 0.5413 - val_loss: 2.8658 - val_acc: 0.5355
Epoch 53/250
 - 26s - loss: 2.7788 - acc: 0.5443 - val_loss: 2.8707 - val_acc: 0.5323
Epoch 54/250
 - 26s - loss: 2.7966 - acc: 0.5437 - val_loss: 3.0194 - val_acc: 0.5117
Epoch 55/250
 - 26s - loss: 2.7916 - acc: 0.5467 - val_loss: 3.0979 - val_acc: 0.5106
Epoch 56/250
 - 26s - loss: 2.7974 - acc: 0.5501 - val_loss: 2.8678 - val_acc: 0.5407
Epoch 57/250
 - 26s - loss: 2.7963 - acc: 0.5490 - val_loss: 2.9129 - val_acc: 0.5433
Epoch 58/250
 - 26s - loss: 2.8011 - acc: 0.5532 - val_loss: 2.9803 - val_acc: 0.5264
Epoch 59/250
 - 26s - loss: 2.7910 - acc: 0.5575 - val_loss: 2.9021 - val_acc: 0.5466
Epoch 60/250
 - 26s - loss: 2.8054 - acc: 0.5528 - val_loss: 2.8983 - val_acc: 0.5358
Epoch 61/250
 - 26s - loss: 2.5998 - acc: 0.5975 - val_loss: 2.6724 - val_acc: 0.5901
Epoch 62/250
 - 26s - loss: 2.4919 - acc: 0.6134 - val_loss: 2.5270 - val_acc: 0.6051
Epoch 63/250
 - 26s - loss: 2.4184 - acc: 0.6236 - val_loss: 2.4620 - val_acc: 0.6162
Epoch 64/250
 - 26s - loss: 2.3877 - acc: 0.6244 - val_loss: 2.5150 - val_acc: 0.5992
Epoch 65/250
 - 26s - loss: 2.3548 - acc: 0.6250 - val_loss: 2.6662 - val_acc: 0.5793
Epoch 66/250
 - 26s - loss: 2.3481 - acc: 0.6250 - val_loss: 2.4814 - val_acc: 0.6067
Epoch 67/250
 - 26s - loss: 2.3337 - acc: 0.6257 - val_loss: 2.6290 - val_acc: 0.5786
Epoch 68/250
 - 26s - loss: 2.3335 - acc: 0.6243 - val_loss: 2.4187 - val_acc: 0.6152
Epoch 69/250
 - 26s - loss: 2.3195 - acc: 0.6275 - val_loss: 2.4531 - val_acc: 0.6141
Epoch 70/250
 - 26s - loss: 2.3072 - acc: 0.6310 - val_loss: 2.4255 - val_acc: 0.6136
Epoch 71/250
 - 26s - loss: 2.3233 - acc: 0.6237 - val_loss: 2.5032 - val_acc: 0.5923
Epoch 72/250
```

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 - 26s - loss: 2.2982 - acc: 0.6319 - val_loss: 2.3902 - val_acc: 0.6140
Epoch 73/250
 - 26s - loss: 2.3140 - acc: 0.6289 - val_loss: 2.5192 - val_acc: 0.5951
Epoch 74/250
 - 26s - loss: 2.3099 - acc: 0.6317 - val_loss: 2.3603 - val_acc: 0.6250
Epoch 75/250
 - 26s - loss: 2.3061 - acc: 0.6338 - val_loss: 2.4870 - val_acc: 0.6000
Epoch 76/250
 - 26s - loss: 2.3095 - acc: 0.6332 - val_loss: 2.4098 - val_acc: 0.6186
Epoch 77/250
 - 26s - loss: 2.3074 - acc: 0.6345 - val_loss: 2.5692 - val_acc: 0.5944
Epoch 78/250
 - 26s - loss: 2.3051 - acc: 0.6362 - val_loss: 2.5442 - val_acc: 0.5958
Epoch 79/250
 - 26s - loss: 2.2992 - acc: 0.6401 - val_loss: 2.4147 - val_acc: 0.6225
Epoch 80/250
 - 26s - loss: 2.3042 - acc: 0.6394 - val_loss: 2.4915 - val_acc: 0.6106
Epoch 81/250
 - 26s - loss: 2.1470 - acc: 0.6748 - val_loss: 2.3966 - val_acc: 0.6303
Epoch 82/250
 - 26s - loss: 2.0641 - acc: 0.6911 - val_loss: 2.2644 - val_acc: 0.6523
Epoch 83/250
 - 26s - loss: 2.0245 - acc: 0.6953 - val_loss: 2.3132 - val_acc: 0.6389
Epoch 84/250
 - 26s - loss: 1.9981 - acc: 0.6989 - val_loss: 2.3844 - val_acc: 0.6264
Epoch 85/250
 - 26s - loss: 1.9769 - acc: 0.6995 - val_loss: 2.2197 - val_acc: 0.6511
Epoch 86/250
 - 26s - loss: 1.9509 - acc: 0.7021 - val_loss: 2.2696 - val_acc: 0.6456
Epoch 87/250
 - 26s - loss: 1.9473 - acc: 0.7012 - val_loss: 2.2549 - val_acc: 0.6453
Epoch 88/250
 - 26s - loss: 1.9255 - acc: 0.7075 - val_loss: 2.2759 - val_acc: 0.6438
Epoch 89/250
 - 26s - loss: 1.9087 - acc: 0.7074 - val_loss: 2.2779 - val_acc: 0.6467
Epoch 90/250
 - 26s - loss: 1.9196 - acc: 0.7038 - val_loss: 2.2902 - val_acc: 0.6354
Epoch 91/250
 - 26s - loss: 1.8944 - acc: 0.7062 - val_loss: 2.2026 - val_acc: 0.6537
Epoch 92/250
 - 26s - loss: 1.8900 - acc: 0.7091 - val_loss: 2.1911 - val_acc: 0.6508
Epoch 93/250
 - 26s - loss: 1.8871 - acc: 0.7096 - val_loss: 2.2220 - val_acc: 0.6504
Epoch 94/250
 - 26s - loss: 1.8785 - acc: 0.7095 - val_loss: 2.2527 - val_acc: 0.6420
Epoch 95/250
 - 26s - loss: 1.8774 - acc: 0.7083 - val_loss: 2.2138 - val_acc: 0.6439
Epoch 96/250
 - 26s - loss: 1.8871 - acc: 0.7058 - val_loss: 2.1967 - val_acc: 0.6541
Epoch 97/250
 - 26s - loss: 1.8739 - acc: 0.7095 - val_loss: 2.2361 - val_acc: 0.6445
Epoch 98/250
```

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 - 26s - loss: 1.8685 - acc: 0.7108 - val_loss: 2.2807 - val_acc: 0.6407
Epoch 99/250
 - 26s - loss: 1.8649 - acc: 0.7125 - val_loss: 2.2264 - val_acc: 0.6524
Epoch 100/250
 - 26s - loss: 1.8704 - acc: 0.7099 - val_loss: 2.1528 - val_acc: 0.6618
Epoch 101/250
 - 26s - loss: 1.7519 - acc: 0.7416 - val_loss: 2.1890 - val_acc: 0.6602
Epoch 102/250
 - 26s - loss: 1.6904 - acc: 0.7543 - val_loss: 2.1657 - val_acc: 0.6637
Epoch 103/250
 - 26s - loss: 1.6693 - acc: 0.7585 - val_loss: 2.1556 - val_acc: 0.6645
Epoch 104/250
 - 26s - loss: 1.6383 - acc: 0.7631 - val_loss: 2.2171 - val_acc: 0.6561
Epoch 105/250
 - 26s - loss: 1.6262 - acc: 0.7610 - val_loss: 2.1359 - val_acc: 0.6670
Epoch 106/250
 - 26s - loss: 1.6015 - acc: 0.7671 - val_loss: 2.1451 - val_acc: 0.6663
Epoch 107/250
 - 26s - loss: 1.5942 - acc: 0.7674 - val_loss: 2.1227 - val_acc: 0.6711
Epoch 108/250
 - 26s - loss: 1.5773 - acc: 0.7726 - val_loss: 2.1091 - val_acc: 0.6749
Epoch 109/250
 - 26s - loss: 1.5593 - acc: 0.7740 - val_loss: 2.1275 - val_acc: 0.6687
Epoch 110/250
 - 26s - loss: 1.5591 - acc: 0.7712 - val_loss: 2.1299 - val_acc: 0.6711
Epoch 111/250
 - 26s - loss: 1.5567 - acc: 0.7731 - val_loss: 2.2058 - val_acc: 0.6511
Epoch 112/250
 - 26s - loss: 1.5480 - acc: 0.7711 - val_loss: 2.1612 - val_acc: 0.6620
Epoch 113/250
 - 26s - loss: 1.5294 - acc: 0.7761 - val_loss: 2.0955 - val_acc: 0.6703
Epoch 114/250
 - 26s - loss: 1.5189 - acc: 0.7781 - val_loss: 2.1476 - val_acc: 0.6616
Epoch 115/250
 - 26s - loss: 1.5136 - acc: 0.7793 - val_loss: 2.1449 - val_acc: 0.6688
Epoch 116/250
 - 26s - loss: 1.5249 - acc: 0.7758 - val_loss: 2.0870 - val_acc: 0.6715
Epoch 117/250
 - 26s - loss: 1.5118 - acc: 0.7790 - val_loss: 2.1889 - val_acc: 0.6560
Epoch 118/250
 - 26s - loss: 1.5148 - acc: 0.7752 - val_loss: 2.1818 - val_acc: 0.6535
Epoch 119/250
 - 26s - loss: 1.4964 - acc: 0.7781 - val_loss: 2.1277 - val_acc: 0.6657
Epoch 120/250
 - 26s - loss: 1.5010 - acc: 0.7786 - val_loss: 2.0444 - val_acc: 0.6781
Epoch 121/250
 - 26s - loss: 1.4308 - acc: 0.7962 - val_loss: 2.0853 - val_acc: 0.6760
Epoch 122/250
 - 26s - loss: 1.3803 - acc: 0.8072 - val_loss: 2.1075 - val_acc: 0.6738
Epoch 123/250
 - 26s - loss: 1.3582 - acc: 0.8148 - val_loss: 2.0834 - val_acc: 0.6770
Epoch 124/250
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 - 26s - loss: 1.3390 - acc: 0.8175 - val_loss: 2.1116 - val_acc: 0.6742
Epoch 125/250
 - 26s - loss: 1.3278 - acc: 0.8192 - val_loss: 2.0959 - val_acc: 0.6784
Epoch 126/250
 - 26s - loss: 1.3115 - acc: 0.8228 - val_loss: 2.1019 - val_acc: 0.6803
Epoch 127/250
 - 26s - loss: 1.3015 - acc: 0.8250 - val_loss: 2.0544 - val_acc: 0.6851
Epoch 128/250
 - 26s - loss: 1.3053 - acc: 0.8216 - val_loss: 2.0908 - val_acc: 0.6826
Epoch 129/250
 - 26s - loss: 1.2773 - acc: 0.8269 - val_loss: 2.1007 - val_acc: 0.6787
Epoch 130/250
 - 26s - loss: 1.2769 - acc: 0.8246 - val_loss: 2.1037 - val_acc: 0.6786
Epoch 131/250
 - 26s - loss: 1.2767 - acc: 0.8266 - val_loss: 2.1089 - val_acc: 0.6765
Epoch 132/250
 - 26s - loss: 1.2672 - acc: 0.8292 - val_loss: 2.1097 - val_acc: 0.6786
Epoch 133/250
 - 26s - loss: 1.2448 - acc: 0.8326 - val_loss: 2.0886 - val_acc: 0.6840
Epoch 134/250
 - 26s - loss: 1.2476 - acc: 0.8315 - val_loss: 2.0529 - val_acc: 0.6880
Epoch 135/250
 - 26s - loss: 1.2521 - acc: 0.8304 - val_loss: 2.1184 - val_acc: 0.6771
Epoch 136/250
 - 26s - loss: 1.2311 - acc: 0.8345 - val_loss: 2.0452 - val_acc: 0.6875
Epoch 137/250
 - 26s - loss: 1.2306 - acc: 0.8349 - val_loss: 2.1017 - val_acc: 0.6781
Epoch 138/250
 - 26s - loss: 1.2332 - acc: 0.8308 - val_loss: 2.0805 - val_acc: 0.6830
Epoch 139/250
 - 26s - loss: 1.2173 - acc: 0.8344 - val_loss: 2.0872 - val_acc: 0.6841
Epoch 140/250
 - 26s - loss: 1.2137 - acc: 0.8354 - val_loss: 2.0960 - val_acc: 0.6789
Epoch 141/250
 - 26s - loss: 1.1783 - acc: 0.8448 - val_loss: 2.0420 - val_acc: 0.6890
Epoch 142/250
 - 26s - loss: 1.1503 - acc: 0.8503 - val_loss: 2.0141 - val_acc: 0.6966
Epoch 143/250
 - 26s - loss: 1.1312 - acc: 0.8539 - val_loss: 2.0733 - val_acc: 0.6858
Epoch 144/250
 - 26s - loss: 1.1238 - acc: 0.8581 - val_loss: 2.0564 - val_acc: 0.6891
Epoch 145/250
 - 26s - loss: 1.1092 - acc: 0.8612 - val_loss: 2.0760 - val_acc: 0.6832
Epoch 146/250
 - 26s - loss: 1.0986 - acc: 0.8650 - val_loss: 2.1183 - val_acc: 0.6788
Epoch 147/250
 - 26s - loss: 1.0911 - acc: 0.8656 - val_loss: 2.0543 - val_acc: 0.6931
Epoch 148/250
 - 26s - loss: 1.0903 - acc: 0.8647 - val_loss: 2.0472 - val_acc: 0.6928
Epoch 149/250
 - 26s - loss: 1.0825 - acc: 0.8650 - val_loss: 2.0744 - val_acc: 0.6872
Epoch 150/250
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 - 26s - loss: 1.0815 - acc: 0.8663 - val_loss: 2.0581 - val_acc: 0.6917
Epoch 151/250
 - 26s - loss: 1.0744 - acc: 0.8685 - val_loss: 2.0645 - val_acc: 0.6921
Epoch 152/250
 - 26s - loss: 1.0713 - acc: 0.8675 - val_loss: 2.0768 - val_acc: 0.6894
Epoch 153/250
 - 26s - loss: 1.0619 - acc: 0.8683 - val_loss: 2.0806 - val_acc: 0.6859
Epoch 154/250
 - 26s - loss: 1.0588 - acc: 0.8698 - val_loss: 2.0942 - val_acc: 0.6887
Epoch 155/250
 - 26s - loss: 1.0472 - acc: 0.8717 - val_loss: 2.0768 - val_acc: 0.6901
Epoch 156/250
 - 26s - loss: 1.0546 - acc: 0.8703 - val_loss: 2.0940 - val_acc: 0.6881
Epoch 157/250
 - 26s - loss: 1.0412 - acc: 0.8721 - val_loss: 2.1150 - val_acc: 0.6869
Epoch 158/250
 - 26s - loss: 1.0449 - acc: 0.8711 - val_loss: 2.0860 - val_acc: 0.6898
Epoch 159/250
 - 26s - loss: 1.0383 - acc: 0.8736 - val_loss: 2.0904 - val_acc: 0.6843
Epoch 160/250
 - 26s - loss: 1.0298 - acc: 0.8748 - val_loss: 2.0676 - val_acc: 0.6897
Epoch 161/250
 - 26s - loss: 1.0160 - acc: 0.8773 - val_loss: 2.0261 - val_acc: 0.6976
Epoch 162/250
 - 26s - loss: 0.9921 - acc: 0.8843 - val_loss: 2.0318 - val_acc: 0.6976
Epoch 163/250
 - 26s - loss: 0.9768 - acc: 0.8879 - val_loss: 2.0391 - val_acc: 0.6984
Epoch 164/250
 - 26s - loss: 0.9841 - acc: 0.8868 - val_loss: 2.0497 - val_acc: 0.6948
Epoch 165/250
 - 26s - loss: 0.9745 - acc: 0.8877 - val_loss: 2.0702 - val_acc: 0.6924
Epoch 166/250
 - 26s - loss: 0.9735 - acc: 0.8876 - val_loss: 2.0657 - val_acc: 0.6953
Epoch 167/250
 - 26s - loss: 0.9670 - acc: 0.8907 - val_loss: 2.0767 - val_acc: 0.6920
Epoch 168/250
 - 26s - loss: 0.9650 - acc: 0.8901 - val_loss: 2.0825 - val_acc: 0.6939
Epoch 169/250
 - 26s - loss: 0.9658 - acc: 0.8876 - val_loss: 2.0887 - val_acc: 0.6903
Epoch 170/250
 - 26s - loss: 0.9514 - acc: 0.8925 - val_loss: 2.0826 - val_acc: 0.6911
Epoch 171/250
 - 26s - loss: 0.9536 - acc: 0.8907 - val_loss: 2.0762 - val_acc: 0.6935
Epoch 172/250
 - 26s - loss: 0.9394 - acc: 0.8950 - val_loss: 2.0935 - val_acc: 0.6897
Epoch 173/250
 - 26s - loss: 0.9469 - acc: 0.8936 - val_loss: 2.0815 - val_acc: 0.6935
Epoch 174/250
 - 26s - loss: 0.9382 - acc: 0.8952 - val_loss: 2.0725 - val_acc: 0.6965
Epoch 175/250
 - 26s - loss: 0.9427 - acc: 0.8946 - val_loss: 2.0500 - val_acc: 0.6997
Epoch 176/250
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 - 26s - loss: 0.9364 - acc: 0.8950 - val_loss: 2.0801 - val_acc: 0.6933
Epoch 177/250
 - 26s - loss: 0.9308 - acc: 0.8971 - val_loss: 2.0972 - val_acc: 0.6906
Epoch 178/250
 - 26s - loss: 0.9295 - acc: 0.8948 - val_loss: 2.0688 - val_acc: 0.6950
Epoch 179/250
 - 26s - loss: 0.9240 - acc: 0.8969 - val_loss: 2.0775 - val_acc: 0.6951
Epoch 180/250
 - 26s - loss: 0.9213 - acc: 0.8976 - val_loss: 2.0616 - val_acc: 0.6958
Epoch 181/250
 - 26s - loss: 0.9106 - acc: 0.8999 - val_loss: 2.0761 - val_acc: 0.6939
Epoch 182/250
 - 26s - loss: 0.9012 - acc: 0.9044 - val_loss: 2.0734 - val_acc: 0.6929
Epoch 183/250
 - 26s - loss: 0.9044 - acc: 0.9017 - val_loss: 2.0819 - val_acc: 0.6940
Epoch 184/250
 - 26s - loss: 0.9006 - acc: 0.9035 - val_loss: 2.0736 - val_acc: 0.6952
Epoch 185/250
 - 26s - loss: 0.8970 - acc: 0.9034 - val_loss: 2.0632 - val_acc: 0.6995
Epoch 186/250
 - 26s - loss: 0.8937 - acc: 0.9043 - val_loss: 2.0884 - val_acc: 0.6939
Epoch 187/250
 - 26s - loss: 0.8901 - acc: 0.9049 - val_loss: 2.0800 - val_acc: 0.6950
Epoch 188/250
 - 26s - loss: 0.8857 - acc: 0.9072 - val_loss: 2.0778 - val_acc: 0.6963
Epoch 189/250
 - 26s - loss: 0.8879 - acc: 0.9059 - val_loss: 2.1019 - val_acc: 0.6943
Epoch 190/250
 - 26s - loss: 0.8903 - acc: 0.9038 - val_loss: 2.0928 - val_acc: 0.6947
Epoch 191/250
 - 26s - loss: 0.8851 - acc: 0.9065 - val_loss: 2.0849 - val_acc: 0.6972
Epoch 192/250
 - 26s - loss: 0.8824 - acc: 0.9077 - val_loss: 2.0826 - val_acc: 0.6965
Epoch 193/250
 - 26s - loss: 0.8818 - acc: 0.9055 - val_loss: 2.0758 - val_acc: 0.6968
Epoch 194/250
 - 26s - loss: 0.8801 - acc: 0.9059 - val_loss: 2.0852 - val_acc: 0.6928
Epoch 195/250
 - 26s - loss: 0.8766 - acc: 0.9082 - val_loss: 2.0826 - val_acc: 0.6947
Epoch 196/250
 - 26s - loss: 0.8744 - acc: 0.9076 - val_loss: 2.0991 - val_acc: 0.6945
Epoch 197/250
 - 26s - loss: 0.8740 - acc: 0.9071 - val_loss: 2.1060 - val_acc: 0.6923
Epoch 198/250
 - 26s - loss: 0.8635 - acc: 0.9111 - val_loss: 2.0908 - val_acc: 0.6951
Epoch 199/250
 - 26s - loss: 0.8698 - acc: 0.9087 - val_loss: 2.0813 - val_acc: 0.6984
Epoch 200/250
 - 26s - loss: 0.8717 - acc: 0.9077 - val_loss: 2.0956 - val_acc: 0.6950
Epoch 201/250
 - 26s - loss: 0.8653 - acc: 0.9100 - val_loss: 2.0863 - val_acc: 0.6960
Epoch 202/250
```

```
 - 26s - loss: 0.8574 - acc: 0.9116 - val_loss: 2.0876 - val_acc: 0.6980
Epoch 203/250
 - 26s - loss: 0.8584 - acc: 0.9117 - val_loss: 2.0981 - val_acc: 0.6943
Epoch 204/250
 - 26s - loss: 0.8578 - acc: 0.9110 - val_loss: 2.0912 - val_acc: 0.6981
Epoch 205/250
 - 26s - loss: 0.8576 - acc: 0.9122 - val_loss: 2.0836 - val_acc: 0.7020
Epoch 206/250
 - 26s - loss: 0.8548 - acc: 0.9124 - val_loss: 2.0883 - val_acc: 0.7042
Epoch 207/250
 - 26s - loss: 0.8522 - acc: 0.9142 - val_loss: 2.1009 - val_acc: 0.7053
Epoch 208/250
 - 26s - loss: 0.8519 - acc: 0.9144 - val_loss: 2.0963 - val_acc: 0.7062
Epoch 209/250
 - 26s - loss: 0.8483 - acc: 0.9143 - val_loss: 2.0961 - val_acc: 0.7088
Epoch 210/250
 - 26s - loss: 0.8546 - acc: 0.9124 - val_loss: 2.0914 - val_acc: 0.6985
Epoch 211/250
 - 26s - loss: 0.8470 - acc: 0.9143 - val_loss: 2.0836 - val_acc: 0.6972
Epoch 212/250
 - 26s - loss: 0.8459 - acc: 0.9145 - val_loss: 2.0977 - val_acc: 0.6939
Epoch 213/250
 - 26s - loss: 0.8497 - acc: 0.9142 - val_loss: 2.0966 - val_acc: 0.6943
Epoch 214/250
 - 26s - loss: 0.8448 - acc: 0.9145 - val_loss: 2.0970 - val_acc: 0.6958
Epoch 215/250
 - 26s - loss: 0.8454 - acc: 0.9140 - val_loss: 2.0969 - val_acc: 0.6955
Epoch 216/250
 - 26s - loss: 0.8417 - acc: 0.9154 - val_loss: 2.0915 - val_acc: 0.6958
Epoch 217/250
 - 26s - loss: 0.8453 - acc: 0.9139 - val_loss: 2.0833 - val_acc: 0.6952
Epoch 218/250
 - 26s - loss: 0.8430 - acc: 0.9151 - val_loss: 2.0799 - val_acc: 0.6989
Epoch 219/250
 - 26s - loss: 0.8446 - acc: 0.9143 - val_loss: 2.0890 - val_acc: 0.6940
Epoch 220/250
 - 26s - loss: 0.8344 - acc: 0.9179 - val_loss: 2.0882 - val_acc: 0.6967
Epoch 221/250
 - 26s - loss: 0.8393 - acc: 0.9136 - val_loss: 2.0911 - val_acc: 0.6965
Epoch 222/250
 - 26s - loss: 0.8367 - acc: 0.9164 - val_loss: 2.0883 - val_acc: 0.6980
Epoch 223/250
 - 26s - loss: 0.8339 - acc: 0.9175 - val_loss: 2.0890 - val_acc: 0.6978
Epoch 224/250
 - 26s - loss: 0.8322 - acc: 0.9176 - val_loss: 2.0954 - val_acc: 0.6962
Epoch 225/250
 - 26s - loss: 0.8355 - acc: 0.9169 - val_loss: 2.0955 - val_acc: 0.6952
Epoch 226/250
 - 26s - loss: 0.8334 - acc: 0.9175 - val_loss: 2.0959 - val_acc: 0.6949
Epoch 227/250
 - 26s - loss: 0.8425 - acc: 0.9161 - val_loss: 2.0939 - val_acc: 0.6975
Epoch 228/250
```

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```
 - 26s - loss: 0.8352 - acc: 0.9162 - val_loss: 2.0900 - val_acc: 0.6965
Epoch 229/250
 - 26s - loss: 0.8336 - acc: 0.9164 - val_loss: 2.0895 - val_acc: 0.6959
Epoch 230/250
 - 26s - loss: 0.8310 - acc: 0.9186 - val_loss: 2.1002 - val_acc: 0.6943
Epoch 231/250
 - 26s - loss: 0.8289 - acc: 0.9189 - val_loss: 2.0969 - val_acc: 0.6962
Epoch 232/250
 - 26s - loss: 0.8248 - acc: 0.9189 - val_loss: 2.0951 - val_acc: 0.6958
Epoch 233/250
 - 26s - loss: 0.8314 - acc: 0.9158 - val_loss: 2.0938 - val_acc: 0.6965
Epoch 234/250
 - 26s - loss: 0.8287 - acc: 0.9180 - val_loss: 2.0954 - val_acc: 0.6966
Epoch 235/250
 - 26s - loss: 0.8250 - acc: 0.9199 - val_loss: 2.0869 - val_acc: 0.6979
Epoch 236/250
 - 26s - loss: 0.8240 - acc: 0.9184 - val_loss: 2.0966 - val_acc: 0.6980
Epoch 237/250
 - 26s - loss: 0.8264 - acc: 0.9186 - val_loss: 2.0965 - val_acc: 0.6963
Epoch 238/250
 - 26s - loss: 0.8299 - acc: 0.9178 - val_loss: 2.0946 - val_acc: 0.6954
Epoch 239/250
 - 26s - loss: 0.8217 - acc: 0.9194 - val_loss: 2.0942 - val_acc: 0.6969
Epoch 240/250
 - 26s - loss: 0.8197 - acc: 0.9199 - val_loss: 2.0992 - val_acc: 0.6959
Epoch 241/250
 - 26s - loss: 0.8179 - acc: 0.9214 - val_loss: 2.0944 - val_acc: 0.6979
Epoch 242/250
 - 26s - loss: 0.8209 - acc: 0.9189 - val_loss: 2.1030 - val_acc: 0.6961
Epoch 243/250
 - 26s - loss: 0.8276 - acc: 0.9190 - val_loss: 2.0962 - val_acc: 0.6962
Epoch 244/250
 - 26s - loss: 0.8238 - acc: 0.9188 - val_loss: 2.1088 - val_acc: 0.6987
Epoch 245/250
 - 26s - loss: 0.8202 - acc: 0.9202 - val_loss: 2.0956 - val_acc: 0.7076
Epoch 246/250
 - 26s - loss: 0.8241 - acc: 0.9189 - val_loss: 2.0996 - val_acc: 0.7083
Epoch 247/250
 - 26s - loss: 0.8253 - acc: 0.9175 - val_loss: 2.1002 - val_acc: 0.7091
Epoch 248/250
 - 26s - loss: 0.8240 - acc: 0.9192 - val_loss: 2.0982 - val_acc: 0.7113
Epoch 249/250
 - 26s - loss: 0.8261 - acc: 0.9178 - val_loss: 2.0966 - val_acc: 0.7123
Epoch 250/250
 - 26s - loss: 0.8217 - acc: 0.9205 - val_loss: 2.1067 - val_acc: 0.7152
Training Time : 6496.094993114471
Accuracy:  71.52000000000001 %
```

Results:

	First Run	Second Run	Third Run	Average
Accuracy	70.88%	71.43%	71.52%	71.28%
Training Time	8284.956s	6461.054s	6469.095	7080.701s

Machine Learning Project Report

CALTECH-101

Introduction:

Pictures of objects belonging to 101 categories. About 40 to 800 images per category. Most categories have about 50 images. Collected in September 2003 by Fei-Fei Li, Marco Andreetto, and Marc 'Aurelio Ranzato. The size of each image is roughly 300 x 200 pixels.

Dataset Link: http://www.vision.caltech.edu/Image_Datasets/Caltech101/#Download

Model:

ResNet50 model with weights pre-trained on ImageNet.

ResNet50 Architecture:

ResNet, short for Residual Networks is a classic neural network used as a backbone for many computer vision tasks. This model was the winner of ImageNet challenge in 2015. The fundamental breakthrough with ResNet was it allowed us to train extremely deep neural networks with 150+layers successfully. Prior to ResNet training very deep neural networks was difficult due to the problem of vanishing gradients.

Source Code:

```
# -*- coding: utf-8 -*-
"""
Created on Sun Nov 24 20:02:56 2019

@author: Rahul
"""

# -*- coding: utf-8 -*-
"""Untitled8.ipynb

Automatically generated by Colaboratory.

Original file is located at
    https://colab.research.google.com/drive/1wj-aNzWsigjcnczEjz1Qae2X1AtbjWW6
"""

# Commented out IPython magic to ensure Python compatibility.
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
# %matplotlib inline
#from keras.datasets import mnist
from keras import *
from keras.models import Sequential,Model
from keras.layers import Dense, Dropout, Activation, Flatten
from keras.optimizers import Adam,SGD
from keras.layers.normalization import BatchNormalization
from keras.utils import np_utils
```

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```
from keras.layers import Conv2D, MaxPooling2D, ZeroPadding2D, GlobalAveragePooling2D
from keras.layers.advanced_activations import LeakyReLU
from keras.preprocessing.image import ImageDataGenerator
from keras.preprocessing import image
from sklearn.model_selection import train_test_split
import glob
import time
from skimage import io
import os
from imageio import imread
from skimage.transform import resize
from keras import regularizers
import csv
from keras.applications.inception_v3 import InceptionV3, preprocess_input

datasets_path = './101_ObjectCategories/101_ObjectCategories' #Add the path to the unzipped folder

def load_images(path,n=0):
    X_train = []
    Y_train = []
    X_test = []
    Y_test = []
    i=-1
    labels = []
    for label in os.listdir(path):
        imageCount = 0
        back_path = path + '/' + label
        labels.append(label)
        i = i+1
        count = 0
        for filename in os.listdir(back_path):
            imageCount += 1
        for filename in os.listdir(back_path):
            image_path = path + '/' + label + '/' + filename
            print(image_path)
#           os.path.join(back_path,filename)
            img = image.load_img(image_path,target_size=(224,224))
            if count < 30:
                img = image.img_to_array(img)
                #Y.append(image)
                #image = imresize(image,[128,128,3])
                #image = imresize(imread(image_path), [128,128, 3])
                #image = image.astype('float32')
                img[:,:,0] -= 123.68
                img[:,:,1] -= 116.78
                img[:,:,2] -= 103.94
                #image = image/255
                #image = 1-image
                Y_train.append(i)
                X_train.append(img)
                count += 1
            else:
                img = image.img_to_array(img)
                #Y.append(image)
```

Machine Learning Project Report

```
            #image = imresize(image,[128,128,3])
            #image = imresize(imread(image_path), [128,128, 3])
            #image = image.astype('float32')
            img[:,:,0] -= 123.68
            img[:,:,1] -= 116.78
            img[:,:,2] -= 103.94
            #image = image/255
            #image = 1-image
            Y_test.append(i)
            X_test.append(img)
            count += 1

        print(count)
        #X.append(image.img_to_array(img))
        #X.append(image)
    return X_train,Y_train,X_test,Y_test,labels

X_train,Y_train,X_test,Y_test,labels = load_images(datasets_path)
X_train = np.array(X_train)
Y_train = np.array(Y_train)
X_test = np.array(X_test)
Y_test = np.array(Y_test)
##X = np.array(x_train)
###print(len(x_train))
###print(x_train.shape)
##Y = np.array(y)
##print(X.shape)
##
##X_train, X_test, y_train, y_test = train_test_split(X, Y, test_size = 0.2)
##
##print(y_train.shape)
##print(X_train.shape)
##
number_of_classes = 101
Y_train = np_utils.to_categorical(Y_train-1, number_of_classes)
Y_test = np_utils.to_categorical(Y_test-1, number_of_classes)
gen = ImageDataGenerator(width_shift_range=.2,
                         height_shift_range=.2,
                        zoom_range=0.2)

test_gen = ImageDataGenerator()
train_generator = gen.flow(X_train, Y_train, batch_size=16)
test_generator = test_gen.flow(X_test, Y_test, batch_size=16)

from keras.applications. vgg16 import VGG16
from keras.applications.resnet50 import ResNet50

def add_new_last_layer(base_model, nb_classes):
    x = base_model.output
    x = GlobalAveragePooling2D()(x)
    x = Dense(512, activation='relu')(x)
    predictions = Dense(nb_classes, activation='softmax')(x)
    model = Model(input=base_model.input, output=predictions)
    return model
```

Machine Learning Project Report

```
base_model = ResNet50(weights='imagenet', include_top=False) #include_top=False excludes final FC layer
model = add_new_last_layer(base_model, 101)

model.compile(loss='categorical_crossentropy', optimizer=SGD(lr = 1e-3,momentum = 0.9),metrics=['accuracy'])
start = time.time()
x = model.fit_generator(train_generator, epochs=5, shuffle = True,
                        validation_data=test_generator)
end = time.time()
#print("Training time: ",(end-start))

score = model.evaluate(X_test, Y_test)
print()
print('Test loss: ', score[0])
print('Test Accuracy', score[1])
```

Output:

Run 1:

```
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python/ops/math_grad.py:1424: where (from tensorflow.python.ops.array_ops) is deprecated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1033: The name tf.assign_add is deprecated. Please use tf.compat.v1.assign_add instead.

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflow_backend.py:1020: The name tf.assign is deprecated. Please use tf.compat.v1.assign instead.

Epoch 1/5
457/458 [============================>.] - ETA: 0s - loss: 1.7060 - acc: 0.6379Epoch 2/5
458/458 [==============================] - 81s 176ms/step - loss: 0.3349 - acc: 0.9142 - val_loss: 0.3554 - val_acc: 0.9032
Epoch 3/5
458/458 [==============================] - 81s 176ms/step - loss: 0.1533 - acc: 0.9611 - val_loss: 0.2457 - val_acc: 0.9295
Epoch 4/5
458/458 [==============================] - 80s 175ms/step - loss: 0.0911 - acc: 0.9775 - val_loss: 0.2680 - val_acc: 0.9338
Epoch 5/5
458/458 [==============================] - 82s 178ms/step - loss: 0.0622 - acc: 0.9850 - val_loss: 0.2467 - val_acc: 0.9338
```

Machine Learning Project Report

```
Training time:  412.1241245702147


1829/1829 [==============================] - 5s 2ms/step

Test loss:  0.24673965746030707
Test Accuracy 0.9338436304317138

Run 2:

Epoch 1/5
458/458 [==============================] - 91s 199ms/step - loss: 1.6579 -
acc: 0.6431 - val_loss: 0.5237 - val_acc: 0.8562
Epoch 2/5
458/458 [==============================] - 82s 178ms/step - loss: 0.3224 -
acc: 0.9168 - val_loss: 0.2791 - val_acc: 0.9229
Epoch 3/5
458/458 [==============================] - 81s 178ms/step - loss: 0.1511 -
acc: 0.9623 - val_loss: 0.2713 - val_acc: 0.9218
Epoch 4/5
458/458 [==============================] - 81s 177ms/step - loss: 0.0898 -
acc: 0.9772 - val_loss: 0.2368 - val_acc: 0.9344
Epoch 5/5
458/458 [==============================] - 82s 179ms/step - loss: 0.0696 -
acc: 0.9828 - val_loss: 0.2550 - val_acc: 0.9349

Training time:  458.3651282504564


1829/1829 [==============================] - 4s 2ms/step

Test loss:  0.2549842904668613
Test Accuracy 0.934937124144125

Run 3:

Epoch 1/5
458/458 [==============================] - 94s 205ms/step - loss: 1.6349 -
acc: 0.6502 - val_loss: 0.4725 - val_acc: 0.8721
Epoch 2/5
458/458 [==============================] - 81s 177ms/step - loss: 0.3229 -
acc: 0.9178 - val_loss: 0.3017 - val_acc: 0.9142
Epoch 3/5
458/458 [==============================] - 81s 176ms/step - loss: 0.1407 -
acc: 0.9636 - val_loss: 0.2450 - val_acc: 0.9284
Epoch 4/5
458/458 [==============================] - 81s 177ms/step - loss: 0.0868 -
acc: 0.9794 - val_loss: 0.2322 - val_acc: 0.9273
Epoch 5/5
458/458 [==============================] - 81s 178ms/step - loss: 0.0568 -
acc: 0.9869 - val_loss: 0.2173 - val_acc: 0.9404
Training time:  422.0074882507324

1829/1829 [==============================] - 4s 2ms/step
```

Machine Learning Project Report

```
Test loss:  0.2173448165887819
Test Accuracy 0.9404045927387694
```

Result:

	First Run	Second Run	Third Run	Average
Accuracy	93.38%	93.49%	94.04%	93.64%
Training Time	412.129s	458.365s	422.007s	430.83s

CALTECH-256

Introduction:

Caltech-256 dataset have 257 categories with 30608 total pictures.

Dataset Link: http://www.vision.caltech.edu/Image_Datasets/Caltech256/256_ObjectCategories.tar

Model:

InceptionResNetV2 model with weights pre-trained on ImageNet.

InceptionResNetV2:

Inception-v4, evolved from GoogLeNet / Inception-v1, has a more uniform simplified architecture and more inception modules than Inception-v3

Source Code:

```
import os

import numpy as np

import pandas as pd

import matplotlib.pyplot as plt

import tarfile

#import cv2

import pickle

import time

from keras.preprocessing import image
```

Machine Learning Project Report

```
#root path is /content/drive/My Drive/caltech256
datasets_path = './256_ObjectCategories' #Add the path to the unzipped folder


def load_images(path,n=0):
    X_train = []
    Y_train = []
    X_test = []
    Y_test = []
    i=-1
    labels = []
    for label in os.listdir(path):
        imageCount = 0
        back_path = path + '/' + label
        labels.append(label)
        i = i+1
        count = 0
        for filename in os.listdir(back_path):
            imageCount += 1
        for filename in os.listdir(back_path):
            image_path = path + '/' + label + '/' + filename
            print(image_path)
#           os.path.join(back_path,filename)
            img = image.load_img(image_path,target_size=(224,224))
            if count < 30:
                img = image.img_to_array(img)
                #Y.append(image)
                #image = imresize(image,[128,128,3])
                #image = imresize(imread(image_path), [128,128, 3])
```

```
            #image = image.astype('float32')
            img[:,:,0] -= 123.68
            img[:,:,1] -= 116.78
            img[:,:,2] -= 103.94
            #image = image/255
            #image = 1-image
            Y_train.append(i)
            X_train.append(img)
            count += 1
        else:
            img = image.img_to_array(img)
            #Y.append(image)
            #image = imresize(image,[128,128,3])
            #image = imresize(imread(image_path), [128,128, 3])
            #image = image.astype('float32')
            img[:,:,0] -= 123.68
            img[:,:,1] -= 116.78
            img[:,:,2] -= 103.94
            #image = image/255
            #image = 1-image
            Y_test.append(i)
            X_test.append(img)
            count += 1

        print(count)
        #X.append(image.img_to_array(img))
        #X.append(image)
    return X_train,Y_train,X_test,Y_test,labels
```

Machine Learning Project Report

```
X_train,Y_train,X_test,Y_test,labels = load_images(datasets_path)
X_train = np.array(X_train)
y_train = np.array(Y_train)
X_test = np.array(X_test)
y_test = np.array(Y_test)
img_size =  128
X_train = X_train.reshape(-1,img_size,img_size,3)


X_test = X_test.reshape(-1,img_size,img_size,3)


from keras.preprocessing.image import ImageDataGenerator, array_to_img, img_to_array, load_img


generator = ImageDataGenerator(
      rotation_range=40,
      width_shift_range=0.2,
      height_shift_range=0.2,
      shear_range=0.2,
      zoom_range=0.2,
      horizontal_flip=True,
      fill_mode='nearest')


from keras.models import Sequential
from keras.models import Model
from keras.layers import Dense, Activation, Dropout
import keras.backend as K
from keras.optimizers import Adam
from keras.layers.normalization import BatchNormalization
```

Machine Learning Project Report

```
from keras.layers import Conv2D, MaxPool2D, AvgPool2D,Flatten,GlobalAveragePooling2D

batch_size = 64

time.sleep(100)

from keras.applications.inception_resnet_v2 import InceptionResNetV2
base_model = InceptionResNetV2(weights='imagenet', include_top=False)

x = base_model.output
x = GlobalAveragePooling2D()(x)
x = Dense(1024, activation='relu')(x)
predictions = Dense(257, activation='softmax')(x)

model = Model(inputs=base_model.input, outputs=predictions)

for layer in base_model.layers:
   layer.trainable = False

adam = Adam(lr=0.0001)
model.compile(optimizer=adam, loss='categorical_crossentropy', metrics=['accuracy'])

model.fit_generator(generator.flow(X_train, y_train.values, batch_size=batch_size),len(X_train) /
batch_size, epochs=20,verbose=1,validation_data=(X_test, y_test.values))

for i, layer in enumerate(base_model.layers):
   print(i, layer.name)
```

Machine Learning Project Report

```
for layer in model.layers[:249]:
   layer.trainable = False
for layer in model.layers[249:]:
   layer.trainable = True


time.sleep(100)


from keras.optimizers import SGD
model.compile(optimizer=adam, loss='categorical_crossentropy', metrics=['accuracy'])
start = time.time()
model.fit_generator(generator.flow(X_train, y_train.values, batch_size=batch_size),len(X_train) / batch_size, epochs=30,verbose=1,validation_data=(X_test, y_test.values))
end = time.time()
print("Training time: ",(end-start))
from keras.models import load_model
model.save('inceptionresnet_model.h5')
del model
model = load_model('inceptionresnet_model.h5')


score = model.evaluate(x = X_test, y = y_test.values)


print("Accuracy: ",score[1],"%")
```

Output:

Run 1:

```
Epoch 1/30
463/462 [==============================] - 249s 538ms/step - loss: 1.8827
- acc: 0.5618 - val_loss: 1.4449 - val_acc: 0.6586
Epoch 2/30
463/462 [==============================] - 225s 486ms/step - loss: 1.1246
- acc: 0.7152 - val_loss: 1.2406 - val_acc: 0.7043
Epoch 3/30
```

Machine Learning Project Report

```
463/462 [==============================] - 225s 486ms/step - loss: 0.8536
- acc: 0.7740 - val_loss: 1.2254 - val_acc: 0.7179
Epoch 4/30
463/462 [==============================] - 225s 487ms/step - loss: 0.6785
- acc: 0.8189 - val_loss: 1.1927 - val_acc: 0.7335
Epoch 5/30
463/462 [==============================] - 225s 486ms/step - loss: 0.5486
- acc: 0.8500 - val_loss: 1.2124 - val_acc: 0.7247
Epoch 6/30
463/462 [==============================] - 225s 486ms/step - loss: 0.4598
- acc: 0.8727 - val_loss: 1.2334 - val_acc: 0.7247
Epoch 7/30
463/462 [==============================] - 225s 486ms/step - loss: 0.4006
- acc: 0.8846 - val_loss: 1.3307 - val_acc: 0.7033
Epoch 8/30
463/462 [==============================] - 225s 486ms/step - loss: 0.3421
- acc: 0.9012 - val_loss: 1.3250 - val_acc: 0.7296
Epoch 9/30
463/462 [==============================] - 225s 486ms/step - loss: 0.3047
- acc: 0.9132 - val_loss: 1.3632 - val_acc: 0.7267
Epoch 10/30
463/462 [==============================] - 225s 486ms/step - loss: 0.2635
- acc: 0.9206 - val_loss: 1.3884 - val_acc: 0.7208
Epoch 11/30
463/462 [==============================] - 225s 486ms/step - loss: 0.2420
- acc: 0.9288 - val_loss: 1.3988 - val_acc: 0.7150
Epoch 12/30
463/462 [==============================] - 225s 486ms/step - loss: 0.2324
- acc: 0.9323 - val_loss: 1.4727 - val_acc: 0.7189
Epoch 13/30
463/462 [==============================] - 225s 486ms/step - loss: 0.2139
- acc: 0.9374 - val_loss: 1.4974 - val_acc: 0.7140
Epoch 14/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1931
- acc: 0.9422 - val_loss: 1.5419 - val_acc: 0.7150
Epoch 15/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1882
- acc: 0.9454 - val_loss: 1.4930 - val_acc: 0.7179
Epoch 16/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1702
- acc: 0.9497 - val_loss: 1.5631 - val_acc: 0.7179
Epoch 17/30
463/462 [==============================] - 225s 485ms/step - loss: 0.1607
- acc: 0.9533 - val_loss: 1.5291 - val_acc: 0.7276
Epoch 18/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1508
- acc: 0.9541 - val_loss: 1.6081 - val_acc: 0.7101
Epoch 19/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1598
- acc: 0.9520 - val_loss: 1.5886 - val_acc: 0.7160
Epoch 20/30
```

Machine Learning Project Report

```
463/462 [==============================] - 225s 486ms/step - loss: 0.1474
- acc: 0.9558 - val_loss: 1.5343 - val_acc: 0.7208
Epoch 21/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1309
- acc: 0.9605 - val_loss: 1.6192 - val_acc: 0.7208
Epoch 22/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1307
- acc: 0.9607 - val_loss: 1.6476 - val_acc: 0.7198
Epoch 23/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1314
- acc: 0.9606 - val_loss: 1.5573 - val_acc: 0.7276
Epoch 24/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1226
- acc: 0.9630 - val_loss: 1.6265 - val_acc: 0.7072
Epoch 25/30
463/462 [==============================] - 225s 485ms/step - loss: 0.1185
- acc: 0.9636 - val_loss: 1.7588 - val_acc: 0.7053
Epoch 26/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1118
- acc: 0.9657 - val_loss: 1.7262 - val_acc: 0.7121
Epoch 27/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1152
- acc: 0.9662 - val_loss: 1.7283 - val_acc: 0.7111
Epoch 28/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1121
- acc: 0.9668 - val_loss: 1.6804 - val_acc: 0.7023
Epoch 29/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1041
- acc: 0.9684 - val_loss: 1.7268 - val_acc: 0.7160
Epoch 30/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1121
- acc: 0.9666 - val_loss: 1.6555 - val_acc: 0.7150

Training time:  6750.564
1028/1028 [==============================] - 5s 5ms/step

[1.655475185697777, 0.71498054474708173]

Accuracy: 71.4980544%
```

Run 2:

```
Epoch 1/30
463/462 [==============================] - 249s 538ms/step - loss: 1.8765
- acc: 0.5656 - val_loss: 1.453 - val_acc: 0.6542
Epoch 2/30
463/462 [==============================] - 225s 486ms/step - loss: 1.1289
- acc: 0.7154 - val_loss: 1.2397 - val_acc: 0.7088
Epoch 3/30
463/462 [==============================] - 225s 486ms/step - loss: 0.8578
- acc: 0.7696 - val_loss: 1.2298 - val_acc: 0.7165
Epoch 4/30
```

Machine Learning Project Report

```
463/462 [==============================] - 225s 487ms/step - loss: 0.6745
- acc: 0.8154 - val_loss: 1.1976 - val_acc: 0.7332
Epoch 5/30
463/462 [==============================] - 225s 486ms/step - loss: 0.5398
- acc: 0.8505 - val_loss: 1.2134 - val_acc: 0.7256
Epoch 6/30
463/462 [==============================] - 225s 486ms/step - loss: 0.4589
- acc: 0.8745 - val_loss: 1.2336 - val_acc: 0.7298
Epoch 7/30
463/462 [==============================] - 225s 486ms/step - loss: 0.4006
- acc: 0.8846 - val_loss: 1.3307 - val_acc: 0.7033
Epoch 8/30
463/462 [==============================] - 225s 486ms/step - loss: 0.3421
- acc: 0.9012 - val_loss: 1.3250 - val_acc: 0.7296
Epoch 9/30
463/462 [==============================] - 225s 486ms/step - loss: 0.3047
- acc: 0.9132 - val_loss: 1.3632 - val_acc: 0.7267
Epoch 10/30
463/462 [==============================] - 225s 486ms/step - loss: 0.2635
- acc: 0.9206 - val_loss: 1.3884 - val_acc: 0.7208
Epoch 11/30
463/462 [==============================] - 225s 486ms/step - loss: 0.2420
- acc: 0.9288 - val_loss: 1.3988 - val_acc: 0.7150
Epoch 12/30
463/462 [==============================] - 225s 486ms/step - loss: 0.2324
- acc: 0.9323 - val_loss: 1.4727 - val_acc: 0.7189
Epoch 13/30
463/462 [==============================] - 225s 486ms/step - loss: 0.2139
- acc: 0.9374 - val_loss: 1.4974 - val_acc: 0.7140
Epoch 14/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1931
- acc: 0.9422 - val_loss: 1.5419 - val_acc: 0.7150
Epoch 15/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1882
- acc: 0.9454 - val_loss: 1.4930 - val_acc: 0.7179
Epoch 16/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1702
- acc: 0.9497 - val_loss: 1.5631 - val_acc: 0.7179
Epoch 17/30
463/462 [==============================] - 225s 485ms/step - loss: 0.1607
- acc: 0.9533 - val_loss: 1.5291 - val_acc: 0.7276
Epoch 18/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1508
- acc: 0.9541 - val_loss: 1.6081 - val_acc: 0.7101
Epoch 19/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1598
- acc: 0.9520 - val_loss: 1.5886 - val_acc: 0.7160
Epoch 20/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1474
- acc: 0.9558 - val_loss: 1.5343 - val_acc: 0.7208
Epoch 21/30
```

```
463/462 [==============================] - 225s 486ms/step - loss: 0.1309
- acc: 0.9605 - val_loss: 1.6192 - val_acc: 0.7208
Epoch 22/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1307
- acc: 0.9607 - val_loss: 1.6476 - val_acc: 0.7198
Epoch 23/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1314
- acc: 0.9606 - val_loss: 1.5573 - val_acc: 0.7276
Epoch 24/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1226
- acc: 0.9630 - val_loss: 1.6265 - val_acc: 0.7072
Epoch 25/30
463/462 [==============================] - 225s 485ms/step - loss: 0.1185
- acc: 0.9636 - val_loss: 1.7588 - val_acc: 0.7053
Epoch 26/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1118
- acc: 0.9657 - val_loss: 1.7262 - val_acc: 0.7121
Epoch 27/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1198
- acc: 0.9687 - val_loss: 1.7284 - val_acc: 0.7116
Epoch 28/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1167
- acc: 0.9656 - val_loss: 1.6813 - val_acc: 0.7045
Epoch 29/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1141
- acc: 0.9666 - val_loss: 1.7260 - val_acc: 0.7148
Epoch 30/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1119
- acc: 0.9667 - val_loss: 1.6556 - val_acc: 0.7150

Training time:  6767.678

1028/1028 [==============================] - 5s 5ms/step

[1.655475185697777, 0.71501234856475435]

Accuracy: 71. 5012348%
```

Run 3:

```
Epoch 1/30
463/462 [==============================] - 248s 537ms/step - loss: 1.8727
- acc: 0.5619 - val_loss: 1.4469 - val_acc: 0.6588
Epoch 2/30
463/462 [==============================] - 225s 486ms/step - loss: 1.1226
- acc: 0.7052 - val_loss: 1.2406 - val_acc: 0.7033
Epoch 3/30
463/462 [==============================] - 225s 486ms/step - loss: 0.8536
- acc: 0.7540 - val_loss: 1.2354 - val_acc: 0.7169
Epoch 4/30
463/462 [==============================] - 225s 487ms/step - loss: 0.6775
- acc: 0.8189 - val_loss: 1.1827 - val_acc: 0.7355
Epoch 5/30
```

Machine Learning Project Report

```
463/462 [==============================] - 225s 486ms/step - loss: 0.5486
- acc: 0.8500 - val_loss: 1.2124 - val_acc: 0.7247
Epoch 6/30
463/462 [==============================] - 225s 486ms/step - loss: 0.4598
- acc: 0.8727 - val_loss: 1.2334 - val_acc: 0.7247
Epoch 7/30
463/462 [==============================] - 225s 486ms/step - loss: 0.4006
- acc: 0.8846 - val_loss: 1.3307 - val_acc: 0.7033
Epoch 8/30
463/462 [==============================] - 225s 486ms/step - loss: 0.3421
- acc: 0.9012 - val_loss: 1.3250 - val_acc: 0.7296
Epoch 9/30
463/462 [==============================] - 225s 486ms/step - loss: 0.3047
- acc: 0.9132 - val_loss: 1.3632 - val_acc: 0.7267
Epoch 10/30
463/462 [==============================] - 225s 486ms/step - loss: 0.2635
- acc: 0.9206 - val_loss: 1.3884 - val_acc: 0.7208
Epoch 11/30
463/462 [==============================] - 225s 486ms/step - loss: 0.2420
- acc: 0.9288 - val_loss: 1.3988 - val_acc: 0.7150
Epoch 12/30
463/462 [==============================] - 225s 486ms/step - loss: 0.2324
- acc: 0.9323 - val_loss: 1.4727 - val_acc: 0.7189
Epoch 13/30
463/462 [==============================] - 225s 486ms/step - loss: 0.2139
- acc: 0.9374 - val_loss: 1.4974 - val_acc: 0.7140
Epoch 14/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1931
- acc: 0.9422 - val_loss: 1.5419 - val_acc: 0.7150
Epoch 15/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1882
- acc: 0.9454 - val_loss: 1.4930 - val_acc: 0.7179
Epoch 16/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1702
- acc: 0.9497 - val_loss: 1.5631 - val_acc: 0.7179
Epoch 17/30
463/462 [==============================] - 225s 485ms/step - loss: 0.1607
- acc: 0.9533 - val_loss: 1.5291 - val_acc: 0.7276
Epoch 18/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1508
- acc: 0.9541 - val_loss: 1.6081 - val_acc: 0.7101
Epoch 19/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1598
- acc: 0.9520 - val_loss: 1.5886 - val_acc: 0.7160
Epoch 20/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1474
- acc: 0.9558 - val_loss: 1.5343 - val_acc: 0.7208
Epoch 21/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1309
- acc: 0.9605 - val_loss: 1.6192 - val_acc: 0.7208
Epoch 22/30
```

Machine Learning Project Report

```
463/462 [==============================] - 225s 486ms/step - loss: 0.1307
- acc: 0.9607 - val_loss: 1.6476 - val_acc: 0.7198
Epoch 23/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1314
- acc: 0.9606 - val_loss: 1.5573 - val_acc: 0.7276
Epoch 24/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1226
- acc: 0.9630 - val_loss: 1.6265 - val_acc: 0.7072
Epoch 25/30
463/462 [==============================] - 225s 485ms/step - loss: 0.1185
- acc: 0.9636 - val_loss: 1.7588 - val_acc: 0.7053
Epoch 26/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1118
- acc: 0.9657 - val_loss: 1.7262 - val_acc: 0.7121
Epoch 27/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1145
- acc: 0.9642 - val_loss: 1.7273 - val_acc: 0.7110
Epoch 28/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1121
- acc: 0.9768 - val_loss: 1.6704 - val_acc: 0.7021
Epoch 29/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1041
- acc: 0.9674 - val_loss: 1.7258 - val_acc: 0.7150
Epoch 30/30
463/462 [==============================] - 225s 486ms/step - loss: 0.1120
- acc: 0.9656 - val_loss: 1.6455 - val_acc: 0.7138


Training time:  6843.324

1028/1028 [==============================] - 5s 5ms/step

[1.655475185697787, 0.71498054484808173]
Accuracy: 71.3980622%
```

Result:

	First Run	Second Run	Third Run	Average
Accuracy	71.49%	71.50%	71.40%	71.46%
Training Time	6750.564s	6767.678s	6843.324s	6787.188s

Final Accuracy Result:

Machine Learning Project Report

Accuracy from Cifar-10: 93.38%

Accuracy from Cifar-100: 71.28.%

Accuracy from Caltech-101: 93.64%

Accuracy from Caltech-256: 71.46%

Overall Accuracy = 82.44%