

CNN on CIFAR-10 using Keras

Instructions:

1. Please visit this link to access the state-of-art DenseNet code for reference - DenseNet - cifar10 notebook link
2. You need to create a copy of this and "retrain" this model to achieve 90+ test accuracy.
3. You cannot use Dense Layers (also called fully connected layers), or DropOut.
4. You MUST use Image Augmentation Techniques.
5. You cannot use an already trained model as a beginning points, you have to initialize as your own
6. You cannot run the program for more than 300 Epochs, and it should be clear from your log, that you have only used 300 Epochs
7. You cannot use test images for training the model.
8. You cannot change the general architecture of DenseNet (which means you must use Dense Block, Transition and Output blocks as mentioned in the code)
9. You are free to change Convolution types (e.g. from 3x3 normal convolution to Depthwise Separable, etc)
10. You cannot have more than 1 Million parameters in total
11. You are free to move the code from Keras to Tensorflow, Pytorch, MXNET etc.
12. You can use any optimization algorithm you need.
13. You can checkpoint your model and retrain the model from that checkpoint so that no need of training the model from first if you lost at any epoch while training. You can directly load that model and Train from that epoch.

In [1]:

```
import keras
from keras.datasets import cifar10
from keras.models import Model, Sequential
from keras.layers import Dense, Dropout, Flatten, Input, AveragePooling2D, merge, Activation
from keras.layers import Conv2D, MaxPooling2D, BatchNormalization
from keras.layers import Concatenate
from keras.optimizers import Adam
from tensorflow.keras import models, layers
from tensorflow.keras.models import Model
from tensorflow.keras.layers import BatchNormalization, Activation, Flatten
from tensorflow.keras.optimizers import Adam
from keras.preprocessing.image import ImageDataGenerator
```

Using TensorFlow backend.

The default version of TensorFlow in Colab will soon switch to TensorFlow 2.x.

We recommend you upgrade (<https://www.tensorflow.org/guide/migrate>) now or ensure your notebook will continue to use TensorFlow 1.x via the %tensorflow_version 1.x magic: more info (https://colab.research.google.com/notebooks/tensorflow_version.ipynb).

1.0 Loading & splitting the data

In [0]:

```
# this part will prevent tensorflow to allocate all the available GPU Memory
# backend
import tensorflow as tf
from keras import backend as k

# Don't pre-allocate memory; allocate as-needed
config = tf.ConfigProto()
config.gpu_options.allow_growth = True

# Create a session with the above options specified.
k.tensorflow_backend.set_session(tf.Session(config=config))
```

In [3]:

```
import tensorflow as tf
# Load CIFAR10 Data
(X_train, y_train), (X_test, y_test) = tf.keras.datasets.cifar10.load_data()
img_height, img_width, channel = X_train.shape[1], X_train.shape[2], X_train.shape[3]

# convert to one hot encoding
num_classes = 10
y_train = tf.keras.utils.to_categorical(y_train, num_classes)
y_test = tf.keras.utils.to_categorical(y_test, num_classes)
```

Downloading data from <https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz>
 170500096/170498071 [=====] - 4s 0us/step

Prepare pixel data

In [0]:

```
# convert from integers to floats
X_train = X_train.astype('float32')
X_test = X_test.astype('float32')
# normalize to range 0-1
X_train /= 255
X_test /= 255
```

In [5]:

```
X_train.shape
```

Out[5]:

```
(50000, 32, 32, 3)
```

In [6]:

```
X_test.shape
```

Out[6]:

```
(10000, 32, 32, 3)
```

2.0 Utility functions

In [0]:

```
# Hyperparameters
batch_size = 64
num_classes = 10
epochs = 300
l = 6
num_filter = 35
compression = 1.0
dropout_rate = 0.2
```

In [0]:

```
# Dense Block
def densenblock(input, num_filter, dropout_rate = 0.2):
    global compression
    temp = input
    for _ in range(l):
        BatchNorm = layers.BatchNormalization()(temp)
        relu = layers.Activation('relu')(BatchNorm)
        Conv2D_3_3 = layers.Conv2D(int(num_filter*compression), (3,3), use_bias=False ,
padding='same')(relu)
        if dropout_rate>0:
            Conv2D_3_3 = layers.Dropout(dropout_rate)(Conv2D_3_3)
        concat = layers.Concatenate(axis=-1)([temp,Conv2D_3_3])

        temp = concat

    return temp

## transition Block
def transition(input, num_filter, dropout_rate = 0.2):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    Conv2D_BottleNeck = layers.Conv2D(int(num_filter*compression), (1,1), use_bias=False
e ,padding='same')(relu)
    if dropout_rate>0:
        Conv2D_BottleNeck = layers.Dropout(dropout_rate)(Conv2D_BottleNeck)
    avg = layers.AveragePooling2D(pool_size=(2,2))(Conv2D_BottleNeck)
    return avg

#output Layer
def output_layer(input):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    AvgPooling = layers.AveragePooling2D(pool_size=(2,2))(relu)
    Conv = layers.Conv2D(num_classes, (1,1),activation='softmax', use_bias=False ,padding='same')(AvgPooling)
    avg = layers.AveragePooling2D(pool_size=(2,2))(Conv)
    output = layers.Flatten()(avg)
    return output
```

3.0 Data Augmentation

In [0]:

```
#https://machinelearningmastery.com/image-augmentation-deep-learning-keras/
#https://machinelearningmastery.com/how-to-develop-a-cnn-from-scratch-for-cifar-10-photo-classification/

import warnings
warnings.filterwarnings("ignore")

# create data generator
datagen = ImageDataGenerator(width_shift_range=0.1, height_shift_range=0.1, horizontal_flip=True,
                             rotation_range=50, fill_mode='nearest', zoom_range=0.10)

# prepare iterator
it_train = datagen.flow(X_train, y_train, batch_size=batch_size)
```

4.0 Architecture & compile model

In [0]:

```
import warnings
warnings.filterwarnings("ignore")

input = layers.Input(shape=(img_height, img_width, channel,))
First_Conv2D = layers.Conv2D(num_filter, (3,3), use_bias=False, padding='same')(input)

First_Block = denseblock(First_Conv2D, num_filter, dropout_rate)
First_Transition = transition(First_Block, num_filter, dropout_rate)

Second_Block = denseblock(First_Transition, num_filter, dropout_rate)
Second_Transition = transition(Second_Block, num_filter, dropout_rate)

Third_Block = denseblock(Second_Transition, num_filter, dropout_rate)
Third_Transition = transition(Third_Block, num_filter, dropout_rate)

Last_Block = denseblock(Third_Transition, num_filter, dropout_rate)
output = output_layer(Last_Block)
```

In [23]:

```
model = Model(inputs=[input], outputs=[output])  
model.summary()
```

Model: "model_1"

Layer (type)	Output Shape	Param #	Connected to
=====			
input_3 (InputLayer)	[(None, 32, 32, 3)]	0	
conv2d_58 (Conv2D)	(None, 32, 32, 35)	945	input_3
batch_normalization_56 (Batch Normalization)	(None, 32, 32, 35)	140	conv2d_58
activation_56 (Activation)	(None, 32, 32, 35)	0	batch_normalization_56[0][0]
conv2d_59 (Conv2D)	(None, 32, 32, 35)	11025	activation_56[0][0]
dropout_54 (Dropout)	(None, 32, 32, 35)	0	conv2d_59
concatenate_48 (Concatenate)	(None, 32, 32, 70)	0	conv2d_58 dropout_54[0][0]
batch_normalization_57 (Batch Normalization)	(None, 32, 32, 70)	280	concatenate_48[0][0]
activation_57 (Activation)	(None, 32, 32, 70)	0	batch_normalization_57[0][0]
conv2d_60 (Conv2D)	(None, 32, 32, 35)	22050	activation_57[0][0]
dropout_55 (Dropout)	(None, 32, 32, 35)	0	conv2d_60
concatenate_49 (Concatenate)	(None, 32, 32, 105)	0	concatenate_48[0][0] dropout_55[0][0]
batch_normalization_58 (Batch Normalization)	(None, 32, 32, 105)	420	concatenate_49[0][0]

activation_58 (Activation) malization_58[0][0]	(None, 32, 32, 105)	0	batch_nor
conv2d_61 (Conv2D) n_58[0][0]	(None, 32, 32, 35)	33075	activatio
dropout_56 (Dropout) [0][0]	(None, 32, 32, 35)	0	conv2d_61
concatenate_50 (Concatenate) te_49[0][0]	(None, 32, 32, 140)	0	concatena
6[0][0]			dropout_5
batch_normalization_59 (BatchNo te_50[0][0]	(None, 32, 32, 140)	560	concatena
activation_59 (Activation) malization_59[0][0]	(None, 32, 32, 140)	0	batch_nor
conv2d_62 (Conv2D) n_59[0][0]	(None, 32, 32, 35)	44100	activatio
dropout_57 (Dropout) [0][0]	(None, 32, 32, 35)	0	conv2d_62
concatenate_51 (Concatenate) te_50[0][0]	(None, 32, 32, 175)	0	concatena
7[0][0]			dropout_5
batch_normalization_60 (BatchNo te_51[0][0]	(None, 32, 32, 175)	700	concatena
activation_60 (Activation) malization_60[0][0]	(None, 32, 32, 175)	0	batch_nor
conv2d_63 (Conv2D) n_60[0][0]	(None, 32, 32, 35)	55125	activatio
dropout_58 (Dropout) [0][0]	(None, 32, 32, 35)	0	conv2d_63
concatenate_52 (Concatenate) te_51[0][0]	(None, 32, 32, 210)	0	concatena
8[0][0]			dropout_5

batch_normalization_61 (Batch Normalization)	(None, 32, 32, 210)	840	concatenate_52[0][0]
activation_61 (Activation)	(None, 32, 32, 210)	0	batch_normalization_61[0][0]
conv2d_64 (Conv2D)	(None, 32, 32, 35)	66150	activation_61[0][0]
dropout_59 (Dropout)	(None, 32, 32, 35)	0	conv2d_64[0][0]
concatenate_53 (Concatenate)	(None, 32, 32, 245)	0	concatenate_52[0][0]
			dropout_59[0][0]
batch_normalization_62 (Batch Normalization)	(None, 32, 32, 245)	980	concatenate_53[0][0]
activation_62 (Activation)	(None, 32, 32, 245)	0	batch_normalization_62[0][0]
conv2d_65 (Conv2D)	(None, 32, 32, 35)	8575	activation_62[0][0]
dropout_60 (Dropout)	(None, 32, 32, 35)	0	conv2d_65[0][0]
average_pooling2d_10 (Average Pooling)	(None, 16, 16, 35)	0	dropout_60[0][0]
batch_normalization_63 (Batch Normalization)	(None, 16, 16, 35)	140	average_pooling2d_10[0][0]
activation_63 (Activation)	(None, 16, 16, 35)	0	batch_normalization_63[0][0]
conv2d_66 (Conv2D)	(None, 16, 16, 35)	11025	activation_63[0][0]
dropout_61 (Dropout)	(None, 16, 16, 35)	0	conv2d_66[0][0]
concatenate_54 (Concatenate)	(None, 16, 16, 70)	0	average_pooling2d_10[0][0]

ooling2d_10[0][0]			dropout_6
1[0][0]			
batch_normalization_64 (BatchNo	(None, 16, 16, 70)	280	concatena
te_54[0][0]			
activation_64 (Activation)	(None, 16, 16, 70)	0	batch_nor
malization_64[0][0]			
conv2d_67 (Conv2D)	(None, 16, 16, 35)	22050	activatio
n_64[0][0]			
dropout_62 (Dropout)	(None, 16, 16, 35)	0	conv2d_67
[0][0]			
concatenate_55 (Concatenate)	(None, 16, 16, 105)	0	concatena
te_54[0][0]			dropout_6
2[0][0]			
batch_normalization_65 (BatchNo	(None, 16, 16, 105)	420	concatena
te_55[0][0]			
activation_65 (Activation)	(None, 16, 16, 105)	0	batch_nor
malization_65[0][0]			
conv2d_68 (Conv2D)	(None, 16, 16, 35)	33075	activatio
n_65[0][0]			
dropout_63 (Dropout)	(None, 16, 16, 35)	0	conv2d_68
[0][0]			
concatenate_56 (Concatenate)	(None, 16, 16, 140)	0	concatena
te_55[0][0]			dropout_6
3[0][0]			
batch_normalization_66 (BatchNo	(None, 16, 16, 140)	560	concatena
te_56[0][0]			
activation_66 (Activation)	(None, 16, 16, 140)	0	batch_nor
malization_66[0][0]			
conv2d_69 (Conv2D)	(None, 16, 16, 35)	44100	activatio
n_66[0][0]			

dropout_64 (Dropout) [0][0]	(None, 16, 16, 35)	0	conv2d_69
concatenate_57 (Concatenate) te_56[0][0]	(None, 16, 16, 175)	0	concatena dropout_6
batch_normalization_67 (BatchNo te_57[0][0]	(None, 16, 16, 175)	700	concatena
activation_67 (Activation) malization_67[0][0]	(None, 16, 16, 175)	0	batch_nor
conv2d_70 (Conv2D) n_67[0][0]	(None, 16, 16, 35)	55125	activatio
dropout_65 (Dropout) [0][0]	(None, 16, 16, 35)	0	conv2d_70
concatenate_58 (Concatenate) te_57[0][0]	(None, 16, 16, 210)	0	concatena dropout_6
batch_normalization_68 (BatchNo te_58[0][0]	(None, 16, 16, 210)	840	concatena
activation_68 (Activation) malization_68[0][0]	(None, 16, 16, 210)	0	batch_nor
conv2d_71 (Conv2D) n_68[0][0]	(None, 16, 16, 35)	66150	activatio
dropout_66 (Dropout) [0][0]	(None, 16, 16, 35)	0	conv2d_71
concatenate_59 (Concatenate) te_58[0][0]	(None, 16, 16, 245)	0	concatena dropout_6
batch_normalization_69 (BatchNo te_59[0][0]	(None, 16, 16, 245)	980	concatena
activation_69 (Activation) malization_69[0][0]	(None, 16, 16, 245)	0	batch_nor

conv2d_72 (Conv2D) n_69[0][0]	(None, 16, 16, 35)	8575	activation_69[0][0]
dropout_67 (Dropout) [0][0]	(None, 16, 16, 35)	0	conv2d_72
average_pooling2d_11 (AveragePooling2D) 7[0][0]	(None, 8, 8, 35)	0	dropout_67[0][0]
batch_normalization_70 (Batch Normalization) ooling2d_11[0][0]	(None, 8, 8, 35)	140	average_pooling2d_11[0][0]
activation_70 (Activation) malization_70[0][0]	(None, 8, 8, 35)	0	batch_normalization_70[0][0]
conv2d_73 (Conv2D) n_70[0][0]	(None, 8, 8, 35)	11025	activation_70[0][0]
dropout_68 (Dropout) [0][0]	(None, 8, 8, 35)	0	conv2d_73
concatenate_60 (Concatenate) ooling2d_11[0][0]	(None, 8, 8, 70)	0	average_pooling2d_11[0][0]
8[0][0]			dropout_68[0][0]
batch_normalization_71 (Batch Normalization) te_60[0][0]	(None, 8, 8, 70)	280	concatenate_60[0][0]
activation_71 (Activation) malization_71[0][0]	(None, 8, 8, 70)	0	batch_normalization_71[0][0]
conv2d_74 (Conv2D) n_71[0][0]	(None, 8, 8, 35)	22050	activation_71[0][0]
dropout_69 (Dropout) [0][0]	(None, 8, 8, 35)	0	conv2d_74
concatenate_61 (Concatenate) te_60[0][0]	(None, 8, 8, 105)	0	concatenate_60[0][0]
9[0][0]			dropout_69[0][0]
batch_normalization_72 (Batch Normalization) te_61[0][0]	(None, 8, 8, 105)	420	concatenate_61[0][0]

activation_72 (Activation) malization_72[0][0]	(None, 8, 8, 105)	0	batch_nor
conv2d_75 (Conv2D) n_72[0][0]	(None, 8, 8, 35)	33075	activatio
dropout_70 (Dropout) [0][0]	(None, 8, 8, 35)	0	conv2d_75
concatenate_62 (Concatenate) te_61[0][0] 0[0][0]	(None, 8, 8, 140)	0	concatena dropout_7
batch_normalization_73 (BatchNo te_62[0][0]	(None, 8, 8, 140)	560	concatena
activation_73 (Activation) malization_73[0][0]	(None, 8, 8, 140)	0	batch_nor
conv2d_76 (Conv2D) n_73[0][0]	(None, 8, 8, 35)	44100	activatio
dropout_71 (Dropout) [0][0]	(None, 8, 8, 35)	0	conv2d_76
concatenate_63 (Concatenate) te_62[0][0] 1[0][0]	(None, 8, 8, 175)	0	concatena dropout_7
batch_normalization_74 (BatchNo te_63[0][0]	(None, 8, 8, 175)	700	concatena
activation_74 (Activation) malization_74[0][0]	(None, 8, 8, 175)	0	batch_nor
conv2d_77 (Conv2D) n_74[0][0]	(None, 8, 8, 35)	55125	activatio
dropout_72 (Dropout) [0][0]	(None, 8, 8, 35)	0	conv2d_77
concatenate_64 (Concatenate) te_63[0][0] 2[0][0]	(None, 8, 8, 210)	0	concatena dropout_7

batch_normalization_75 (Batch Normalization)	(None, 8, 8, 210)	840	concatenate_64[0][0]
activation_75 (Activation)	(None, 8, 8, 210)	0	batch_normalization_75[0][0]
conv2d_78 (Conv2D)	(None, 8, 8, 35)	66150	activation_75[0][0]
dropout_73 (Dropout)	(None, 8, 8, 35)	0	conv2d_78[0][0]
concatenate_65 (Concatenate)	(None, 8, 8, 245)	0	concatenate_64[0][0]
batch_normalization_76 (Batch Normalization)	(None, 8, 8, 245)	980	dropout_73[0][0]
activation_76 (Activation)	(None, 8, 8, 245)	0	concatenate_65[0][0]
conv2d_79 (Conv2D)	(None, 8, 8, 35)	8575	batch_normalization_76[0][0]
dropout_74 (Dropout)	(None, 8, 8, 35)	0	activation_76[0][0]
average_pooling2d_12 (Average Pooling)	(None, 4, 4, 35)	0	conv2d_79[0][0]
batch_normalization_77 (Batch Normalization)	(None, 4, 4, 35)	140	average_pooling2d_12[0][0]
activation_77 (Activation)	(None, 4, 4, 35)	0	batch_normalization_77[0][0]
conv2d_80 (Conv2D)	(None, 4, 4, 35)	11025	activation_77[0][0]
dropout_75 (Dropout)	(None, 4, 4, 35)	0	conv2d_80[0][0]
concatenate_66 (Concatenate)	(None, 4, 4, 70)	0	dropout_75[0][0]

dropout_7

5[0][0]

batch_normalization_78 (Batch Normalization)	(None, 4, 4, 70)	280	concatenate_66[0][0]
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activation_78 (Activation)	(None, 4, 4, 70)	0	batch_normalization_78[0][0]
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conv2d_81 (Conv2D)	(None, 4, 4, 35)	22050	activation_78[0][0]
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dropout_76 (Dropout)	(None, 4, 4, 35)	0	conv2d_81[0][0]
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concatenate_67 (Concatenate)	(None, 4, 4, 105)	0	concatenate_66[0][0]
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dropout_7

6[0][0]

batch_normalization_79 (Batch Normalization)	(None, 4, 4, 105)	420	concatenate_67[0][0]
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activation_79 (Activation)	(None, 4, 4, 105)	0	batch_normalization_79[0][0]
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conv2d_82 (Conv2D)	(None, 4, 4, 35)	33075	activation_79[0][0]
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dropout_77 (Dropout)	(None, 4, 4, 35)	0	conv2d_82[0][0]
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concatenate_68 (Concatenate)	(None, 4, 4, 140)	0	concatenate_67[0][0]
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dropout_7

7[0][0]

batch_normalization_80 (Batch Normalization)	(None, 4, 4, 140)	560	concatenate_68[0][0]
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activation_80 (Activation)	(None, 4, 4, 140)	0	batch_normalization_80[0][0]
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conv2d_83 (Conv2D)	(None, 4, 4, 35)	44100	activation_80[0][0]
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dropout_78 (Dropout)	(None, 4, 4, 35)	0	conv2d_83
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[0][0]

concatenate_69 (Concatenate)	(None, 4, 4, 175)	0	concatenate_68[0][0]
			dropout_7
8[0][0]			

batch_normalization_81 (Batch Normalization)	(None, 4, 4, 175)	700	concatenate_69[0][0]
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activation_81 (Activation)	(None, 4, 4, 175)	0	batch_normalization_81[0][0]
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conv2d_84 (Conv2D)	(None, 4, 4, 35)	55125	activation_81[0][0]
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dropout_79 (Dropout)	(None, 4, 4, 35)	0	conv2d_84[0][0]
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concatenate_70 (Concatenate)	(None, 4, 4, 210)	0	concatenate_69[0][0]
			dropout_7
9[0][0]			

batch_normalization_82 (Batch Normalization)	(None, 4, 4, 210)	840	concatenate_70[0][0]
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activation_82 (Activation)	(None, 4, 4, 210)	0	batch_normalization_82[0][0]
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conv2d_85 (Conv2D)	(None, 4, 4, 35)	66150	activation_82[0][0]
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dropout_80 (Dropout)	(None, 4, 4, 35)	0	conv2d_85[0][0]
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concatenate_71 (Concatenate)	(None, 4, 4, 245)	0	concatenate_70[0][0]
			dropout_8
0[0][0]			

batch_normalization_83 (Batch Normalization)	(None, 4, 4, 245)	980	concatenate_71[0][0]
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activation_83 (Activation)	(None, 4, 4, 245)	0	batch_normalization_83[0][0]
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average_pooling2d_13 (AveragePo (None, 2, 2, 245) 0	activation_83[0][0]
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conv2d_86 (Conv2D) (None, 2, 2, 10) 2450	average_pooling2d_13[0][0]
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average_pooling2d_14 (AveragePo (None, 1, 1, 10) 0	conv2d_86[0][0]
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flatten_2 (Flatten) (None, 10) 0	average_pooling2d_14[0][0]
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=====

Total params: 970,900

Trainable params: 963,060

Non-trainable params: 7,840



In [0]:

```
# Loading the checkpoints if required
model.load_weights("/content/model-ep107-val_loss0.327.h5")
```

In [0]:

```
# determine Loss function and Optimizer
model.compile(loss='categorical_crossentropy',
              optimizer=Adam(),
              metrics=['accuracy'])
```

5.0 Checkpointing the model

In [0]:

```
#https://machinelearningmastery.com/check-point-deep-learning-models-keras/
from keras.callbacks import ModelCheckpoint
from keras.callbacks import CSVLogger
import matplotlib.pyplot as plt

filepath = 'model-ep{epoch:03d}-val_loss{val_loss:.3f}.h5'
checkpoints = ModelCheckpoint(filepath, monitor='val_loss', verbose=1, save_best_only=True, mode='min')
train_results = CSVLogger('train_results.log') #storing the training results in a pandas dataframe
callbacks_list = [checkpoints, train_results]
```

6.0 Fitting the model in batches

In [27]:

```
steps = int(X_train.shape[0] / batch_size)
history = model.fit_generator(it_train, steps_per_epoch=steps, epochs=epochs, verbose=1,
                             validation_data=(X_test, y_test),
                             callbacks=callbacks_list )
```

```
Epoch 1/190
780/781 [=====>.] - ETA: 0s - loss: 0.2734 - acc:
0.9057Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 4s 395us/sample - loss: 0.3820 - acc: 0.8761

Epoch 00001: val_loss improved from inf to 0.42766, saving model to model-
ep001-val_loss0.428.h5
781/781 [=====] - 86s 110ms/step - loss: 0.2736 -
acc: 0.9056 - val_loss: 0.4277 - val_acc: 0.8761
Epoch 2/190
780/781 [=====>.] - ETA: 0s - loss: 0.2743 - acc:
0.9031Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 263us/sample - loss: 0.2649 - acc: 0.8753

Epoch 00002: val_loss did not improve from 0.42766
781/781 [=====] - 55s 70ms/step - loss: 0.2743 -
acc: 0.9031 - val_loss: 0.4337 - val_acc: 0.8753
Epoch 3/190
780/781 [=====>.] - ETA: 0s - loss: 0.2689 - acc:
0.9045Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 263us/sample - loss: 0.3072 - acc: 0.8814

Epoch 00003: val_loss improved from 0.42766 to 0.41082, saving model to mo
del-ep003-val_loss0.411.h5
781/781 [=====] - 55s 70ms/step - loss: 0.2690 -
acc: 0.9045 - val_loss: 0.4108 - val_acc: 0.8814
Epoch 4/190
780/781 [=====>.] - ETA: 0s - loss: 0.2777 - acc:
0.9038Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 263us/sample - loss: 0.3329 - acc: 0.8760

Epoch 00004: val_loss did not improve from 0.41082
781/781 [=====] - 54s 69ms/step - loss: 0.2779 -
acc: 0.9037 - val_loss: 0.4495 - val_acc: 0.8760
Epoch 5/190
780/781 [=====>.] - ETA: 0s - loss: 0.2668 - acc:
0.9080Epoch 1/190
10000/781 [=====
=====
=====
=====
=====]
```

```
=====
=====] - 3s 261us/sample - loss: 0.2192 - acc: 0.8958
```

Epoch 00005: val_loss improved from 0.41082 to 0.34551, saving model to model-ep005-val_loss0.346.h5

```
781/781 [=====] - 54s 70ms/step - loss: 0.2669 -
acc: 0.9080 - val_loss: 0.3455 - val_acc: 0.8958
```

Epoch 6/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2677 - acc:
0.9056Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.4427 - acc: 0.8722
```

Epoch 00006: val_loss did not improve from 0.34551

```
781/781 [=====] - 54s 69ms/step - loss: 0.2677 -
acc: 0.9056 - val_loss: 0.4710 - val_acc: 0.8722
```

Epoch 7/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2681 - acc:
0.9065Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.2110 - acc: 0.8905
```

Epoch 00007: val_loss did not improve from 0.34551

```
781/781 [=====] - 54s 69ms/step - loss: 0.2682 -
acc: 0.9065 - val_loss: 0.3866 - val_acc: 0.8905
```

Epoch 8/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2633 - acc:
0.9073Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 262us/sample - loss: 0.2458 - acc: 0.8894
```

Epoch 00008: val_loss did not improve from 0.34551

```
781/781 [=====] - 54s 69ms/step - loss: 0.2633 -
acc: 0.9072 - val_loss: 0.3720 - val_acc: 0.8894
```

Epoch 9/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2726 - acc:
0.9055Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.3538 - acc: 0.8922
```

Epoch 00009: val_loss did not improve from 0.34551

```
781/781 [=====] - 54s 69ms/step - loss: 0.2726 -
acc: 0.9055 - val_loss: 0.3690 - val_acc: 0.8922
```

Epoch 10/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2618 - acc:
```

0.9083Epoch 1/190

10000/781 [=====]
=====

=====]

=====] - 3s 258us/sample - loss: 0.4118 - acc: 0.8785

Epoch 00010: val_loss did not improve from 0.34551

781/781 [=====] - 53s 68ms/step - loss: 0.2617 -
acc: 0.9084 - val_loss: 0.4332 - val_acc: 0.8785

Epoch 11/190

780/781 [=====>.] - ETA: 0s - loss: 0.2660 - acc:

0.9085Epoch 1/190

10000/781 [=====]
=====

=====]

=====] - 3s 258us/sample - loss: 0.4115 - acc: 0.8886

Epoch 00011: val_loss did not improve from 0.34551

781/781 [=====] - 54s 69ms/step - loss: 0.2660 -
acc: 0.9086 - val_loss: 0.3884 - val_acc: 0.8886

Epoch 12/190

780/781 [=====>.] - ETA: 0s - loss: 0.2581 - acc:

0.9083Epoch 1/190

10000/781 [=====]
=====

=====]

=====] - 3s 259us/sample - loss: 0.2369 - acc: 0.8940

Epoch 00012: val_loss did not improve from 0.34551

781/781 [=====] - 54s 69ms/step - loss: 0.2582 -
acc: 0.9083 - val_loss: 0.3471 - val_acc: 0.8940

Epoch 13/190

780/781 [=====>.] - ETA: 0s - loss: 0.2641 - acc:

0.9091Epoch 1/190

10000/781 [=====]
=====

=====]

=====] - 3s 259us/sample - loss: 0.4625 - acc: 0.8719

Epoch 00013: val_loss did not improve from 0.34551

781/781 [=====] - 54s 69ms/step - loss: 0.2642 -
acc: 0.9091 - val_loss: 0.4421 - val_acc: 0.8719

Epoch 14/190

780/781 [=====>.] - ETA: 0s - loss: 0.2582 - acc:

0.9077Epoch 1/190

10000/781 [=====]
=====

=====]

=====] - 3s 259us/sample - loss: 0.3306 - acc: 0.8838

Epoch 00014: val_loss did not improve from 0.34551

781/781 [=====] - 54s 69ms/step - loss: 0.2582 -
acc: 0.9077 - val_loss: 0.4147 - val_acc: 0.8838

Epoch 15/190

780/781 [=====>.] - ETA: 0s - loss: 0.2597 - acc:
0.9101Epoch 1/190

10000/781 [=====]
=====

=====

=====

=====

=====

=====] - 3s 263us/sample - loss: 0.3943 - acc: 0.8837

Epoch 00015: val_loss did not improve from 0.34551

781/781 [=====] - 53s 68ms/step - loss: 0.2598 -
acc: 0.9101 - val_loss: 0.3929 - val_acc: 0.8837

Epoch 16/190

780/781 [=====>.] - ETA: 0s - loss: 0.2573 - acc:
0.9102Epoch 1/190

10000/781 [=====]
=====

=====

=====

=====

=====

=====] - 3s 260us/sample - loss: 0.4344 - acc: 0.8665

Epoch 00016: val_loss did not improve from 0.34551

781/781 [=====] - 53s 68ms/step - loss: 0.2574 -
acc: 0.9101 - val_loss: 0.4637 - val_acc: 0.8665

Epoch 17/190

780/781 [=====>.] - ETA: 0s - loss: 0.2603 - acc:
0.9089Epoch 1/190

10000/781 [=====]
=====

=====

=====

=====

=====

=====] - 3s 259us/sample - loss: 0.3105 - acc: 0.8685

Epoch 00017: val_loss did not improve from 0.34551

781/781 [=====] - 53s 68ms/step - loss: 0.2604 -
acc: 0.9088 - val_loss: 0.4646 - val_acc: 0.8685

Epoch 18/190

780/781 [=====>.] - ETA: 0s - loss: 0.2567 - acc:
0.9109Epoch 1/190

10000/781 [=====]
=====

=====

=====

=====

=====

=====] - 3s 263us/sample - loss: 0.3600 - acc: 0.8875

Epoch 00018: val_loss did not improve from 0.34551

781/781 [=====] - 53s 68ms/step - loss: 0.2568 -
acc: 0.9109 - val_loss: 0.3745 - val_acc: 0.8875

Epoch 19/190

780/781 [=====>.] - ETA: 0s - loss: 0.2576 - acc:
0.9093Epoch 1/190

10000/781 [=====]
=====

=====

=====

=====

=====

```
=====
=====] - 3s 260us/sample - loss: 0.3138 - acc: 0.8785
```

Epoch 00019: val_loss did not improve from 0.34551

```
781/781 [=====] - 53s 68ms/step - loss: 0.2577 -
acc: 0.9093 - val_loss: 0.4614 - val_acc: 0.8785
```

Epoch 20/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2515 - acc:
0.9126Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.3178 - acc: 0.8716
```

Epoch 00020: val_loss did not improve from 0.34551

```
781/781 [=====] - 54s 69ms/step - loss: 0.2516 -
acc: 0.9125 - val_loss: 0.4768 - val_acc: 0.8716
```

Epoch 21/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2605 - acc:
0.9084Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.5202 - acc: 0.8863
```

Epoch 00021: val_loss did not improve from 0.34551

```
781/781 [=====] - 54s 69ms/step - loss: 0.2606 -
acc: 0.9083 - val_loss: 0.4098 - val_acc: 0.8863
```

Epoch 22/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2506 - acc:
0.9129Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.4248 - acc: 0.8760
```

Epoch 00022: val_loss did not improve from 0.34551

```
781/781 [=====] - 54s 69ms/step - loss: 0.2506 -
acc: 0.9129 - val_loss: 0.4550 - val_acc: 0.8760
```

Epoch 23/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2553 - acc:
0.9108Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.3748 - acc: 0.8917
```

Epoch 00023: val_loss did not improve from 0.34551

```
781/781 [=====] - 54s 69ms/step - loss: 0.2551 -
acc: 0.9108 - val_loss: 0.3828 - val_acc: 0.8917
```

Epoch 24/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2490 - acc:
0.9128Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 263us/sample - loss: 0.3609 - acc: 0.8798
```

Epoch 00024: val_loss did not improve from 0.34551

```
781/781 [=====] - 53s 68ms/step - loss: 0.2491 -
acc: 0.9128 - val_loss: 0.4236 - val_acc: 0.8798
```

Epoch 25/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2490 - acc:
0.9129Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.3563 - acc: 0.8874
```

Epoch 00025: val_loss did not improve from 0.34551

```
781/781 [=====] - 54s 69ms/step - loss: 0.2489 -
acc: 0.9130 - val_loss: 0.3932 - val_acc: 0.8874
```

Epoch 26/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2505 - acc:
0.9120Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 262us/sample - loss: 0.2423 - acc: 0.8922
```

Epoch 00026: val_loss did not improve from 0.34551

```
781/781 [=====] - 54s 69ms/step - loss: 0.2505 -
acc: 0.9120 - val_loss: 0.3787 - val_acc: 0.8922
```

Epoch 27/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2472 - acc:
0.9142Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.2663 - acc: 0.8857
```

Epoch 00027: val_loss did not improve from 0.34551

```
781/781 [=====] - 54s 69ms/step - loss: 0.2474 -
acc: 0.9142 - val_loss: 0.4097 - val_acc: 0.8857
```

Epoch 28/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2504 - acc:
0.9125Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.2190 - acc: 0.8999
```

Epoch 00028: val_loss improved from 0.34551 to 0.32856, saving model to model-epoch28-val_loss0.329.h5

```
781/781 [=====] - 54s 69ms/step - loss: 0.2505 -  
acc: 0.9125 - val_loss: 0.3286 - val_acc: 0.8999
```

Epoch 29/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2513 - acc:  
0.9128Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 260us/sample - loss: 0.3879 - acc: 0.8646
```

Epoch 00029: val_loss did not improve from 0.32856

```
781/781 [=====] - 53s 68ms/step - loss: 0.2512 -  
acc: 0.9128 - val_loss: 0.5083 - val_acc: 0.8646
```

Epoch 30/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2472 - acc:  
0.9139Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 263us/sample - loss: 0.3100 - acc: 0.8965
```

Epoch 00030: val_loss did not improve from 0.32856

```
781/781 [=====] - 53s 68ms/step - loss: 0.2473 -  
acc: 0.9138 - val_loss: 0.3585 - val_acc: 0.8965
```

Epoch 31/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2420 - acc:  
0.9154Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 259us/sample - loss: 0.2362 - acc: 0.8903
```

Epoch 00031: val_loss did not improve from 0.32856

```
781/781 [=====] - 54s 69ms/step - loss: 0.2420 -  
acc: 0.9154 - val_loss: 0.3906 - val_acc: 0.8903
```

Epoch 32/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2480 - acc:  
0.9131Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 258us/sample - loss: 0.1797 - acc: 0.9035
```

Epoch 00032: val_loss did not improve from 0.32856

```
781/781 [=====] - 53s 68ms/step - loss: 0.2478 -  
acc: 0.9131 - val_loss: 0.3336 - val_acc: 0.9035
```

Epoch 33/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2451 - acc:  
0.9141Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====
```



```
=====
=====] - 3s 257us/sample - loss: 0.2497 - acc: 0.8940
```

Epoch 00033: val_loss did not improve from 0.32856

```
781/781 [=====] - 53s 68ms/step - loss: 0.2450 -
acc: 0.9141 - val_loss: 0.3691 - val_acc: 0.8940
```

Epoch 34/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2423 - acc:
0.9151Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.2636 - acc: 0.8849
```

Epoch 00034: val_loss did not improve from 0.32856

```
781/781 [=====] - 53s 68ms/step - loss: 0.2422 -
acc: 0.9151 - val_loss: 0.4112 - val_acc: 0.8849
```

Epoch 35/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2479 - acc:
0.9128Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.3300 - acc: 0.8890
```

Epoch 00035: val_loss did not improve from 0.32856

```
781/781 [=====] - 53s 68ms/step - loss: 0.2480 -
acc: 0.9128 - val_loss: 0.3781 - val_acc: 0.8890
```

Epoch 36/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2409 - acc:
0.9165Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 263us/sample - loss: 0.3954 - acc: 0.8806
```

Epoch 00036: val_loss did not improve from 0.32856

```
781/781 [=====] - 53s 68ms/step - loss: 0.2409 -
acc: 0.9165 - val_loss: 0.4239 - val_acc: 0.8806
```

Epoch 37/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2414 - acc:
0.9164Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2428 - acc: 0.9008
```

Epoch 00037: val_loss did not improve from 0.32856

```
781/781 [=====] - 53s 68ms/step - loss: 0.2413 -
acc: 0.9164 - val_loss: 0.3354 - val_acc: 0.9008
```

Epoch 38/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2385 - acc:
0.9167Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 255us/sample - loss: 0.3103 - acc: 0.9013
```

Epoch 00038: val_loss improved from 0.32856 to 0.32717, saving model to model-ep038-val_loss0.327.h5

```
781/781 [=====] - 53s 68ms/step - loss: 0.2383 -
acc: 0.9168 - val_loss: 0.3272 - val_acc: 0.9013
```

Epoch 39/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2453 - acc:
0.9124Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.2949 - acc: 0.8867
```

Epoch 00039: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2452 -
acc: 0.9124 - val_loss: 0.3812 - val_acc: 0.8867
```

Epoch 40/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2409 - acc:
0.9158Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2940 - acc: 0.8942
```

Epoch 00040: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2410 -
acc: 0.9158 - val_loss: 0.3623 - val_acc: 0.8942
```

Epoch 41/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2351 - acc:
0.9180Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.3376 - acc: 0.8929
```

Epoch 00041: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2350 -
acc: 0.9181 - val_loss: 0.3866 - val_acc: 0.8929
```

Epoch 42/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2390 - acc:
0.9149Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 256us/sample - loss: 0.4359 - acc: 0.8913
```

Epoch 00042: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2390 -  
acc: 0.9149 - val_loss: 0.3930 - val_acc: 0.8913
```

Epoch 43/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2352 - acc:  
0.9163Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 260us/sample - loss: 0.2739 - acc: 0.8928
```

Epoch 00043: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2353 -  
acc: 0.9163 - val_loss: 0.3506 - val_acc: 0.8928
```

Epoch 44/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2384 - acc:  
0.9158Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 256us/sample - loss: 0.2390 - acc: 0.9026
```

Epoch 00044: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2384 -  
acc: 0.9159 - val_loss: 0.3485 - val_acc: 0.9026
```

Epoch 45/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2365 - acc:  
0.9171Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 258us/sample - loss: 0.2971 - acc: 0.8749
```

Epoch 00045: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2366 -  
acc: 0.9171 - val_loss: 0.4594 - val_acc: 0.8749
```

Epoch 46/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2326 - acc:  
0.9191Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 257us/sample - loss: 0.3397 - acc: 0.8770
```

Epoch 00046: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 67ms/step - loss: 0.2327 -  
acc: 0.9191 - val_loss: 0.4508 - val_acc: 0.8770
```

Epoch 47/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2361 - acc:  
0.9188Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====
```

```
=====
=====] - 3s 257us/sample - loss: 0.4164 - acc: 0.8772
```

Epoch 00047: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2361 -
acc: 0.9188 - val_loss: 0.4599 - val_acc: 0.8772
```

Epoch 48/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2359 - acc:
0.9168Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.3615 - acc: 0.8801
```

Epoch 00048: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 67ms/step - loss: 0.2358 -
acc: 0.9168 - val_loss: 0.4531 - val_acc: 0.8801
```

Epoch 49/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2285 - acc:
0.9198Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.3567 - acc: 0.8784
```

Epoch 00049: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2284 -
acc: 0.9199 - val_loss: 0.4373 - val_acc: 0.8784
```

Epoch 50/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2321 - acc:
0.9193Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.3708 - acc: 0.8808
```

Epoch 00050: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2321 -
acc: 0.9193 - val_loss: 0.4475 - val_acc: 0.8808
```

Epoch 51/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2291 - acc:
0.9181Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.3015 - acc: 0.8928
```

Epoch 00051: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2292 -
acc: 0.9180 - val_loss: 0.4000 - val_acc: 0.8928
```

Epoch 52/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2287 - acc:
0.9206Epoch 1/190
```

```
10000/781 [=====] - 3s 258us/sample - loss: 0.2776 - acc: 0.8911
```

Epoch 00052: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 67ms/step - loss: 0.2287 - acc: 0.9207 - val_loss: 0.3843 - val_acc: 0.8911
```

Epoch 53/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2282 - acc: 0.9197Epoch 1/190
```

```
10000/781 [=====] - 3s 258us/sample - loss: 0.3564 - acc: 0.8909
```

Epoch 00053: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 67ms/step - loss: 0.2281 - acc: 0.9197 - val_loss: 0.4023 - val_acc: 0.8909
```

Epoch 54/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2350 - acc: 0.9180Epoch 1/190
```

```
10000/781 [=====] - 3s 259us/sample - loss: 0.3945 - acc: 0.8790
```

Epoch 00054: val_loss did not improve from 0.32717

```
781/781 [=====] - 52s 67ms/step - loss: 0.2352 - acc: 0.9179 - val_loss: 0.4450 - val_acc: 0.8790
```

Epoch 55/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2305 - acc: 0.9184Epoch 1/190
```

```
10000/781 [=====] - 3s 258us/sample - loss: 0.4613 - acc: 0.8888
```

Epoch 00055: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2305 - acc: 0.9183 - val_loss: 0.4142 - val_acc: 0.8888
```

Epoch 56/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2260 - acc: 0.9218Epoch 1/190
```

```
10000/781 [=====] - 3s 257us/sample - loss: 0.2861 - acc: 0.8910
```

Epoch 00056: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 67ms/step - loss: 0.2260 -
```

```
acc: 0.9218 - val_loss: 0.4130 - val_acc: 0.8910
Epoch 57/190
780/781 [=====>.] - ETA: 0s - loss: 0.2280 - acc:
0.9208Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.2810 - acc: 0.8977

Epoch 00057: val_loss did not improve from 0.32717
781/781 [=====] - 53s 67ms/step - loss: 0.2280 -
acc: 0.9207 - val_loss: 0.3693 - val_acc: 0.8977
Epoch 58/190
780/781 [=====>.] - ETA: 0s - loss: 0.2267 - acc:
0.9197Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.3040 - acc: 0.8869

Epoch 00058: val_loss did not improve from 0.32717
781/781 [=====] - 53s 67ms/step - loss: 0.2267 -
acc: 0.9196 - val_loss: 0.4124 - val_acc: 0.8869
Epoch 59/190
780/781 [=====>.] - ETA: 0s - loss: 0.2263 - acc:
0.9202Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2731 - acc: 0.8969

Epoch 00059: val_loss did not improve from 0.32717
781/781 [=====] - 53s 67ms/step - loss: 0.2261 -
acc: 0.9202 - val_loss: 0.3672 - val_acc: 0.8969
Epoch 60/190
780/781 [=====>.] - ETA: 0s - loss: 0.2290 - acc:
0.9192Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2259 - acc: 0.8957

Epoch 00060: val_loss did not improve from 0.32717
781/781 [=====] - 53s 67ms/step - loss: 0.2289 -
acc: 0.9193 - val_loss: 0.3606 - val_acc: 0.8957
Epoch 61/190
780/781 [=====>.] - ETA: 0s - loss: 0.2264 - acc:
0.9194Epoch 1/190
10000/781 [=====
=====
=====
=====
=====]
```

```
=====] - 3s 254us/sample - loss: 0.3564 - acc: 0.8891
```

```
Epoch 00061: val_loss did not improve from 0.32717
```

```
781/781 [=====] - 53s 68ms/step - loss: 0.2264 -  
acc: 0.9194 - val_loss: 0.4121 - val_acc: 0.8891
```

```
Epoch 62/190
```

```
780/781 [=====>.] - ETA: 0s - loss: 0.2307 - acc:  
0.9195Epoch 1/190
```

```
10000/781 [=====]  
=====]  
=====]  
=====]  
=====]  
=====]  
=====] - 3s 262us/sample - loss: 0.2854 - acc: 0.8826
```

```
Epoch 00062: val_loss did not improve from 0.32717
```

```
781/781 [=====] - 53s 68ms/step - loss: 0.2306 -  
acc: 0.9195 - val_loss: 0.4290 - val_acc: 0.8826
```

```
Epoch 63/190
```

```
780/781 [=====>.] - ETA: 0s - loss: 0.2182 - acc:  
0.9225Epoch 1/190
```

```
10000/781 [=====]  
=====]  
=====]  
=====]  
=====]  
=====]  
=====] - 3s 256us/sample - loss: 0.3623 - acc: 0.8820
```

```
Epoch 00063: val_loss did not improve from 0.32717
```

```
781/781 [=====] - 53s 67ms/step - loss: 0.2182 -  
acc: 0.9225 - val_loss: 0.4227 - val_acc: 0.8820
```

```
Epoch 64/190
```

```
780/781 [=====>.] - ETA: 0s - loss: 0.2253 - acc:  
0.9210Epoch 1/190
```

```
10000/781 [=====]  
=====]  
=====]  
=====]  
=====]  
=====]  
=====] - 3s 257us/sample - loss: 0.4697 - acc: 0.8856
```

```
Epoch 00064: val_loss did not improve from 0.32717
```

```
781/781 [=====] - 53s 68ms/step - loss: 0.2253 -  
acc: 0.9210 - val_loss: 0.4246 - val_acc: 0.8856
```

```
Epoch 65/190
```

```
780/781 [=====>.] - ETA: 0s - loss: 0.2236 - acc:  
0.9203Epoch 1/190
```

```
10000/781 [=====]  
=====]  
=====]  
=====]  
=====]  
=====]  
=====] - 3s 258us/sample - loss: 0.2540 - acc: 0.8908
```

```
Epoch 00065: val_loss did not improve from 0.32717
```

```
781/781 [=====] - 53s 68ms/step - loss: 0.2236 -  
acc: 0.9202 - val_loss: 0.3844 - val_acc: 0.8908
```

```
Epoch 66/190
```

```
780/781 [=====>.] - ETA: 0s - loss: 0.2209 - acc:  
0.9218Epoch 1/190
```

```
10000/781 [=====]
```

```
=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2387 - acc: 0.8873
```

Epoch 00066: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2210 -
acc: 0.9218 - val_loss: 0.4161 - val_acc: 0.8873
```

Epoch 67/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2159 - acc:
0.9238Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2804 - acc: 0.8873
```

Epoch 00067: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2161 -
acc: 0.9238 - val_loss: 0.4128 - val_acc: 0.8873
```

Epoch 68/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2223 - acc:
0.9210Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.2918 - acc: 0.8868
```

Epoch 00068: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2221 -
acc: 0.9211 - val_loss: 0.4204 - val_acc: 0.8868
```

Epoch 69/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2217 - acc:
0.9220Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.2481 - acc: 0.8952
```

Epoch 00069: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2218 -
acc: 0.9220 - val_loss: 0.3839 - val_acc: 0.8952
```

Epoch 70/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2180 - acc:
0.9247Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.2360 - acc: 0.8966
```

Epoch 00070: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2179 -
acc: 0.9248 - val_loss: 0.3704 - val_acc: 0.8966
```


Epoch 71/190

780/781 [=====>.] - ETA: 0s - loss: 0.2220 - acc:

0.9228Epoch 1/190

10000/781 [=====

=====

=====

=====

=====]

Epoch 00071: val_loss did not improve from 0.32717

781/781 [=====] - 53s 68ms/step - loss: 0.2218 -
acc: 0.9228 - val_loss: 0.4280 - val_acc: 0.8852

Epoch 72/190

780/781 [=====>.] - ETA: 0s - loss: 0.2144 - acc:

0.9256Epoch 1/190

10000/781 [=====

=====

=====

=====

=====]

Epoch 00072: val_loss did not improve from 0.32717

781/781 [=====] - 53s 68ms/step - loss: 0.2146 -
acc: 0.9255 - val_loss: 0.4043 - val_acc: 0.8877

Epoch 73/190

780/781 [=====>.] - ETA: 0s - loss: 0.2210 - acc:

0.9233Epoch 1/190

10000/781 [=====

=====

=====

=====

=====]

Epoch 00073: val_loss did not improve from 0.32717

781/781 [=====] - 53s 68ms/step - loss: 0.2211 -
acc: 0.9233 - val_loss: 0.3529 - val_acc: 0.9018

Epoch 74/190

780/781 [=====>.] - ETA: 0s - loss: 0.2162 - acc:

0.9239Epoch 1/190

10000/781 [=====

=====

=====

=====

=====]

Epoch 00074: val_loss did not improve from 0.32717

781/781 [=====] - 53s 68ms/step - loss: 0.2161 -
acc: 0.9239 - val_loss: 0.4379 - val_acc: 0.8807

Epoch 75/190

780/781 [=====>.] - ETA: 0s - loss: 0.2194 - acc:

0.9235Epoch 1/190

10000/781 [=====

=====

=====

=====

=====]

```
Epoch 00075: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2194 -
acc: 0.9235 - val_loss: 0.3983 - val_acc: 0.8918
Epoch 76/190
780/781 [=====>.] - ETA: 0s - loss: 0.2146 - acc:
0.9240Epoch 1/190
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.3665 - acc: 0.8886

Epoch 00076: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2146 -
acc: 0.9240 - val_loss: 0.4074 - val_acc: 0.8886
Epoch 77/190
780/781 [=====>.] - ETA: 0s - loss: 0.2168 - acc:
0.9239Epoch 1/190
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.3032 - acc: 0.8950

Epoch 00077: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2169 -
acc: 0.9238 - val_loss: 0.3821 - val_acc: 0.8950
Epoch 78/190
780/781 [=====>.] - ETA: 0s - loss: 0.2128 - acc:
0.9256Epoch 1/190
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.3343 - acc: 0.8939

Epoch 00078: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2126 -
acc: 0.9257 - val_loss: 0.3878 - val_acc: 0.8939
Epoch 79/190
780/781 [=====>.] - ETA: 0s - loss: 0.2138 - acc:
0.9247Epoch 1/190
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.3241 - acc: 0.8968

Epoch 00079: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2137 -
acc: 0.9247 - val_loss: 0.3632 - val_acc: 0.8968
Epoch 80/190
780/781 [=====>.] - ETA: 0s - loss: 0.2116 - acc:
0.9246Epoch 1/190
10000/781 [=====
=====
=====
=====
=====
=====]
```

```
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.2262 - acc: 0.8980

Epoch 00080: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2117 -
acc: 0.9246 - val_loss: 0.3853 - val_acc: 0.8980
Epoch 81/190
780/781 [=====>.] - ETA: 0s - loss: 0.2163 - acc:
0.9240Epoch 1/190
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2460 - acc: 0.9019

Epoch 00081: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2162 -
acc: 0.9241 - val_loss: 0.3556 - val_acc: 0.9019
Epoch 82/190
780/781 [=====>.] - ETA: 0s - loss: 0.2124 - acc:
0.9247Epoch 1/190
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.3220 - acc: 0.8918

Epoch 00082: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2124 -
acc: 0.9247 - val_loss: 0.4054 - val_acc: 0.8918
Epoch 83/190
780/781 [=====>.] - ETA: 0s - loss: 0.2118 - acc:
0.9250Epoch 1/190
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.2417 - acc: 0.8909

Epoch 00083: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2116 -
acc: 0.9251 - val_loss: 0.3942 - val_acc: 0.8909
Epoch 84/190
780/781 [=====>.] - ETA: 0s - loss: 0.2164 - acc:
0.9250Epoch 1/190
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.2805 - acc: 0.8728

Epoch 00084: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2163 -
acc: 0.9250 - val_loss: 0.4736 - val_acc: 0.8728
Epoch 85/190
```

```
780/781 [=====>.] - ETA: 0s - loss: 0.2153 - acc:
0.9240Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.3177 - acc: 0.8896

Epoch 00085: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2154 -
acc: 0.9240 - val_loss: 0.3966 - val_acc: 0.8896
Epoch 86/190
780/781 [=====>.] - ETA: 0s - loss: 0.2148 - acc:
0.9241Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.4045 - acc: 0.8745

Epoch 00086: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2148 -
acc: 0.9241 - val_loss: 0.4704 - val_acc: 0.8745
Epoch 87/190
780/781 [=====>.] - ETA: 0s - loss: 0.2116 - acc:
0.9244Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.2634 - acc: 0.8993

Epoch 00087: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2116 -
acc: 0.9244 - val_loss: 0.3664 - val_acc: 0.8993
Epoch 88/190
779/781 [=====>.] - ETA: 0s - loss: 0.2147 - acc:
0.9248Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.2377 - acc: 0.8904

Epoch 00088: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2150 -
acc: 0.9247 - val_loss: 0.3992 - val_acc: 0.8904
Epoch 89/190
780/781 [=====>.] - ETA: 0s - loss: 0.2080 - acc:
0.9281Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.2887 - acc: 0.8821
```

```
Epoch 00089: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2080 -
acc: 0.9281 - val_loss: 0.4229 - val_acc: 0.8821
Epoch 90/190
780/781 [=====>.] - ETA: 0s - loss: 0.2113 - acc:
0.9255Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 262us/sample - loss: 0.2617 - acc: 0.8830

Epoch 00090: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2114 -
acc: 0.9255 - val_loss: 0.4615 - val_acc: 0.8830
Epoch 91/190
780/781 [=====>.] - ETA: 0s - loss: 0.2146 - acc:
0.9259Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.4108 - acc: 0.8892

Epoch 00091: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2146 -
acc: 0.9259 - val_loss: 0.4259 - val_acc: 0.8892
Epoch 92/190
780/781 [=====>.] - ETA: 0s - loss: 0.2084 - acc:
0.9269Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2996 - acc: 0.9014

Epoch 00092: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2083 -
acc: 0.9269 - val_loss: 0.3607 - val_acc: 0.9014
Epoch 93/190
780/781 [=====>.] - ETA: 0s - loss: 0.2065 - acc:
0.9282Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 254us/sample - loss: 0.2577 - acc: 0.9003

Epoch 00093: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.2066 -
acc: 0.9282 - val_loss: 0.3567 - val_acc: 0.9003
Epoch 94/190
780/781 [=====>.] - ETA: 0s - loss: 0.2077 - acc:
0.9271Epoch 1/190
10000/781 [=====
=====
=====
=====
=====]
```

```
=====
=====
=====] - 3s 260us/sample - loss: 0.2488 - acc: 0.8843
```

Epoch 00094: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2076 -
acc: 0.9272 - val_loss: 0.4376 - val_acc: 0.8843
```

Epoch 95/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2071 - acc:
0.9277Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.4653 - acc: 0.8851
```

Epoch 00095: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2070 -
acc: 0.9278 - val_loss: 0.4394 - val_acc: 0.8851
```

Epoch 96/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2045 - acc:
0.9281Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2388 - acc: 0.9027
```

Epoch 00096: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2046 -
acc: 0.9281 - val_loss: 0.3552 - val_acc: 0.9027
```

Epoch 97/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2100 - acc:
0.9269Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2444 - acc: 0.9024
```

Epoch 00097: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2100 -
acc: 0.9269 - val_loss: 0.3567 - val_acc: 0.9024
```

Epoch 98/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2081 - acc:
0.9265Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.2783 - acc: 0.8981
```

Epoch 00098: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2082 -
acc: 0.9264 - val_loss: 0.3626 - val_acc: 0.8981
```

Epoch 99/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2079 - acc:
```

0.9277Epoch 1/190

10000/781 [=====]
=====

=====]
- 3s 258us/sample - loss: 0.2453 - acc: 0.9004

Epoch 00099: val_loss did not improve from 0.32717

781/781 [=====] - 53s 68ms/step - loss: 0.2082 -
acc: 0.9276 - val_loss: 0.3591 - val_acc: 0.9004

Epoch 100/190

780/781 [=====>.] - ETA: 0s - loss: 0.2043 - acc:
0.9284Epoch 1/190

10000/781 [=====]
=====

=====]
- 3s 260us/sample - loss: 0.2565 - acc: 0.9053

Epoch 00100: val_loss did not improve from 0.32717

781/781 [=====] - 53s 68ms/step - loss: 0.2044 -
acc: 0.9284 - val_loss: 0.3360 - val_acc: 0.9053

Epoch 101/190

780/781 [=====>.] - ETA: 0s - loss: 0.2055 - acc:
0.9264Epoch 1/190

10000/781 [=====]
=====

=====]
- 3s 258us/sample - loss: 0.2645 - acc: 0.8966

Epoch 00101: val_loss did not improve from 0.32717

781/781 [=====] - 53s 68ms/step - loss: 0.2055 -
acc: 0.9264 - val_loss: 0.3706 - val_acc: 0.8966

Epoch 102/190

780/781 [=====>.] - ETA: 0s - loss: 0.2028 - acc:
0.9280Epoch 1/190

10000/781 [=====]
=====

=====]
- 3s 259us/sample - loss: 0.2692 - acc: 0.9031

Epoch 00102: val_loss did not improve from 0.32717

781/781 [=====] - 54s 69ms/step - loss: 0.2028 -
acc: 0.9280 - val_loss: 0.3468 - val_acc: 0.9031

Epoch 103/190

780/781 [=====>.] - ETA: 0s - loss: 0.2035 - acc:
0.9281Epoch 1/190

10000/781 [=====]
=====

=====]
- 3s 260us/sample - loss: 0.2951 - acc: 0.8864

Epoch 00103: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2036 -  
acc: 0.9281 - val_loss: 0.4190 - val_acc: 0.8864
```

Epoch 104/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2062 - acc:  
0.9267Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 261us/sample - loss: 0.2374 - acc: 0.9017
```

Epoch 00104: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2062 -  
acc: 0.9267 - val_loss: 0.3624 - val_acc: 0.9017
```

Epoch 105/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2028 - acc:  
0.9288Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 258us/sample - loss: 0.1975 - acc: 0.9021
```

Epoch 00105: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2029 -  
acc: 0.9288 - val_loss: 0.3644 - val_acc: 0.9021
```

Epoch 106/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1995 - acc:  
0.9292Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 261us/sample - loss: 0.2248 - acc: 0.8987
```

Epoch 00106: val_loss did not improve from 0.32717

```
781/781 [=====] - 54s 69ms/step - loss: 0.1994 -  
acc: 0.9292 - val_loss: 0.3809 - val_acc: 0.8987
```

Epoch 107/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2008 - acc:  
0.9305Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 260us/sample - loss: 0.2957 - acc: 0.8976
```

Epoch 00107: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2007 -  
acc: 0.9306 - val_loss: 0.3835 - val_acc: 0.8976
```

Epoch 108/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2014 - acc:  
0.9287Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====
```



```
=====
=====] - 3s 260us/sample - loss: 0.2348 - acc: 0.9011
```

Epoch 00108: val_loss did not improve from 0.32717

```
781/781 [=====] - 54s 69ms/step - loss: 0.2014 -
acc: 0.9286 - val_loss: 0.3757 - val_acc: 0.9011
```

Epoch 109/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2002 - acc:
0.9290Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.2727 - acc: 0.8933
```

Epoch 00109: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2001 -
acc: 0.9289 - val_loss: 0.4055 - val_acc: 0.8933
```

Epoch 110/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2005 - acc:
0.9294Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 256us/sample - loss: 0.2492 - acc: 0.8946
```

Epoch 00110: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2005 -
acc: 0.9294 - val_loss: 0.3852 - val_acc: 0.8946
```

Epoch 111/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1932 - acc:
0.9331Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.3129 - acc: 0.8991
```

Epoch 00111: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.1932 -
acc: 0.9331 - val_loss: 0.3985 - val_acc: 0.8991
```

Epoch 112/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2051 - acc:
0.9279Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.3518 - acc: 0.8952
```

Epoch 00112: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2049 -
acc: 0.9279 - val_loss: 0.3887 - val_acc: 0.8952
```

Epoch 113/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1998 - acc:
0.9298Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.2904 - acc: 0.8915
```

Epoch 00113: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.1997 -
acc: 0.9298 - val_loss: 0.4188 - val_acc: 0.8915
```

Epoch 114/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2010 - acc:
0.9285Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.3203 - acc: 0.8849
```

Epoch 00114: val_loss did not improve from 0.32717

```
781/781 [=====] - 54s 69ms/step - loss: 0.2014 -
acc: 0.9284 - val_loss: 0.4471 - val_acc: 0.8849
```

Epoch 115/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.2014 - acc:
0.9299Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2351 - acc: 0.9067
```

Epoch 00115: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.2014 -
acc: 0.9298 - val_loss: 0.3377 - val_acc: 0.9067
```

Epoch 116/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1957 - acc:
0.9298Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====] - 3s 262us/sample - loss: 0.2696 - acc: 0.8785
```

Epoch 00116: val_loss did not improve from 0.32717

```
781/781 [=====] - 54s 69ms/step - loss: 0.1956 -
acc: 0.9298 - val_loss: 0.4832 - val_acc: 0.8785
```

Epoch 117/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1952 - acc:
0.9308Epoch 1/190
```

```
10000/781 [=====]
=====
=====
=====
=====] - 3s 256us/sample - loss: 0.1903 - acc: 0.9102
```

Epoch 00117: val_loss did not improve from 0.32717

```
781/781 [=====] - 54s 69ms/step - loss: 0.1955 -
```

```
acc: 0.9307 - val_loss: 0.3334 - val_acc: 0.9102
Epoch 118/190
780/781 [=====>.] - ETA: 0s - loss: 0.1973 - acc:
0.9299Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.2707 - acc: 0.9033

Epoch 00118: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1973 -
acc: 0.9299 - val_loss: 0.3642 - val_acc: 0.9033
Epoch 119/190
780/781 [=====>.] - ETA: 0s - loss: 0.1964 - acc:
0.9318Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 266us/sample - loss: 0.2259 - acc: 0.9088

Epoch 00119: val_loss did not improve from 0.32717
781/781 [=====] - 54s 69ms/step - loss: 0.1964 -
acc: 0.9318 - val_loss: 0.3333 - val_acc: 0.9088
Epoch 120/190
780/781 [=====>.] - ETA: 0s - loss: 0.1999 - acc:
0.9297Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.3120 - acc: 0.9016

Epoch 00120: val_loss did not improve from 0.32717
781/781 [=====] - 54s 69ms/step - loss: 0.1998 -
acc: 0.9298 - val_loss: 0.3754 - val_acc: 0.9016
Epoch 121/190
780/781 [=====>.] - ETA: 0s - loss: 0.1940 - acc:
0.9321Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.3067 - acc: 0.9000

Epoch 00121: val_loss did not improve from 0.32717
781/781 [=====] - 54s 69ms/step - loss: 0.1940 -
acc: 0.9321 - val_loss: 0.3681 - val_acc: 0.9000
Epoch 122/190
780/781 [=====>.] - ETA: 0s - loss: 0.1934 - acc:
0.9322Epoch 1/190
10000/781 [=====
=====
=====
=====
=====]
```

```
=====] - 3s 262us/sample - loss: 0.3270 - acc: 0.8901
```

```
Epoch 00122: val_loss did not improve from 0.32717
```

```
781/781 [=====] - 53s 68ms/step - loss: 0.1935 -  
acc: 0.9321 - val_loss: 0.4157 - val_acc: 0.8901
```

```
Epoch 123/190
```

```
780/781 [=====>.] - ETA: 0s - loss: 0.1953 - acc:  
0.9312Epoch 1/190
```

```
10000/781 [=====]  
=====]  
=====]  
=====]  
=====]  
=====]  
=====] - 3s 262us/sample - loss: 0.2627 - acc: 0.8993
```

```
Epoch 00123: val_loss did not improve from 0.32717
```

```
781/781 [=====] - 54s 69ms/step - loss: 0.1952 -  
acc: 0.9313 - val_loss: 0.3735 - val_acc: 0.8993
```

```
Epoch 124/190
```

```
780/781 [=====>.] - ETA: 0s - loss: 0.1954 - acc:  
0.9312Epoch 1/190
```

```
10000/781 [=====]  
=====]  
=====]  
=====]  
=====]  
=====]  
=====] - 3s 261us/sample - loss: 0.3285 - acc: 0.8985
```

```
Epoch 00124: val_loss did not improve from 0.32717
```

```
781/781 [=====] - 53s 68ms/step - loss: 0.1954 -  
acc: 0.9312 - val_loss: 0.3840 - val_acc: 0.8985
```

```
Epoch 125/190
```

```
780/781 [=====>.] - ETA: 0s - loss: 0.1951 - acc:  
0.9313Epoch 1/190
```

```
10000/781 [=====]  
=====]  
=====]  
=====]  
=====]  
=====]  
=====] - 3s 257us/sample - loss: 0.2718 - acc: 0.8964
```

```
Epoch 00125: val_loss did not improve from 0.32717
```

```
781/781 [=====] - 54s 69ms/step - loss: 0.1951 -  
acc: 0.9313 - val_loss: 0.3662 - val_acc: 0.8964
```

```
Epoch 126/190
```

```
780/781 [=====>.] - ETA: 0s - loss: 0.1907 - acc:  
0.9326Epoch 1/190
```

```
10000/781 [=====]  
=====]  
=====]  
=====]  
=====]  
=====]  
=====] - 3s 260us/sample - loss: 0.1839 - acc: 0.9070
```

```
Epoch 00126: val_loss did not improve from 0.32717
```

```
781/781 [=====] - 53s 68ms/step - loss: 0.1906 -  
acc: 0.9326 - val_loss: 0.3413 - val_acc: 0.9070
```

```
Epoch 127/190
```

```
780/781 [=====>.] - ETA: 0s - loss: 0.1962 - acc:  
0.9311Epoch 1/190
```

```
10000/781 [=====]
```

```
=====
=====
=====
=====
=====] - 3s 262us/sample - loss: 0.3336 - acc: 0.8931
```

Epoch 00127: val_loss did not improve from 0.32717

```
781/781 [=====] - 54s 69ms/step - loss: 0.1961 -
acc: 0.9311 - val_loss: 0.4264 - val_acc: 0.8931
```

Epoch 128/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1964 - acc:
0.9318Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.3268 - acc: 0.8932
```

Epoch 00128: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.1964 -
acc: 0.9318 - val_loss: 0.4049 - val_acc: 0.8932
```

Epoch 129/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1936 - acc:
0.9330Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.3195 - acc: 0.8934
```

Epoch 00129: val_loss did not improve from 0.32717

```
781/781 [=====] - 54s 69ms/step - loss: 0.1937 -
acc: 0.9330 - val_loss: 0.4254 - val_acc: 0.8934
```

Epoch 130/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1921 - acc:
0.9320Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====] - 3s 263us/sample - loss: 0.2604 - acc: 0.8996
```

Epoch 00130: val_loss did not improve from 0.32717

```
781/781 [=====] - 54s 69ms/step - loss: 0.1922 -
acc: 0.9320 - val_loss: 0.3801 - val_acc: 0.8996
```

Epoch 131/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1975 - acc:
0.9298Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====] - 3s 262us/sample - loss: 0.2909 - acc: 0.8983
```

Epoch 00131: val_loss did not improve from 0.32717

```
781/781 [=====] - 54s 69ms/step - loss: 0.1975 -
acc: 0.9298 - val_loss: 0.3875 - val_acc: 0.8983
```

```
Epoch 132/190
780/781 [=====>.] - ETA: 0s - loss: 0.1882 - acc:
0.9335Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 266us/sample - loss: 0.2707 - acc: 0.9068

Epoch 00132: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1883 -
acc: 0.9335 - val_loss: 0.3409 - val_acc: 0.9068
Epoch 133/190
780/781 [=====>.] - ETA: 0s - loss: 0.1911 - acc:
0.9322Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.2223 - acc: 0.9068

Epoch 00133: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1913 -
acc: 0.9322 - val_loss: 0.3306 - val_acc: 0.9068
Epoch 134/190
780/781 [=====>.] - ETA: 0s - loss: 0.1900 - acc:
0.9339Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.2250 - acc: 0.9015

Epoch 00134: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1898 -
acc: 0.9340 - val_loss: 0.3544 - val_acc: 0.9015
Epoch 135/190
780/781 [=====>.] - ETA: 0s - loss: 0.1860 - acc:
0.9338Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.3056 - acc: 0.8959

Epoch 00135: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1861 -
acc: 0.9337 - val_loss: 0.4000 - val_acc: 0.8959
Epoch 136/190
780/781 [=====>.] - ETA: 0s - loss: 0.1914 - acc:
0.9328Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 262us/sample - loss: 0.3103 - acc: 0.9011
```

```
Epoch 00136: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1913 -
acc: 0.9329 - val_loss: 0.3738 - val_acc: 0.9011
Epoch 137/190
780/781 [=====>.] - ETA: 0s - loss: 0.1958 - acc:
0.9319Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 262us/sample - loss: 0.3047 - acc: 0.8895

Epoch 00137: val_loss did not improve from 0.32717
781/781 [=====] - 54s 69ms/step - loss: 0.1959 -
acc: 0.9319 - val_loss: 0.4227 - val_acc: 0.8895
Epoch 138/190
780/781 [=====>.] - ETA: 0s - loss: 0.1912 - acc:
0.9323Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 264us/sample - loss: 0.2727 - acc: 0.8952

Epoch 00138: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1912 -
acc: 0.9323 - val_loss: 0.3993 - val_acc: 0.8952
Epoch 139/190
780/781 [=====>.] - ETA: 0s - loss: 0.1905 - acc:
0.9333Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.2312 - acc: 0.8969

Epoch 00139: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1906 -
acc: 0.9333 - val_loss: 0.3690 - val_acc: 0.8969
Epoch 140/190
780/781 [=====>.] - ETA: 0s - loss: 0.1855 - acc:
0.9351Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 262us/sample - loss: 0.2876 - acc: 0.8882

Epoch 00140: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1855 -
acc: 0.9351 - val_loss: 0.4257 - val_acc: 0.8882
Epoch 141/190
780/781 [=====>.] - ETA: 0s - loss: 0.1893 - acc:
0.9324Epoch 1/190
10000/781 [=====
=====
=====
=====
=====]
```

```
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.2441 - acc: 0.8993

Epoch 00141: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1893 -
acc: 0.9324 - val_loss: 0.3808 - val_acc: 0.8993
Epoch 142/190
780/781 [=====>.] - ETA: 0s - loss: 0.1906 - acc:
0.9336Epoch 1/190
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.2100 - acc: 0.9021

Epoch 00142: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1906 -
acc: 0.9336 - val_loss: 0.3492 - val_acc: 0.9021
Epoch 143/190
780/781 [=====>.] - ETA: 0s - loss: 0.1887 - acc:
0.9338Epoch 1/190
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.1940 - acc: 0.9047

Epoch 00143: val_loss did not improve from 0.32717
781/781 [=====] - 54s 69ms/step - loss: 0.1886 -
acc: 0.9338 - val_loss: 0.3274 - val_acc: 0.9047
Epoch 144/190
780/781 [=====>.] - ETA: 0s - loss: 0.1878 - acc:
0.9332Epoch 1/190
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.2607 - acc: 0.8952

Epoch 00144: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1878 -
acc: 0.9333 - val_loss: 0.3863 - val_acc: 0.8952
Epoch 145/190
780/781 [=====>.] - ETA: 0s - loss: 0.1851 - acc:
0.9356Epoch 1/190
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.2082 - acc: 0.8999

Epoch 00145: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1850 -
acc: 0.9356 - val_loss: 0.3689 - val_acc: 0.8999
Epoch 146/190
```



```
780/781 [=====>.] - ETA: 0s - loss: 0.1855 - acc:
0.9344Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2350 - acc: 0.9017

Epoch 00146: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1856 -
acc: 0.9344 - val_loss: 0.3589 - val_acc: 0.9017
Epoch 147/190
780/781 [=====>.] - ETA: 0s - loss: 0.1862 - acc:
0.9335Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.2875 - acc: 0.8979

Epoch 00147: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1862 -
acc: 0.9335 - val_loss: 0.3740 - val_acc: 0.8979
Epoch 148/190
780/781 [=====>.] - ETA: 0s - loss: 0.1846 - acc:
0.9346Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 269us/sample - loss: 0.2341 - acc: 0.9005

Epoch 00148: val_loss did not improve from 0.32717
781/781 [=====] - 54s 69ms/step - loss: 0.1846 -
acc: 0.9347 - val_loss: 0.3741 - val_acc: 0.9005
Epoch 149/190
780/781 [=====>.] - ETA: 0s - loss: 0.1855 - acc:
0.9341Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.2011 - acc: 0.9010

Epoch 00149: val_loss did not improve from 0.32717
781/781 [=====] - 54s 69ms/step - loss: 0.1855 -
acc: 0.9341 - val_loss: 0.3599 - val_acc: 0.9010
Epoch 150/190
780/781 [=====>.] - ETA: 0s - loss: 0.1840 - acc:
0.9353Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.2123 - acc: 0.9021
```

```
Epoch 00150: val_loss did not improve from 0.32717
781/781 [=====] - 54s 69ms/step - loss: 0.1839 -
acc: 0.9353 - val_loss: 0.3753 - val_acc: 0.9021
Epoch 151/190
780/781 [=====>.] - ETA: 0s - loss: 0.1897 - acc:
0.9339Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.2453 - acc: 0.8990

Epoch 00151: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1897 -
acc: 0.9339 - val_loss: 0.3826 - val_acc: 0.8990
Epoch 152/190
780/781 [=====>.] - ETA: 0s - loss: 0.1869 - acc:
0.9344Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2285 - acc: 0.9035

Epoch 00152: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1868 -
acc: 0.9344 - val_loss: 0.3526 - val_acc: 0.9035
Epoch 153/190
780/781 [=====>.] - ETA: 0s - loss: 0.1826 - acc:
0.9374Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.2032 - acc: 0.9038

Epoch 00153: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1827 -
acc: 0.9374 - val_loss: 0.3508 - val_acc: 0.9038
Epoch 154/190
780/781 [=====>.] - ETA: 0s - loss: 0.1880 - acc:
0.9334Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.2486 - acc: 0.9031

Epoch 00154: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1878 -
acc: 0.9335 - val_loss: 0.3577 - val_acc: 0.9031
Epoch 155/190
780/781 [=====>.] - ETA: 0s - loss: 0.1820 - acc:
0.9367Epoch 1/190
10000/781 [=====
=====
=====
=====
=====]
```

```
=====
=====
=====] - 3s 259us/sample - loss: 0.2506 - acc: 0.8987
```

Epoch 00155: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.1819 -
acc: 0.9367 - val_loss: 0.3999 - val_acc: 0.8987
```

Epoch 156/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1785 - acc:
0.9363Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2048 - acc: 0.9017
```

Epoch 00156: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.1785 -
acc: 0.9362 - val_loss: 0.3633 - val_acc: 0.9017
```

Epoch 157/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1830 - acc:
0.9349Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.2539 - acc: 0.9026
```

Epoch 00157: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.1831 -
acc: 0.9349 - val_loss: 0.3843 - val_acc: 0.9026
```

Epoch 158/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1834 - acc:
0.9355Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.1990 - acc: 0.9070
```

Epoch 00158: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.1835 -
acc: 0.9354 - val_loss: 0.3432 - val_acc: 0.9070
```

Epoch 159/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1824 - acc:
0.9362Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.2396 - acc: 0.9025
```

Epoch 00159: val_loss did not improve from 0.32717

```
781/781 [=====] - 53s 68ms/step - loss: 0.1823 -
acc: 0.9362 - val_loss: 0.3577 - val_acc: 0.9025
```

Epoch 160/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1820 - acc:
```

```
0.9361Epoch 1/190
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 262us/sample - loss: 0.2502 - acc: 0.9015
```

```
Epoch 00160: val_loss did not improve from 0.32717
781/781 [=====] - 53s 68ms/step - loss: 0.1820 -
acc: 0.9361 - val_loss: 0.3755 - val_acc: 0.9015
```

```
Epoch 161/190
780/781 [=====>.] - ETA: 0s - loss: 0.1857 - acc:
0.9362Epoch 1/190
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 257us/sample - loss: 0.2269 - acc: 0.9097
```

```
Epoch 00161: val_loss improved from 0.32717 to 0.31908, saving model to mo
del-ep161-val_loss0.319.h5
```

```
781/781 [=====] - 53s 68ms/step - loss: 0.1858 -
acc: 0.9362 - val_loss: 0.3191 - val_acc: 0.9097
```

```
Epoch 162/190
780/781 [=====>.] - ETA: 0s - loss: 0.1790 - acc:
0.9370Epoch 1/190
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 256us/sample - loss: 0.1843 - acc: 0.9124
```

```
Epoch 00162: val_loss did not improve from 0.31908
781/781 [=====] - 53s 68ms/step - loss: 0.1790 -
acc: 0.9370 - val_loss: 0.3279 - val_acc: 0.9124
```

```
Epoch 163/190
780/781 [=====>.] - ETA: 0s - loss: 0.1802 - acc:
0.9356Epoch 1/190
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 262us/sample - loss: 0.2091 - acc: 0.9076
```

```
Epoch 00163: val_loss did not improve from 0.31908
781/781 [=====] - 53s 68ms/step - loss: 0.1802 -
acc: 0.9356 - val_loss: 0.3399 - val_acc: 0.9076
```

```
Epoch 164/190
780/781 [=====>.] - ETA: 0s - loss: 0.1780 - acc:
0.9372Epoch 1/190
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.1877 - acc: 0.9065
```

```
Epoch 00164: val_loss did not improve from 0.31908
781/781 [=====] - 53s 68ms/step - loss: 0.1780 -
acc: 0.9372 - val_loss: 0.3413 - val_acc: 0.9065
Epoch 165/190
780/781 [=====>.] - ETA: 0s - loss: 0.1811 - acc:
0.9352Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.2128 - acc: 0.8994

Epoch 00165: val_loss did not improve from 0.31908
781/781 [=====] - 53s 68ms/step - loss: 0.1811 -
acc: 0.9352 - val_loss: 0.4037 - val_acc: 0.8994
Epoch 166/190
780/781 [=====>.] - ETA: 0s - loss: 0.1790 - acc:
0.9374Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 262us/sample - loss: 0.2567 - acc: 0.8961

Epoch 00166: val_loss did not improve from 0.31908
781/781 [=====] - 54s 69ms/step - loss: 0.1789 -
acc: 0.9374 - val_loss: 0.3834 - val_acc: 0.8961
Epoch 167/190
780/781 [=====>.] - ETA: 0s - loss: 0.1838 - acc:
0.9349Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 262us/sample - loss: 0.2563 - acc: 0.8914

Epoch 00167: val_loss did not improve from 0.31908
781/781 [=====] - 53s 68ms/step - loss: 0.1837 -
acc: 0.9349 - val_loss: 0.4127 - val_acc: 0.8914
Epoch 168/190
780/781 [=====>.] - ETA: 0s - loss: 0.1818 - acc:
0.9365Epoch 1/190
10000/781 [=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.2279 - acc: 0.8985

Epoch 00168: val_loss did not improve from 0.31908
781/781 [=====] - 53s 68ms/step - loss: 0.1817 -
acc: 0.9365 - val_loss: 0.3872 - val_acc: 0.8985
Epoch 169/190
780/781 [=====>.] - ETA: 0s - loss: 0.1794 - acc:
0.9366Epoch 1/190
10000/781 [=====
=====
=====
=====
=====]
```

```
=====
=====
=====] - 3s 261us/sample - loss: 0.1999 - acc: 0.9051
```

Epoch 00169: val_loss did not improve from 0.31908

```
781/781 [=====] - 54s 69ms/step - loss: 0.1793 -
acc: 0.9366 - val_loss: 0.3542 - val_acc: 0.9051
```

Epoch 170/190

```
779/781 [=====>.] - ETA: 0s - loss: 0.1794 - acc:
0.9376Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.2615 - acc: 0.8913
```

Epoch 00170: val_loss did not improve from 0.31908

```
781/781 [=====] - 53s 68ms/step - loss: 0.1795 -
acc: 0.9375 - val_loss: 0.4366 - val_acc: 0.8913
```

Epoch 171/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1836 - acc:
0.9360Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.2436 - acc: 0.9056
```

Epoch 00171: val_loss did not improve from 0.31908

```
781/781 [=====] - 53s 68ms/step - loss: 0.1837 -
acc: 0.9359 - val_loss: 0.3537 - val_acc: 0.9056
```

Epoch 172/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1781 - acc:
0.9371Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.2668 - acc: 0.9073
```

Epoch 00172: val_loss did not improve from 0.31908

```
781/781 [=====] - 54s 69ms/step - loss: 0.1780 -
acc: 0.9371 - val_loss: 0.3702 - val_acc: 0.9073
```

Epoch 173/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1810 - acc:
0.9366Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.4841 - acc: 0.8971
```

Epoch 00173: val_loss did not improve from 0.31908

```
781/781 [=====] - 53s 68ms/step - loss: 0.1810 -
acc: 0.9366 - val_loss: 0.3990 - val_acc: 0.8971
```

Epoch 174/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1791 - acc:
```

```
0.9374Epoch 1/190
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.3116 - acc: 0.9092
```

```
Epoch 00174: val_loss did not improve from 0.31908
781/781 [=====] - 53s 68ms/step - loss: 0.1792 -
acc: 0.9373 - val_loss: 0.3432 - val_acc: 0.9092
```

```
Epoch 175/190
780/781 [=====>.] - ETA: 0s - loss: 0.1762 - acc:
0.9386Epoch 1/190
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 262us/sample - loss: 0.3139 - acc: 0.8897
```

```
Epoch 00175: val_loss did not improve from 0.31908
781/781 [=====] - 53s 68ms/step - loss: 0.1761 -
acc: 0.9386 - val_loss: 0.4371 - val_acc: 0.8897
```

```
Epoch 176/190
780/781 [=====>.] - ETA: 0s - loss: 0.1749 - acc:
0.9376Epoch 1/190
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 260us/sample - loss: 0.2756 - acc: 0.8942
```

```
Epoch 00176: val_loss did not improve from 0.31908
781/781 [=====] - 53s 68ms/step - loss: 0.1749 -
acc: 0.9376 - val_loss: 0.4109 - val_acc: 0.8942
```

```
Epoch 177/190
780/781 [=====>.] - ETA: 0s - loss: 0.1815 - acc:
0.9364Epoch 1/190
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.2283 - acc: 0.9094
```

```
Epoch 00177: val_loss did not improve from 0.31908
781/781 [=====] - 53s 68ms/step - loss: 0.1815 -
acc: 0.9364 - val_loss: 0.3270 - val_acc: 0.9094
```

```
Epoch 178/190
780/781 [=====>.] - ETA: 0s - loss: 0.1776 - acc:
0.9385Epoch 1/190
10000/781 [=====]
=====
=====
=====
=====
=====] - 3s 259us/sample - loss: 0.2903 - acc: 0.8806
```

```
Epoch 00178: val_loss did not improve from 0.31908
```

```
781/781 [=====] - 54s 69ms/step - loss: 0.1777 -  
acc: 0.9384 - val_loss: 0.4632 - val_acc: 0.8806
```

Epoch 179/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1780 - acc:  
0.9391Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 258us/sample - loss: 0.3388 - acc: 0.9086
```

Epoch 00179: val_loss did not improve from 0.31908

```
781/781 [=====] - 54s 69ms/step - loss: 0.1779 -  
acc: 0.9391 - val_loss: 0.3398 - val_acc: 0.9086
```

Epoch 180/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1741 - acc:  
0.9387Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 262us/sample - loss: 0.3017 - acc: 0.9107
```

Epoch 00180: val_loss did not improve from 0.31908

```
781/781 [=====] - 54s 69ms/step - loss: 0.1740 -  
acc: 0.9387 - val_loss: 0.3293 - val_acc: 0.9107
```

Epoch 181/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1755 - acc:  
0.9375Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 263us/sample - loss: 0.3326 - acc: 0.9050
```

Epoch 00181: val_loss did not improve from 0.31908

```
781/781 [=====] - 53s 68ms/step - loss: 0.1755 -  
acc: 0.9375 - val_loss: 0.3585 - val_acc: 0.9050
```

Epoch 182/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1770 - acc:  
0.9377Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====] - 3s 259us/sample - loss: 0.2104 - acc: 0.9092
```

Epoch 00182: val_loss did not improve from 0.31908

```
781/781 [=====] - 53s 68ms/step - loss: 0.1771 -  
acc: 0.9377 - val_loss: 0.3390 - val_acc: 0.9092
```

Epoch 183/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1748 - acc:  
0.9387Epoch 1/190
```

```
10000/781 [=====]  
=====
```

=====

```
=====
```

=====

```
=====
```



```
=====
=====] - 3s 265us/sample - loss: 0.2752 - acc: 0.9030
```

Epoch 00183: val_loss did not improve from 0.31908

```
781/781 [=====] - 54s 69ms/step - loss: 0.1749 -
acc: 0.9386 - val_loss: 0.3655 - val_acc: 0.9030
```

Epoch 184/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1748 - acc:
0.9384Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 263us/sample - loss: 0.2014 - acc: 0.9076
```

Epoch 00184: val_loss improved from 0.31908 to 0.31710, saving model to model-ep184-val_loss0.317.h5

```
781/781 [=====] - 54s 69ms/step - loss: 0.1748 -
acc: 0.9384 - val_loss: 0.3171 - val_acc: 0.9076
```

Epoch 185/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1728 - acc:
0.9389Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.2156 - acc: 0.9034
```

Epoch 00185: val_loss did not improve from 0.31710

```
781/781 [=====] - 53s 68ms/step - loss: 0.1727 -
acc: 0.9389 - val_loss: 0.3401 - val_acc: 0.9034
```

Epoch 186/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1698 - acc:
0.9401Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 258us/sample - loss: 0.1969 - acc: 0.9074
```

Epoch 00186: val_loss did not improve from 0.31710

```
781/781 [=====] - 53s 68ms/step - loss: 0.1699 -
acc: 0.9400 - val_loss: 0.3548 - val_acc: 0.9074
```

Epoch 187/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1762 - acc:
0.9377Epoch 1/190
```

```
10000/781 [=====
=====
=====
=====
=====
=====] - 3s 261us/sample - loss: 0.2303 - acc: 0.9005
```

Epoch 00187: val_loss did not improve from 0.31710

```
781/781 [=====] - 54s 69ms/step - loss: 0.1761 -
acc: 0.9377 - val_loss: 0.3838 - val_acc: 0.9005
```

Epoch 188/190

```
780/781 [=====>.] - ETA: 0s - loss: 0.1753 - acc:
```

```

0.9390Epoch 1/190
10000/781 [=====] - 3s 261us/sample - loss: 0.2474 - acc: 0.9091
=====
=====
=====
=====
=====]

```

```

Epoch 00188: val_loss did not improve from 0.31710
781/781 [=====] - 54s 69ms/step - loss: 0.1753 -
acc: 0.9390 - val_loss: 0.3350 - val_acc: 0.9091

```

```

Epoch 189/190
780/781 [=====>.] - ETA: 0s - loss: 0.1750 - acc:
0.9385Epoch 1/190
10000/781 [=====] - 3s 261us/sample - loss: 0.2487 - acc: 0.9064
=====
=====
=====
=====
=====]

```

```

Epoch 00189: val_loss did not improve from 0.31710
781/781 [=====] - 54s 69ms/step - loss: 0.1749 -
acc: 0.9386 - val_loss: 0.3452 - val_acc: 0.9064

```

```

Epoch 190/190
780/781 [=====>.] - ETA: 0s - loss: 0.1789 - acc:
0.9382Epoch 1/190
10000/781 [=====] - 3s 261us/sample - loss: 0.2492 - acc: 0.9047
=====
=====
=====
=====
=====]

```

```

Epoch 00190: val_loss did not improve from 0.31710
781/781 [=====] - 53s 68ms/step - loss: 0.1790 -
acc: 0.9382 - val_loss: 0.3529 - val_acc: 0.9047

```

In [28]:

```

# Save the trained weights in to .h5 format
model.save_weights("DNST_model.h5")
print("Saved model to disk")

```

Saved model to disk

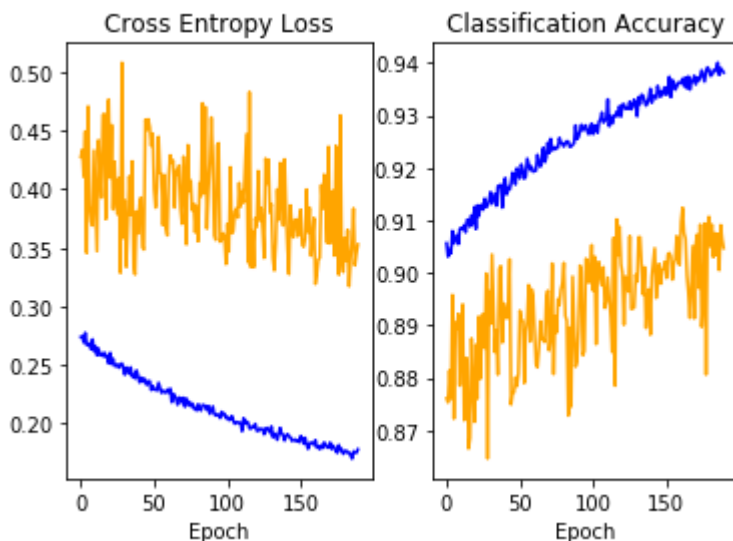
7.0 Plots on training results

In [0]:

```
# function to plot epoch vs Loss
%matplotlib notebook
%matplotlib inline
from matplotlib import pyplot
def plot(history):
    # plot Loss
    pyplot.subplot(121)
    pyplot.title('Cross Entropy Loss')
    pyplot.xlabel('Epoch')
    pyplot.plot(history.history['loss'], color='blue', label='train')
    pyplot.plot(history.history['val_loss'], color='orange', label='test')
    # plot accuracy
    pyplot.subplot(122)
    pyplot.title('\nClassification Accuracy')
    pyplot.xlabel('Epoch')
    pyplot.plot(history.history['acc'], color='blue', label='train')
    pyplot.plot(history.history['val_acc'], color='orange', label='test')
```

In [30]:

```
plot(history)
```



8.0 Model Testing

In [31]:

```
score = model.evaluate(X_test, y_test, verbose=1)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

```
10000/10000 [=====] - 3s 319us/sample - loss: 0.3
540 - acc: 0.9047
Test loss: 0.3539511471837759
Test accuracy: 0.9047
```