Assignment 25 - CNN On CIFR

In [1]:

```
import warnings
warnings.filterwarnings("ignore")
import os
import tensorflow as tf
from tensorflow import keras
```

In [2]:

```
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
```

In [3]:

```
# Hyperparameters
batch_size = 128
num_classes = 10
epochs = 10
l = 40
num_filter = 12
compression = 0.5
dropout_rate = 0.2
```

Loading data

In [4]:

```
# 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 encoing
y_train = tf.keras.utils.to_categorical(y_train, num_classes)
y_test = tf.keras.utils.to_categorical(y_test, num_classes)
```

In [5]:

```
X_train.shape
```

Out[5]:

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

Standarding data

In [6]:

```
def prep_pixels(train, test):
# convert from integers to floats
    train_norm = train.astype('float32')
    test_norm = test.astype('float32')
# normalize to range 0-1
    train_norm = train_norm / 255.0
    test_norm = test_norm / 255.0
# return normalized images
    return train_norm, test_norm
```

In [7]:

```
X_train,X_test=prep_pixels(X_train,X_test)
```

In [8]:

```
#https://machinelearningmastery.com/how-to-configure-image-data-augmentation-when-training-deep-learning-neural-networks/
from numpy import expand_dims
from keras.preprocessing.image import load_img
from keras.preprocessing.image import img_to_array
from keras.preprocessing.image import ImageDataGenerator
from matplotlib import pyplot
c=X_train[1]
c.shape
samples = expand_dims(c, 0)
# create image data augmentation generator
datagen = ImageDataGenerator(rotation_range=90)
# prepare iterator
it = datagen.flow(samples, batch_size=1)
# generate samples and plot
for i in range(9):
    pyplot.subplot(330 + 1 + i)
# generate batch of images
    batch = it.next()
# convert to unsigned integers for viewing
    image = batch[0].astype('uint8')
# plot raw pixel data
    pyplot.imshow(image)
# show the figure

pyplot.show()
```

```
Using TensorFlow backend.
```

```
<Figure size 640x480 with 9 Axes>
```

Defining the model

Model using dense layer

In [9]:

```
# Dense Block
def denseblock(input, num_filter = 64, dropout_rate = 0):
    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),
(5,5),kernel_initializer="he_uniform" ,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 Blosck
def transition(input, num_filter = 32, dropout_rate = 0):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    Conv2D_BottleNeck = layers.Conv2D(int(num_filter*compression), (5,5), kernel_initializer="he_un
iform" ,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)
    flat = layers.Flatten()(AvgPooling)
    output = layers.Dense(num_classes, activation='softmax')(flat)
    return output
```

In [10]:

```
num_filter = 10
dropout_rate = 0
l = 12
input = layers.Input(shape=(img_height, img_width, channel,))
First_Conv2D = layers.Conv2D(num_filter, (5,5), use_bias=False ,padding='same')(input)
BatchNorm = layers.BatchNormalization()(First_Conv2D)

First_Block = denseblock(BatchNorm,32, dropout_rate)
First_Transition = transition(First_Block, num_filter, dropout_rate)

Second_Block = denseblock(First_Transition, 16, 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 [0]:

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

```
Model: "model_5"
_________________________________________________________________________________________________
Layer (type)                 Output Shape              Param #     Connected to
=================================================================================================
input_9 (InputLayer)         [(None, 32, 32, 3)]       0
_________________________________________________________________________________________________
conv2d_365 (Conv2D)          (None, 32, 32, 10)        750         input_9[0][0]
_________________________________________________________________________________________________
batch_normalization_373 (BatchN (None, 32, 32, 10)        40          conv2d_365[0][0]
_________________________________________________________________________________________________
batch_normalization_374 (BatchN (None, 32, 32, 10)        40          batch_normalization_373[0][0]
_________________________________________________________________________________________________
activation_365 (Activation)  (None, 32, 32, 10)        0           batch_normalization_374[0][0]
_________________________________________________________________________________________________
conv2d_366 (Conv2D)          (None, 32, 32, 16)        4016        activation_365[0][0]
_________________________________________________________________________________________________
concatenate_336 (Concatenate)   (None, 32, 32, 26)        0           batch_normalization_373[0][0]
                                                                     conv2d_366[0][0]
_________________________________________________________________________________________________
batch_normalization_375 (BatchN (None, 32, 32, 26)        104         concatenate_336[0][0]
_________________________________________________________________________________________________
activation_366 (Activation)  (None, 32, 32, 26)        0           batch_normalization_375[0][0]
_________________________________________________________________________________________________
conv2d_367 (Conv2D)          (None, 32, 32, 16)        10416       activation_366[0][0]
_________________________________________________________________________________________________
concatenate_337 (Concatenate)   (None, 32, 32, 42)        0           concatenate_336[0][0]
                                                                     conv2d_367[0][0]
_________________________________________________________________________________________________
batch_normalization_376 (BatchN (None, 32, 32, 42)        168         concatenate_337[0][0]
_________________________________________________________________________________________________
activation_367 (Activation)  (None, 32, 32, 42)        0           batch_normalization_376[0][0]
_________________________________________________________________________________________________
conv2d_368 (Conv2D)          (None, 32, 32, 16)        16816       activation_367[0][0]
_________________________________________________________________________________________________
concatenate_338 (Concatenate)   (None, 32, 32, 58)        0           concatenate_337[0][0]
                                                                     conv2d_368[0][0]
_________________________________________________________________________________________________
batch_normalization_377 (BatchN (None, 32, 32, 58)        232         concatenate_338[0][0]
_________________________________________________________________________________________________
```

activation_368 (Activation)	(None, 32, 32, 58)	0	batch_normalization_377[0][0]
conv2d_369 (Conv2D)	(None, 32, 32, 16)	23216	activation_368[0][0]
concatenate_339 (Concatenate)	(None, 32, 32, 74)	0	concatenate_338[0][0] conv2d_369[0][0]
batch_normalization_378 (BatchN	(None, 32, 32, 74)	296	concatenate_339[0][0]
activation_369 (Activation)	(None, 32, 32, 74)	0	batch_normalization_378[0][0]
conv2d_370 (Conv2D)	(None, 32, 32, 16)	29616	activation_369[0][0]
concatenate_340 (Concatenate)	(None, 32, 32, 90)	0	concatenate_339[0][0] conv2d_370[0][0]
batch_normalization_379 (BatchN	(None, 32, 32, 90)	360	concatenate_340[0][0]
activation_370 (Activation)	(None, 32, 32, 90)	0	batch_normalization_379[0][0]
conv2d_371 (Conv2D)	(None, 32, 32, 16)	36016	activation_370[0][0]
concatenate_341 (Concatenate)	(None, 32, 32, 106)	0	concatenate_340[0][0] conv2d_371[0][0]
batch_normalization_380 (BatchN	(None, 32, 32, 106)	424	concatenate_341[0][0]
activation_371 (Activation)	(None, 32, 32, 106)	0	batch_normalization_380[0][0]
conv2d_372 (Conv2D)	(None, 32, 32, 16)	42416	activation_371[0][0]
concatenate_342 (Concatenate)	(None, 32, 32, 122)	0	concatenate_341[0][0] conv2d_372[0][0]
batch_normalization_381 (BatchN	(None, 32, 32, 122)	488	concatenate_342[0][0]
activation_372 (Activation)	(None, 32, 32, 122)	0	batch_normalization_381[0][0]
conv2d_373 (Conv2D)	(None, 32, 32, 16)	48816	activation_372[0][0]
concatenate_343 (Concatenate)	(None, 32, 32, 138)	0	concatenate_342[0][0] conv2d_373[0][0]
batch_normalization_382 (BatchN	(None, 32, 32, 138)	552	concatenate_343[0][0]
activation_373 (Activation)	(None, 32, 32, 138)	0	batch_normalization_382[0][0]
conv2d_374 (Conv2D)	(None, 32, 32, 16)	55216	activation_373[0][0]
concatenate_344 (Concatenate)	(None, 32, 32, 154)	0	concatenate_343[0][0] conv2d_374[0][0]
batch_normalization_383 (BatchN	(None, 32, 32, 154)	616	concatenate_344[0][0]
activation_374 (Activation)	(None, 32, 32, 154)	0	batch_normalization_383[0][0]
conv2d_375 (Conv2D)	(None, 32, 32, 16)	61616	activation_374[0][0]
concatenate_345 (Concatenate)	(None, 32, 32, 170)	0	concatenate_344[0][0] conv2d_375[0][0]
batch_normalization_384 (BatchN	(None, 32, 32, 170)	680	concatenate_345[0][0]
activation_375 (Activation)	(None, 32, 32, 170)	0	batch_normalization_384[0][0]
conv2d_376 (Conv2D)	(None, 32, 32, 16)	68016	activation_375[0][0]
concatenate_346 (Concatenate)	(None, 32, 32, 186)	0	concatenate_345[0][0] conv2d_376[0][0]
batch_normalization_385 (BatchN	(None, 32, 32, 186)	744	concatenate_346[0][0]
activation_376 (Activation)	(None, 32, 32, 186)	0	batch_normalization_385[0][0]
conv2d_377 (Conv2D)	(None, 32, 32, 16)	74416	activation_376[0][0]
concatenate_347 (Concatenate)	(None, 32, 32, 202)	0	concatenate_346[0][0]

			conv2d_377[0][0]
batch_normalization_386 (BatchN	(None, 32, 32, 202)	808	concatenate_347[0][0]
activation_377 (Activation)	(None, 32, 32, 202)	0	batch_normalization_386[0][0]
conv2d_378 (Conv2D)	(None, 32, 32, 5)	25255	activation_377[0][0]
average_pooling2d_28 (AveragePo	(None, 16, 16, 5)	0	conv2d_378[0][0]
batch_normalization_387 (BatchN	(None, 16, 16, 5)	20	average_pooling2d_28[0][0]
activation_378 (Activation)	(None, 16, 16, 5)	0	batch_normalization_387[0][0]
conv2d_379 (Conv2D)	(None, 16, 16, 8)	1008	activation_378[0][0]
concatenate_348 (Concatenate)	(None, 16, 16, 13)	0	average_pooling2d_28[0][0] conv2d_379[0][0]
batch_normalization_388 (BatchN	(None, 16, 16, 13)	52	concatenate_348[0][0]
activation_379 (Activation)	(None, 16, 16, 13)	0	batch_normalization_388[0][0]
conv2d_380 (Conv2D)	(None, 16, 16, 8)	2608	activation_379[0][0]
concatenate_349 (Concatenate)	(None, 16, 16, 21)	0	concatenate_348[0][0] conv2d_380[0][0]
batch_normalization_389 (BatchN	(None, 16, 16, 21)	84	concatenate_349[0][0]
activation_380 (Activation)	(None, 16, 16, 21)	0	batch_normalization_389[0][0]
conv2d_381 (Conv2D)	(None, 16, 16, 8)	4208	activation_380[0][0]
concatenate_350 (Concatenate)	(None, 16, 16, 29)	0	concatenate_349[0][0] conv2d_381[0][0]
batch_normalization_390 (BatchN	(None, 16, 16, 29)	116	concatenate_350[0][0]
activation_381 (Activation)	(None, 16, 16, 29)	0	batch_normalization_390[0][0]
conv2d_382 (Conv2D)	(None, 16, 16, 8)	5808	activation_381[0][0]
concatenate_351 (Concatenate)	(None, 16, 16, 37)	0	concatenate_350[0][0] conv2d_382[0][0]
batch_normalization_391 (BatchN	(None, 16, 16, 37)	148	concatenate_351[0][0]
activation_382 (Activation)	(None, 16, 16, 37)	0	batch_normalization_391[0][0]
conv2d_383 (Conv2D)	(None, 16, 16, 8)	7408	activation_382[0][0]
concatenate_352 (Concatenate)	(None, 16, 16, 45)	0	concatenate_351[0][0] conv2d_383[0][0]
batch_normalization_392 (BatchN	(None, 16, 16, 45)	180	concatenate_352[0][0]
activation_383 (Activation)	(None, 16, 16, 45)	0	batch_normalization_392[0][0]
conv2d_384 (Conv2D)	(None, 16, 16, 8)	9008	activation_383[0][0]
concatenate_353 (Concatenate)	(None, 16, 16, 53)	0	concatenate_352[0][0] conv2d_384[0][0]
batch_normalization_393 (BatchN	(None, 16, 16, 53)	212	concatenate_353[0][0]
activation_384 (Activation)	(None, 16, 16, 53)	0	batch_normalization_393[0][0]
conv2d_385 (Conv2D)	(None, 16, 16, 8)	10608	activation_384[0][0]
concatenate_354 (Concatenate)	(None, 16, 16, 61)	0	concatenate_353[0][0] conv2d_385[0][0]
batch_normalization_394 (BatchN	(None, 16, 16, 61)	244	concatenate_354[0][0]
activation_385 (Activation)	(None, 16, 16, 61)	0	batch_normalization_394[0][0]

conv2d_386 (Conv2D)	(None, 16, 16, 8)	12208	activation_385[0][0]
concatenate_355 (Concatenate)	(None, 16, 16, 69)	0	concatenate_354[0][0] conv2d_386[0][0]
batch_normalization_395 (BatchN	(None, 16, 16, 69)	276	concatenate_355[0][0]
activation_386 (Activation)	(None, 16, 16, 69)	0	batch_normalization_395[0][0]
conv2d_387 (Conv2D)	(None, 16, 16, 8)	13808	activation_386[0][0]
concatenate_356 (Concatenate)	(None, 16, 16, 77)	0	concatenate_355[0][0] conv2d_387[0][0]
batch_normalization_396 (BatchN	(None, 16, 16, 77)	308	concatenate_356[0][0]
activation_387 (Activation)	(None, 16, 16, 77)	0	batch_normalization_396[0][0]
conv2d_388 (Conv2D)	(None, 16, 16, 8)	15408	activation_387[0][0]
concatenate_357 (Concatenate)	(None, 16, 16, 85)	0	concatenate_356[0][0] conv2d_388[0][0]
batch_normalization_397 (BatchN	(None, 16, 16, 85)	340	concatenate_357[0][0]
activation_388 (Activation)	(None, 16, 16, 85)	0	batch_normalization_397[0][0]
conv2d_389 (Conv2D)	(None, 16, 16, 8)	17008	activation_388[0][0]
concatenate_358 (Concatenate)	(None, 16, 16, 93)	0	concatenate_357[0][0] conv2d_389[0][0]
batch_normalization_398 (BatchN	(None, 16, 16, 93)	372	concatenate_358[0][0]
activation_389 (Activation)	(None, 16, 16, 93)	0	batch_normalization_398[0][0]
conv2d_390 (Conv2D)	(None, 16, 16, 8)	18608	activation_389[0][0]
concatenate_359 (Concatenate)	(None, 16, 16, 101)	0	concatenate_358[0][0] conv2d_390[0][0]
batch_normalization_399 (BatchN	(None, 16, 16, 101)	404	concatenate_359[0][0]
activation_390 (Activation)	(None, 16, 16, 101)	0	batch_normalization_399[0][0]
conv2d_391 (Conv2D)	(None, 16, 16, 5)	12630	activation_390[0][0]
average_pooling2d_29 (AveragePo	(None, 8, 8, 5)	0	conv2d_391[0][0]
batch_normalization_400 (BatchN	(None, 8, 8, 5)	20	average_pooling2d_29[0][0]
activation_391 (Activation)	(None, 8, 8, 5)	0	batch_normalization_400[0][0]
conv2d_392 (Conv2D)	(None, 8, 8, 5)	630	activation_391[0][0]
concatenate_360 (Concatenate)	(None, 8, 8, 10)	0	average_pooling2d_29[0][0] conv2d_392[0][0]
batch_normalization_401 (BatchN	(None, 8, 8, 10)	40	concatenate_360[0][0]
activation_392 (Activation)	(None, 8, 8, 10)	0	batch_normalization_401[0][0]
conv2d_393 (Conv2D)	(None, 8, 8, 5)	1255	activation_392[0][0]
concatenate_361 (Concatenate)	(None, 8, 8, 15)	0	concatenate_360[0][0] conv2d_393[0][0]
batch_normalization_402 (BatchN	(None, 8, 8, 15)	60	concatenate_361[0][0]
activation_393 (Activation)	(None, 8, 8, 15)	0	batch_normalization_402[0][0]
conv2d_394 (Conv2D)	(None, 8, 8, 5)	1880	activation_393[0][0]
concatenate_362 (Concatenate)	(None, 8, 8, 20)	0	concatenate_361[0][0] conv2d_394[0][0]
batch_normalization_403 (BatchN	(None, 8, 8, 20)	80	concatenate_362[0][0]

activation_394 (Activation)	(None, 8, 8, 20)	0	batch_normalization_403[0][0]
conv2d_395 (Conv2D)	(None, 8, 8, 5)	2505	activation_394[0][0]
concatenate_363 (Concatenate)	(None, 8, 8, 25)	0	concatenate_362[0][0] conv2d_395[0][0]
batch_normalization_404 (BatchN	(None, 8, 8, 25)	100	concatenate_363[0][0]
activation_395 (Activation)	(None, 8, 8, 25)	0	batch_normalization_404[0][0]
conv2d_396 (Conv2D)	(None, 8, 8, 5)	3130	activation_395[0][0]
concatenate_364 (Concatenate)	(None, 8, 8, 30)	0	concatenate_363[0][0] conv2d_396[0][0]
batch_normalization_405 (BatchN	(None, 8, 8, 30)	120	concatenate_364[0][0]
activation_396 (Activation)	(None, 8, 8, 30)	0	batch_normalization_405[0][0]
conv2d_397 (Conv2D)	(None, 8, 8, 5)	3755	activation_396[0][0]
concatenate_365 (Concatenate)	(None, 8, 8, 35)	0	concatenate_364[0][0] conv2d_397[0][0]
batch_normalization_406 (BatchN	(None, 8, 8, 35)	140	concatenate_365[0][0]
activation_397 (Activation)	(None, 8, 8, 35)	0	batch_normalization_406[0][0]
conv2d_398 (Conv2D)	(None, 8, 8, 5)	4380	activation_397[0][0]
concatenate_366 (Concatenate)	(None, 8, 8, 40)	0	concatenate_365[0][0] conv2d_398[0][0]
batch_normalization_407 (BatchN	(None, 8, 8, 40)	160	concatenate_366[0][0]
activation_398 (Activation)	(None, 8, 8, 40)	0	batch_normalization_407[0][0]
conv2d_399 (Conv2D)	(None, 8, 8, 5)	5005	activation_398[0][0]
concatenate_367 (Concatenate)	(None, 8, 8, 45)	0	concatenate_366[0][0] conv2d_399[0][0]
batch_normalization_408 (BatchN	(None, 8, 8, 45)	180	concatenate_367[0][0]
activation_399 (Activation)	(None, 8, 8, 45)	0	batch_normalization_408[0][0]
conv2d_400 (Conv2D)	(None, 8, 8, 5)	5630	activation_399[0][0]
concatenate_368 (Concatenate)	(None, 8, 8, 50)	0	concatenate_367[0][0] conv2d_400[0][0]
batch_normalization_409 (BatchN	(None, 8, 8, 50)	200	concatenate_368[0][0]
activation_400 (Activation)	(None, 8, 8, 50)	0	batch_normalization_409[0][0]
conv2d_401 (Conv2D)	(None, 8, 8, 5)	6255	activation_400[0][0]
concatenate_369 (Concatenate)	(None, 8, 8, 55)	0	concatenate_368[0][0] conv2d_401[0][0]
batch_normalization_410 (BatchN	(None, 8, 8, 55)	220	concatenate_369[0][0]
activation_401 (Activation)	(None, 8, 8, 55)	0	batch_normalization_410[0][0]
conv2d_402 (Conv2D)	(None, 8, 8, 5)	6880	activation_401[0][0]
concatenate_370 (Concatenate)	(None, 8, 8, 60)	0	concatenate_369[0][0] conv2d_402[0][0]
batch_normalization_411 (BatchN	(None, 8, 8, 60)	240	concatenate_370[0][0]
activation_402 (Activation)	(None, 8, 8, 60)	0	batch_normalization_411[0][0]
conv2d_403 (Conv2D)	(None, 8, 8, 5)	7505	activation_402[0][0]

concatenate_371 (Concatenate)	(None, 8, 8, 65)	0	concatenate_370[0][0] conv2d_403[0][0]
batch_normalization_412 (BatchN	(None, 8, 8, 65)	260	concatenate_371[0][0]
activation_403 (Activation)	(None, 8, 8, 65)	0	batch_normalization_412[0][0]
conv2d_404 (Conv2D)	(None, 8, 8, 5)	8130	activation_403[0][0]
average_pooling2d_30 (AveragePo	(None, 4, 4, 5)	0	conv2d_404[0][0]
batch_normalization_413 (BatchN	(None, 4, 4, 5)	20	average_pooling2d_30[0][0]
activation_404 (Activation)	(None, 4, 4, 5)	0	batch_normalization_413[0][0]
conv2d_405 (Conv2D)	(None, 4, 4, 5)	630	activation_404[0][0]
concatenate_372 (Concatenate)	(None, 4, 4, 10)	0	average_pooling2d_30[0][0] conv2d_405[0][0]
batch_normalization_414 (BatchN	(None, 4, 4, 10)	40	concatenate_372[0][0]
activation_405 (Activation)	(None, 4, 4, 10)	0	batch_normalization_414[0][0]
conv2d_406 (Conv2D)	(None, 4, 4, 5)	1255	activation_405[0][0]
concatenate_373 (Concatenate)	(None, 4, 4, 15)	0	concatenate_372[0][0] conv2d_406[0][0]
batch_normalization_415 (BatchN	(None, 4, 4, 15)	60	concatenate_373[0][0]
activation_406 (Activation)	(None, 4, 4, 15)	0	batch_normalization_415[0][0]
conv2d_407 (Conv2D)	(None, 4, 4, 5)	1880	activation_406[0][0]
concatenate_374 (Concatenate)	(None, 4, 4, 20)	0	concatenate_373[0][0] conv2d_407[0][0]
batch_normalization_416 (BatchN	(None, 4, 4, 20)	80	concatenate_374[0][0]
activation_407 (Activation)	(None, 4, 4, 20)	0	batch_normalization_416[0][0]
conv2d_408 (Conv2D)	(None, 4, 4, 5)	2505	activation_407[0][0]
concatenate_375 (Concatenate)	(None, 4, 4, 25)	0	concatenate_374[0][0] conv2d_408[0][0]
batch_normalization_417 (BatchN	(None, 4, 4, 25)	100	concatenate_375[0][0]
activation_408 (Activation)	(None, 4, 4, 25)	0	batch_normalization_417[0][0]
conv2d_409 (Conv2D)	(None, 4, 4, 5)	3130	activation_408[0][0]
concatenate_376 (Concatenate)	(None, 4, 4, 30)	0	concatenate_375[0][0] conv2d_409[0][0]
batch_normalization_418 (BatchN	(None, 4, 4, 30)	120	concatenate_376[0][0]
activation_409 (Activation)	(None, 4, 4, 30)	0	batch_normalization_418[0][0]
conv2d_410 (Conv2D)	(None, 4, 4, 5)	3755	activation_409[0][0]
concatenate_377 (Concatenate)	(None, 4, 4, 35)	0	concatenate_376[0][0] conv2d_410[0][0]
batch_normalization_419 (BatchN	(None, 4, 4, 35)	140	concatenate_377[0][0]
activation_410 (Activation)	(None, 4, 4, 35)	0	batch_normalization_419[0][0]
conv2d_411 (Conv2D)	(None, 4, 4, 5)	4380	activation_410[0][0]
concatenate_378 (Concatenate)	(None, 4, 4, 40)	0	concatenate_377[0][0] conv2d_411[0][0]
batch_normalization_420 (BatchN	(None, 4, 4, 40)	160	concatenate_378[0][0]
activation_411 (Activation)	(None, 4, 4, 40)	0	batch_normalization_420[0][0]

```
conv2d_412 (Conv2D)              (None, 4, 4, 5)       5005        activation_411[0][0]
concatenate_379 (Concatenate)    (None, 4, 4, 45)      0           concatenate_378[0][0]
                                                                   conv2d_412[0][0]
batch_normalization_421 (BatchN (None, 4, 4, 45)      180         concatenate_379[0][0]
activation_412 (Activation)      (None, 4, 4, 45)      0           batch_normalization_421[0][0]
conv2d_413 (Conv2D)              (None, 4, 4, 5)       5630        activation_412[0][0]
concatenate_380 (Concatenate)    (None, 4, 4, 50)      0           concatenate_379[0][0]
                                                                   conv2d_413[0][0]
batch_normalization_422 (BatchN (None, 4, 4, 50)      200         concatenate_380[0][0]
activation_413 (Activation)      (None, 4, 4, 50)      0           batch_normalization_422[0][0]
conv2d_414 (Conv2D)              (None, 4, 4, 5)       6255        activation_413[0][0]
concatenate_381 (Concatenate)    (None, 4, 4, 55)      0           concatenate_380[0][0]
                                                                   conv2d_414[0][0]
batch_normalization_423 (BatchN (None, 4, 4, 55)      220         concatenate_381[0][0]
activation_414 (Activation)      (None, 4, 4, 55)      0           batch_normalization_423[0][0]
conv2d_415 (Conv2D)              (None, 4, 4, 5)       6880        activation_414[0][0]
concatenate_382 (Concatenate)    (None, 4, 4, 60)      0           concatenate_381[0][0]
                                                                   conv2d_415[0][0]
batch_normalization_424 (BatchN (None, 4, 4, 60)      240         concatenate_382[0][0]
activation_415 (Activation)      (None, 4, 4, 60)      0           batch_normalization_424[0][0]
conv2d_416 (Conv2D)              (None, 4, 4, 5)       7505        activation_415[0][0]
concatenate_383 (Concatenate)    (None, 4, 4, 65)      0           concatenate_382[0][0]
                                                                   conv2d_416[0][0]
batch_normalization_425 (BatchN (None, 4, 4, 65)      260         concatenate_383[0][0]
activation_416 (Activation)      (None, 4, 4, 65)      0           batch_normalization_425[0][0]
average_pooling2d_31 (AveragePo (None, 2, 2, 65)      0           activation_416[0][0]
flatten_7 (Flatten)              (None, 260)           0           average_pooling2d_31[0][0]
dense_7 (Dense)                  (None, 10)            2610        flatten_7[0][0]
==================================================================================================
Total params: 747,231
Trainable params: 741,257
Non-trainable params: 5,974
__________________________________________________________________________________________________
```

In [0]:

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

In [0]:

```
#https://machinelearningmastery.com/how-to-develop-a-cnn-from-scratch-for-cifar-10-photo-classification/
def summarize_diagnostics(history):
    # plot loss
    pyplot.subplot(121)
    pyplot.title('Cross Entropy Loss')
    pyplot.plot(history.history['loss'], color='blue', label='train')
    pyplot.plot(history.history['val_loss'], color='orange', label='test')
    pyplot.show()
```

```
# run the test harness for evaluating a model
def run_test_harness():

    # define model
    # create data generator
    datagen = ImageDataGenerator(width_shift_range=0.1, height_shift_range=0.1, horizontal_flip=Tru
e)
    # prepare iterator
    it_train = datagen.flow(X_train, y_train, batch_size=64)
    # fit model
    steps = int(X_train.shape[0] / 64)
    history = model.fit_generator(it_train, steps_per_epoch=steps, epochs=75, validation_data=(X_te
st, y_test), verbose=1)
    # evaluate model
    _, acc = model.evaluate(X_test, y_test, verbose=0)
    print('> %.3f' % (acc * 100.0))
    # learning curves
    summarize_diagnostics(history)

# entry point, run the test harness
run_test_harness()
```

```
Epoch 1/75
780/781 [============================>.] - ETA: 0s - loss: 1.5275 - acc: 0.4362Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 13s 1ms/sample - l
oss: 1.4382 - acc: 0.4974
781/781 [==============================] - 186s 238ms/step - loss: 1.5274 - acc: 0.4364 -
val_loss: 1.3837 - val_acc: 0.4974
Epoch 2/75
780/781 [============================>.] - ETA: 0s - loss: 1.2076 - acc: 0.5613Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 1.5742 - acc: 0.5652
781/781 [==============================] - 183s 234ms/step - loss: 1.2077 - acc: 0.5612 -
val_loss: 1.2507 - val_acc: 0.5652
Epoch 3/75
780/781 [============================>.] - ETA: 0s - loss: 0.9900 - acc: 0.6452Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 10s 1ms/sample - l
oss: 1.3140 - acc: 0.6044
781/781 [==============================] - 183s 234ms/step - loss: 0.9901 - acc: 0.6451 -
val_loss: 1.2087 - val_acc: 0.6044
Epoch 4/75
780/781 [============================>.] - ETA: 0s - loss: 0.8670 - acc: 0.6949Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.7690 - acc: 0.6924
781/781 [==============================] - 183s 234ms/step - loss: 0.8669 - acc: 0.6950 -
val_loss: 0.8870 - val_acc: 0.6924
Epoch 5/75
780/781 [============================>.] - ETA: 0s - loss: 0.7756 - acc: 0.7274Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.7836 - acc: 0.6953
781/781 [==============================] - 183s 234ms/step - loss: 0.7755 - acc: 0.7274 -
val_loss: 0.8746 - val_acc: 0.6953
Epoch 6/75
780/781 [============================>.] - ETA: 0s - loss: 0.7118 - acc: 0.7523Epoch 1/75
10000/781
```

```
[==============================================================================
==============================================================================
==============================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.9152 - acc: 0.7054
781/781 [==============================] - 183s 235ms/step - loss: 0.7118 - acc: 0.7524 -
val_loss: 0.8560 - val_acc: 0.7054
Epoch 7/75
780/781 [============================>.] - ETA: 0s - loss: 0.6602 - acc: 0.7689Epoch 1/75
10000/781
[==============================================================================
==============================================================================
==============================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.6077 - acc: 0.7401
781/781 [==============================] - 185s 236ms/step - loss: 0.6604 - acc: 0.7689 -
val_loss: 0.7374 - val_acc: 0.7401
Epoch 8/75
780/781 [============================>.] - ETA: 0s - loss: 0.6170 - acc: 0.7850Epoch 1/75
10000/781
[==============================================================================
==============================================================================
==============================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.7451 - acc: 0.7286
781/781 [==============================] - 185s 236ms/step - loss: 0.6167 - acc: 0.7851 -
val_loss: 0.7916 - val_acc: 0.7286
Epoch 9/75
780/781 [============================>.] - ETA: 0s - loss: 0.5827 - acc: 0.7996Epoch 1/75
10000/781
[==============================================================================
==============================================================================
==============================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.6747 - acc: 0.7739
781/781 [==============================] - 185s 236ms/step - loss: 0.5825 - acc: 0.7997 -
val_loss: 0.6578 - val_acc: 0.7739
Epoch 10/75
780/781 [============================>.] - ETA: 0s - loss: 0.5473 - acc: 0.8092Epoch 1/75
10000/781
[==============================================================================
==============================================================================
==============================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.6126 - acc: 0.7666
781/781 [==============================] - 183s 235ms/step - loss: 0.5474 - acc: 0.8092 -
val_loss: 0.6991 - val_acc: 0.7666
Epoch 11/75
780/781 [============================>.] - ETA: 0s - loss: 0.5221 - acc: 0.8213Epoch 1/75
10000/781
[==============================================================================
==============================================================================
==============================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.6866 - acc: 0.7694
781/781 [==============================] - 183s 235ms/step - loss: 0.5226 - acc: 0.8211 -
val_loss: 0.6816 - val_acc: 0.7694
Epoch 12/75
780/781 [============================>.] - ETA: 0s - loss: 0.5038 - acc: 0.8255Epoch 1/75
10000/781
[==============================================================================
==============================================================================
==============================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.5435 - acc: 0.7885
781/781 [==============================] - 183s 234ms/step - loss: 0.5039 - acc: 0.8255 -
val_loss: 0.6486 - val_acc: 0.7885
Epoch 13/75
780/781 [============================>.] - ETA: 0s - loss: 0.4813 - acc: 0.8331Epoch 1/75
10000/781
[==============================================================================
==============================================================================
==============================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.3991 - acc: 0.8047
781/781 [==============================] - 184s 235ms/step - loss: 0.4811 - acc: 0.8332 -
val_loss: 0.5849 - val_acc: 0.8047
```

```
Epoch 14/75
780/781 [============================>.] - ETA: 0s - loss: 0.4567 - acc: 0.8416Epoch 1/75
10000/781
[==============================================================================================
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==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.5540 - acc: 0.7849
781/781 [==============================] - 183s 234ms/step - loss: 0.4566 - acc: 0.8417 -
val_loss: 0.6536 - val_acc: 0.7849
Epoch 15/75
780/781 [============================>.] - ETA: 0s - loss: 0.4379 - acc: 0.8481Epoch 1/75
10000/781
[==============================================================================================
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==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.6660 - acc: 0.8011
781/781 [==============================] - 184s 235ms/step - loss: 0.4378 - acc: 0.8481 -
val_loss: 0.6330 - val_acc: 0.8011
Epoch 16/75
780/781 [============================>.] - ETA: 0s - loss: 0.4213 - acc: 0.8549Epoch 1/75
10000/781
[==============================================================================================
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==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.5207 - acc: 0.8034
781/781 [==============================] - 182s 233ms/step - loss: 0.4212 - acc: 0.8550 -
val_loss: 0.5885 - val_acc: 0.8034
Epoch 17/75
780/781 [============================>.] - ETA: 0s - loss: 0.4086 - acc: 0.8589Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.4926 - acc: 0.8185
781/781 [==============================] - 182s 233ms/step - loss: 0.4087 - acc: 0.8589 -
val_loss: 0.5474 - val_acc: 0.8185
Epoch 18/75
780/781 [============================>.] - ETA: 0s - loss: 0.3931 - acc: 0.8635Epoch 1/75
10000/781
[==============================================================================================
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==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.7165 - acc: 0.7686
781/781 [==============================] - 182s 233ms/step - loss: 0.3930 - acc: 0.8636 -
val_loss: 0.7313 - val_acc: 0.7686
Epoch 19/75
780/781 [============================>.] - ETA: 0s - loss: 0.3815 - acc: 0.8663Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.4423 - acc: 0.8287
781/781 [==============================] - 181s 232ms/step - loss: 0.3814 - acc: 0.8663 -
val_loss: 0.5105 - val_acc: 0.8287
Epoch 20/75
780/781 [============================>.] - ETA: 0s - loss: 0.3705 - acc: 0.8704Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.5411 - acc: 0.8122
781/781 [==============================] - 182s 233ms/step - loss: 0.3704 - acc: 0.8705 -
val_loss: 0.5606 - val_acc: 0.8122
Epoch 21/75
780/781 [============================>.] - ETA: 0s - loss: 0.3542 - acc: 0.8774Epoch 1/75
10000/781
[==============================================================================================
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==============================================================================================
==========================================================================] - 11s 1ms/sample - l
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oss: 0.6598 - acc: 0.7990
781/781 [==============================] - 182s 233ms/step - loss: 0.3543 - acc: 0.8774 -
val_loss: 0.6226 - val_acc: 0.7990
Epoch 22/75
780/781 [==============================>.] - ETA: 0s - loss: 0.3448 - acc: 0.8801Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.7122 - acc: 0.8209
781/781 [==============================] - 182s 233ms/step - loss: 0.3454 - acc: 0.8800 -
val_loss: 0.5809 - val_acc: 0.8209
Epoch 23/75
780/781 [==============================>.] - ETA: 0s - loss: 0.3381 - acc: 0.8830Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.6153 - acc: 0.8135
781/781 [==============================] - 183s 234ms/step - loss: 0.3380 - acc: 0.8830 -
val_loss: 0.5634 - val_acc: 0.8135
Epoch 24/75
780/781 [==============================>.] - ETA: 0s - loss: 0.3289 - acc: 0.8860Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.5751 - acc: 0.8294
781/781 [==============================] - 183s 234ms/step - loss: 0.3288 - acc: 0.8860 -
val_loss: 0.5340 - val_acc: 0.8294
Epoch 25/75
780/781 [==============================>.] - ETA: 0s - loss: 0.3184 - acc: 0.8898Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.4361 - acc: 0.8350
781/781 [==============================] - 184s 235ms/step - loss: 0.3182 - acc: 0.8899 -
val_loss: 0.5087 - val_acc: 0.8350
Epoch 26/75
780/781 [==============================>.] - ETA: 0s - loss: 0.3128 - acc: 0.8905Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.5287 - acc: 0.8252
781/781 [==============================] - 184s 235ms/step - loss: 0.3129 - acc: 0.8905 -
val_loss: 0.5501 - val_acc: 0.8252
Epoch 27/75
780/781 [==============================>.] - ETA: 0s - loss: 0.3015 - acc: 0.8948Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.6227 - acc: 0.8130
781/781 [==============================] - 183s 235ms/step - loss: 0.3013 - acc: 0.8949 -
val_loss: 0.5863 - val_acc: 0.8130
Epoch 28/75
780/781 [==============================>.] - ETA: 0s - loss: 0.2948 - acc: 0.8964Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.7176 - acc: 0.8146
781/781 [==============================] - 183s 235ms/step - loss: 0.2948 - acc: 0.8964 -
val_loss: 0.5912 - val_acc: 0.8146
Epoch 29/75
780/781 [==============================>.] - ETA: 0s - loss: 0.2887 - acc: 0.8999Epoch 1/75
10000/781
[==============================================================================================
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==============================================================================================================
==============================================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.6390 - acc: 0.8458
781/781 [==============================] - 184s 236ms/step - loss: 0.2886 - acc: 0.8999 -
val_loss: 0.4839 - val_acc: 0.8458
Epoch 30/75
780/781 [============================>.] - ETA: 0s - loss: 0.2746 - acc: 0.9037Epoch 1/75
10000/781
[==============================================================================================================
==============================================================================================================
==============================================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.6728 - acc: 0.8389
781/781 [==============================] - 183s 234ms/step - loss: 0.2749 - acc: 0.9037 -
val_loss: 0.5129 - val_acc: 0.8389
Epoch 31/75
780/781 [============================>.] - ETA: 0s - loss: 0.2753 - acc: 0.9033Epoch 1/75
10000/781
[==============================================================================================================
==============================================================================================================
==============================================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.8001 - acc: 0.8289
781/781 [==============================] - 185s 237ms/step - loss: 0.2755 - acc: 0.9033 -
val_loss: 0.5541 - val_acc: 0.8289
Epoch 32/75
780/781 [============================>.] - ETA: 0s - loss: 0.2650 - acc: 0.9076Epoch 1/75
10000/781
[==============================================================================================================
==============================================================================================================
==============================================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.7446 - acc: 0.8447
781/781 [==============================] - 185s 237ms/step - loss: 0.2650 - acc: 0.9076 -
val_loss: 0.5066 - val_acc: 0.8447
Epoch 33/75
780/781 [============================>.] - ETA: 0s - loss: 0.2663 - acc: 0.9062Epoch 1/75
10000/781
[==============================================================================================================
==============================================================================================================
==============================================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 1.0106 - acc: 0.8115
781/781 [==============================] - 185s 236ms/step - loss: 0.2663 - acc: 0.9062 -
val_loss: 0.6585 - val_acc: 0.8115
Epoch 34/75
780/781 [============================>.] - ETA: 0s - loss: 0.2530 - acc: 0.9133Epoch 1/75
10000/781
[==============================================================================================================
==============================================================================================================
==============================================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.4725 - acc: 0.8524
781/781 [==============================] - 184s 236ms/step - loss: 0.2533 - acc: 0.9132 -
val_loss: 0.4882 - val_acc: 0.8524
Epoch 35/75
780/781 [============================>.] - ETA: 0s - loss: 0.2439 - acc: 0.9147Epoch 1/75
10000/781
[==============================================================================================================
==============================================================================================================
==============================================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.5355 - acc: 0.8450
781/781 [==============================] - 185s 237ms/step - loss: 0.2439 - acc: 0.9147 -
val_loss: 0.5012 - val_acc: 0.8450
Epoch 36/75
780/781 [============================>.] - ETA: 0s - loss: 0.2429 - acc: 0.9157Epoch 1/75
10000/781
[==============================================================================================================
==============================================================================================================
==============================================================================================================
==============================================================================] - 11s 1ms/sample - l
oss: 0.4714 - acc: 0.8458
781/781 [==============================] - 184s 236ms/step - loss: 0.2429 - acc: 0.9158 -
val_loss: 0.5050 - val_acc: 0.8458
Epoch 37/75
```

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780/781 [============================>.] - ETA: 0s - loss: 0.2397 - acc: 0.9160Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.5399 - acc: 0.8448
781/781 [==============================] - 184s 236ms/step - loss: 0.2397 - acc: 0.9161 -
val_loss: 0.4885 - val_acc: 0.8448
Epoch 38/75
780/781 [============================>.] - ETA: 0s - loss: 0.2331 - acc: 0.9185Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.8010 - acc: 0.8393
781/781 [==============================] - 184s 236ms/step - loss: 0.2330 - acc: 0.9186 -
val_loss: 0.5291 - val_acc: 0.8393
Epoch 39/75
780/781 [============================>.] - ETA: 0s - loss: 0.2278 - acc: 0.9198Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.5445 - acc: 0.8517
781/781 [==============================] - 185s 236ms/step - loss: 0.2278 - acc: 0.9198 -
val_loss: 0.4968 - val_acc: 0.8517
Epoch 40/75
780/781 [============================>.] - ETA: 0s - loss: 0.2221 - acc: 0.9221Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.6301 - acc: 0.8407
781/781 [==============================] - 185s 237ms/step - loss: 0.2221 - acc: 0.9221 -
val_loss: 0.5120 - val_acc: 0.8407
Epoch 41/75
780/781 [============================>.] - ETA: 0s - loss: 0.2149 - acc: 0.9229Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.6066 - acc: 0.8432
781/781 [==============================] - 185s 237ms/step - loss: 0.2150 - acc: 0.9229 -
val_loss: 0.5300 - val_acc: 0.8432
Epoch 42/75
780/781 [============================>.] - ETA: 0s - loss: 0.2155 - acc: 0.9237Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.4853 - acc: 0.8459
781/781 [==============================] - 185s 237ms/step - loss: 0.2154 - acc: 0.9238 -
val_loss: 0.4969 - val_acc: 0.8459
Epoch 43/75
780/781 [============================>.] - ETA: 0s - loss: 0.2074 - acc: 0.9271Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.7062 - acc: 0.8567
781/781 [==============================] - 185s 237ms/step - loss: 0.2077 - acc: 0.9270 -
val_loss: 0.4684 - val_acc: 0.8567
Epoch 44/75
780/781 [============================>.] - ETA: 0s - loss: 0.2027 - acc: 0.9279Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.7565 - acc: 0.8354
```

```
781/781 [==============================] - 185s 237ms/step - loss: 0.2030 - acc: 0.9279 -
val_loss: 0.5808 - val_acc: 0.8354
Epoch 45/75
780/781 [============================>.] - ETA: 0s - loss: 0.2004 - acc: 0.9297Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.6132 - acc: 0.8532
781/781 [==============================] - 185s 237ms/step - loss: 0.2004 - acc: 0.9298 -
val_loss: 0.5076 - val_acc: 0.8532
Epoch 46/75
780/781 [============================>.] - ETA: 0s - loss: 0.1944 - acc: 0.9306Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.5246 - acc: 0.8232
781/781 [==============================] - 185s 237ms/step - loss: 0.1945 - acc: 0.9305 -
val_loss: 0.6643 - val_acc: 0.8232
Epoch 47/75
780/781 [============================>.] - ETA: 0s - loss: 0.1928 - acc: 0.9318Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.5511 - acc: 0.8419
781/781 [==============================] - 185s 237ms/step - loss: 0.1927 - acc: 0.9318 -
val_loss: 0.5415 - val_acc: 0.8419
Epoch 48/75
780/781 [============================>.] - ETA: 0s - loss: 0.1881 - acc: 0.9341Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.6489 - acc: 0.8280
781/781 [==============================] - 185s 237ms/step - loss: 0.1880 - acc: 0.9341 -
val_loss: 0.6352 - val_acc: 0.8280
Epoch 49/75
780/781 [============================>.] - ETA: 0s - loss: 0.1840 - acc: 0.9345Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.4874 - acc: 0.8336
781/781 [==============================] - 185s 237ms/step - loss: 0.1840 - acc: 0.9345 -
val_loss: 0.5864 - val_acc: 0.8336
Epoch 50/75
780/781 [============================>.] - ETA: 0s - loss: 0.1864 - acc: 0.9348Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.5959 - acc: 0.8535
781/781 [==============================] - 184s 236ms/step - loss: 0.1864 - acc: 0.9348 -
val_loss: 0.4996 - val_acc: 0.8535
Epoch 51/75
780/781 [============================>.] - ETA: 0s - loss: 0.1799 - acc: 0.9363Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
==============================================================================================
==========================================================================] - 11s 1ms/sample - l
oss: 0.5982 - acc: 0.8551
781/781 [==============================] - 185s 237ms/step - loss: 0.1797 - acc: 0.9363 -
val_loss: 0.5011 - val_acc: 0.8551
Epoch 52/75
780/781 [============================>.] - ETA: 0s - loss: 0.1766 - acc: 0.9357Epoch 1/75
10000/781
[==============================================================================================
==============================================================================================
```

```
==========================================================================================================
==========================================================================]  - 11s 1ms/sample - l
oss: 0.7926 - acc: 0.8349
781/781 [==============================] - 185s 237ms/step - loss: 0.1766 - acc: 0.9357 -
val_loss: 0.6149 - val_acc: 0.8349
Epoch 53/75
780/781 [============================>.] - ETA: 0s - loss: 0.1759 - acc: 0.9372Epoch 1/75
10000/781
[==========================================================================================================
==========================================================================================================
==========================================================================================================
==========================================================================]  - 11s 1ms/sample - l
oss: 0.5796 - acc: 0.8486
781/781 [==============================] - 184s 235ms/step - loss: 0.1760 - acc: 0.9371 -
val_loss: 0.5058 - val_acc: 0.8486
Epoch 54/75
780/781 [============================>.] - ETA: 0s - loss: 0.1700 - acc: 0.9401Epoch 1/75
10000/781
[==========================================================================================================
==========================================================================================================
==========================================================================================================
==========================================================================]  - 11s 1ms/sample - l
oss: 0.6026 - acc: 0.8495
781/781 [==============================] - 184s 235ms/step - loss: 0.1702 - acc: 0.9400 -
val_loss: 0.5278 - val_acc: 0.8495
Epoch 55/75
780/781 [============================>.] - ETA: 0s - loss: 0.1680 - acc: 0.9395Epoch 1/75
10000/781
[==========================================================================================================
==========================================================================================================
==========================================================================================================
==========================================================================]  - 11s 1ms/sample - l
oss: 0.7365 - acc: 0.8562
781/781 [==============================] - 184s 235ms/step - loss: 0.1680 - acc: 0.9395 -
val_loss: 0.5138 - val_acc: 0.8562
Epoch 56/75
780/781 [============================>.] - ETA: 0s - loss: 0.1618 - acc: 0.9425Epoch 1/75
10000/781
[==========================================================================================================
==========================================================================================================
==========================================================================================================
==========================================================================]  - 11s 1ms/sample - l
oss: 0.5387 - acc: 0.8668
781/781 [==============================] - 184s 236ms/step - loss: 0.1618 - acc: 0.9424 -
val_loss: 0.4570 - val_acc: 0.8668
Epoch 57/75
780/781 [============================>.] - ETA: 0s - loss: 0.1607 - acc: 0.9420Epoch 1/75
10000/781
[==========================================================================================================
==========================================================================================================
==========================================================================================================
==========================================================================]  - 11s 1ms/sample - l
oss: 0.3619 - acc: 0.8581
781/781 [==============================] - 184s 236ms/step - loss: 0.1606 - acc: 0.9420 -
val_loss: 0.5153 - val_acc: 0.8581
Epoch 58/75
780/781 [============================>.] - ETA: 0s - loss: 0.1586 - acc: 0.9444Epoch 1/75
10000/781
[==========================================================================================================
==========================================================================================================
==========================================================================================================
==========================================================================]  - 11s 1ms/sample - l
oss: 0.5780 - acc: 0.8325
781/781 [==============================] - 184s 236ms/step - loss: 0.1586 - acc: 0.9443 -
val_loss: 0.6298 - val_acc: 0.8325
Epoch 59/75
780/781 [============================>.] - ETA: 0s - loss: 0.1538 - acc: 0.9449Epoch 1/75
10000/781
[==========================================================================================================
==========================================================================================================
==========================================================================================================
==========================================================================]  - 11s 1ms/sample - l
oss: 0.7664 - acc: 0.8466
781/781 [==============================] - 185s 237ms/step - loss: 0.1537 - acc: 0.9449 -
val_loss: 0.5534 - val_acc: 0.8466
Epoch 60/75
780/781 [============================>.] - ETA: 0s - loss: 0.1519 - acc: 0.9464Epoch 1/75
```

10000/781
[==
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==
==] - 11s 1ms/sample - l
oss: 0.5921 - acc: 0.8507
781/781 [==============================] - 185s 236ms/step - loss: 0.1520 - acc: 0.9463 -
val_loss: 0.5623 - val_acc: 0.8507
Epoch 61/75
780/781 [==============================>.] - ETA: 0s - loss: 0.1540 - acc: 0.9462Epoch 1/75
10000/781
[==
==
==
==] - 11s 1ms/sample - l
oss: 0.3668 - acc: 0.8671
781/781 [==============================] - 183s 235ms/step - loss: 0.1540 - acc: 0.9462 -
val_loss: 0.4643 - val_acc: 0.8671
Epoch 62/75
780/781 [==============================>.] - ETA: 0s - loss: 0.1472 - acc: 0.9482Epoch 1/75
10000/781
[==
==
==
==] - 11s 1ms/sample - l
oss: 0.5684 - acc: 0.8559
781/781 [==============================] - 184s 236ms/step - loss: 0.1473 - acc: 0.9481 -
val_loss: 0.5186 - val_acc: 0.8559
Epoch 63/75
780/781 [==============================>.] - ETA: 0s - loss: 0.1476 - acc: 0.9478Epoch 1/75
10000/781
[==
==
==
==] - 11s 1ms/sample - l
oss: 0.5775 - acc: 0.8475
781/781 [==============================] - 184s 236ms/step - loss: 0.1476 - acc: 0.9479 -
val_loss: 0.5531 - val_acc: 0.8475
Epoch 64/75
780/781 [==============================>.] - ETA: 0s - loss: 0.1432 - acc: 0.9494Epoch 1/75
10000/781
[==
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==
==] - 11s 1ms/sample - l
oss: 0.6088 - acc: 0.8444
781/781 [==============================] - 184s 235ms/step - loss: 0.1432 - acc: 0.9494 -
val_loss: 0.6028 - val_acc: 0.8444
Epoch 65/75
780/781 [==============================>.] - ETA: 0s - loss: 0.1415 - acc: 0.9488Epoch 1/75
10000/781
[==
==
==
==] - 11s 1ms/sample - l
oss: 0.5566 - acc: 0.8535
781/781 [==============================] - 184s 236ms/step - loss: 0.1415 - acc: 0.9489 -
val_loss: 0.5429 - val_acc: 0.8535
Epoch 66/75
780/781 [==============================>.] - ETA: 0s - loss: 0.1400 - acc: 0.9506Epoch 1/75
10000/781
[==
==
==
==] - 11s 1ms/sample - l
oss: 0.6963 - acc: 0.8622
781/781 [==============================] - 184s 236ms/step - loss: 0.1400 - acc: 0.9506 -
val_loss: 0.5102 - val_acc: 0.8622
Epoch 67/75
780/781 [==============================>.] - ETA: 0s - loss: 0.1372 - acc: 0.9521Epoch 1/75
10000/781
[==
==
==
==] - 11s 1ms/sample - l
oss: 0.8653 - acc: 0.8293
781/781 [==============================] - 185s 236ms/step - loss: 0.1372 - acc: 0.9521 -

val_loss: 0.6689 - val_acc: 0.8293
Epoch 68/75
780/781 [============================>.] - ETA: 0s - loss: 0.1324 - acc: 0.9527Epoch 1/75
10000/781
[==
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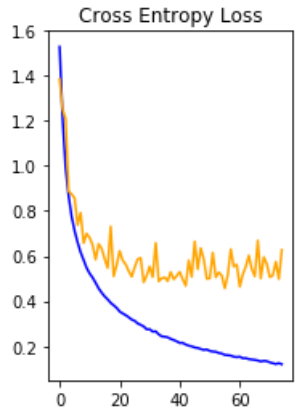
==
==] - 11s 1ms/sample - l
oss: 0.6295 - acc: 0.8695
781/781 [==============================] - 184s 235ms/step - loss: 0.1325 - acc: 0.9527 -
val_loss: 0.5008 - val_acc: 0.8695
Epoch 69/75
780/781 [============================>.] - ETA: 0s - loss: 0.1354 - acc: 0.9516Epoch 1/75
10000/781
[==
==
==
==] - 11s 1ms/sample - l
oss: 0.6534 - acc: 0.8510
781/781 [==============================] - 183s 235ms/step - loss: 0.1353 - acc: 0.9516 -
val_loss: 0.5953 - val_acc: 0.8510
Epoch 70/75
780/781 [============================>.] - ETA: 0s - loss: 0.1341 - acc: 0.9517Epoch 1/75
10000/781
[==
==
==
==] - 11s 1ms/sample - l
oss: 0.5366 - acc: 0.8482
781/781 [==============================] - 185s 237ms/step - loss: 0.1341 - acc: 0.9517 -
val_loss: 0.5657 - val_acc: 0.8482
Epoch 71/75
780/781 [============================>.] - ETA: 0s - loss: 0.1288 - acc: 0.9551Epoch 1/75
10000/781
[==
==
==
==] - 11s 1ms/sample - l
oss: 0.4635 - acc: 0.8641
781/781 [==============================] - 184s 236ms/step - loss: 0.1287 - acc: 0.9552 -
val_loss: 0.5063 - val_acc: 0.8641
Epoch 72/75
780/781 [============================>.] - ETA: 0s - loss: 0.1252 - acc: 0.9558Epoch 1/75
10000/781
[==
==
==
==] - 11s 1ms/sample - l
oss: 0.4408 - acc: 0.8674
781/781 [==============================] - 184s 236ms/step - loss: 0.1252 - acc: 0.9558 -
val_loss: 0.5141 - val_acc: 0.8674
Epoch 73/75
780/781 [============================>.] - ETA: 0s - loss: 0.1214 - acc: 0.9566Epoch 1/75
10000/781
[==
==
==
==] - 11s 1ms/sample - l
oss: 0.7239 - acc: 0.8531
781/781 [==============================] - 185s 237ms/step - loss: 0.1214 - acc: 0.9566 -
val_loss: 0.5747 - val_acc: 0.8531
Epoch 74/75
780/781 [============================>.] - ETA: 0s - loss: 0.1253 - acc: 0.9553Epoch 1/75
10000/781
[==
==
==
==] - 11s 1ms/sample - l
oss: 0.5088 - acc: 0.8679
781/781 [==============================] - 185s 237ms/step - loss: 0.1252 - acc: 0.9553 -
val_loss: 0.4984 - val_acc: 0.8679
Epoch 75/75
780/781 [============================>.] - ETA: 0s - loss: 0.1203 - acc: 0.9561Epoch 1/75
10000/781
[==
==
==

```
==============================================================================] - 11s 1ms/sample - l
oss: 0.8336 - acc: 0.8439
781/781 [==============================] - 185s 237ms/step - loss: 0.1203 - acc: 0.9561 -
val_loss: 0.6271 - val_acc: 0.8439
> 84.390
```



train_loss: 0.1203 train_acc: 0.9561

val_loss: 0.6271 val_acc: 0.8439

Model without dense layer

In [9]:

```
from keras import regularizers
# Dense Block
def denseblock(input, num_filter = 12, 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), (5,5), use_bias=False ,padding='sam
e')(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 Blosck
def transition(input, num_filter = 12, dropout_rate = 0.2):
    global compression
    BatchNorm = layers.BatchNormalization()(input)
    relu = layers.Activation('relu')(BatchNorm)
    Conv2D_BottleNeck = layers.Conv2D(int(num_filter*compression), (5,5), use_bias=False ,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. MaxPooling2D(pool_size=(2,2))(relu)

    output = layers.Conv2D(filters=10,kernel_size=(2,2),activation='softmax')(AvgPooling)

    flat = layers.Flatten()(output)
    return flat
```

```
num_filter = 12
dropout_rate = 0
l = 12
input = layers.Input(shape=(img_height, img_width, channel,))
First_Conv2D = layers.Conv2D(32, (3,3), use_bias=False ,padding='same')(input)

First_Block = denseblock(First_Conv2D,10, dropout_rate)
First_Transition = transition(First_Block, 64, dropout_rate)

Second_Block = denseblock(First_Transition, 10, dropout_rate)
Second_Transition = transition(Second_Block, 32, dropout_rate)

Third_Block = denseblock(Second_Transition, num_filter, dropout_rate)
Third_Transition = transition(Third_Block, 32, dropout_rate)

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

```
WARNING:tensorflow:From C:\Users\santosh\Anaconda3\lib\site-
packages\tensorflow\python\ops\resource_variable_ops.py:435: colocate_with (from
tensorflow.python.framework.ops) is deprecated and will be removed in a future version.
Instructions for updating:
Colocations handled automatically by placer.
```

In [10]:

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

```
__________________________________________________________________________________________________
Layer (type)                    Output Shape         Param #     Connected to
==================================================================================================
input_1 (InputLayer)            (None, 32, 32, 3)    0
__________________________________________________________________________________________________
conv2d (Conv2D)                 (None, 32, 32, 32)   864         input_1[0][0]
__________________________________________________________________________________________________
batch_normalization_v1 (BatchNo (None, 32, 32, 32)   128         conv2d[0][0]
__________________________________________________________________________________________________
activation (Activation)         (None, 32, 32, 32)   0           batch_normalization_v1[0][0]
__________________________________________________________________________________________________
conv2d_1 (Conv2D)               (None, 32, 32, 5)    4000        activation[0][0]
__________________________________________________________________________________________________
concatenate (Concatenate)       (None, 32, 32, 37)   0           conv2d[0][0]
                                                                 conv2d_1[0][0]
__________________________________________________________________________________________________
batch_normalization_v1_1 (Batch (None, 32, 32, 37)   148         concatenate[0][0]
__________________________________________________________________________________________________
activation_1 (Activation)       (None, 32, 32, 37)   0           batch_normalization_v1_1[0][0]
__________________________________________________________________________________________________
conv2d_2 (Conv2D)               (None, 32, 32, 5)    4625        activation_1[0][0]
__________________________________________________________________________________________________
concatenate_1 (Concatenate)     (None, 32, 32, 42)   0           concatenate[0][0]
                                                                 conv2d_2[0][0]
__________________________________________________________________________________________________
batch_normalization_v1_2 (Batch (None, 32, 32, 42)   168         concatenate_1[0][0]
__________________________________________________________________________________________________
activation_2 (Activation)       (None, 32, 32, 42)   0           batch_normalization_v1_2[0][0]
__________________________________________________________________________________________________
conv2d_3 (Conv2D)               (None, 32, 32, 5)    5250        activation_2[0][0]
__________________________________________________________________________________________________
concatenate_2 (Concatenate)     (None, 32, 32, 47)   0           concatenate_1[0][0]
                                                                 conv2d_3[0][0]
__________________________________________________________________________________________________
batch_normalization_v1_3 (Batch (None, 32, 32, 47)   188         concatenate_2[0][0]
__________________________________________________________________________________________________
activation_3 (Activation)       (None, 32, 32, 47)   0           batch_normalization_v1_3[0][0]
__________________________________________________________________________________________________
conv2d_4 (Conv2D)               (None, 32, 32, 5)    5875        activation_3[0][0]
__________________________________________________________________________________________________
concatenate_3 (Concatenate)     (None, 32, 32, 52)   0           concatenate_2[0][0]
                                                                 conv2d_4[0][0]
__________________________________________________________________________________________________
batch_normalization_v1_4 (Batch (None, 32, 32, 52)   208         concatenate_3[0][0]
```

batch_normalization_v1_4 (Batch	(None, 32, 32, 52)	208	concatenate_3[0][0]
activation_4 (Activation)	(None, 32, 32, 52)	0	batch_normalization_v1_4[0][0]
conv2d_5 (Conv2D)	(None, 32, 32, 5)	6500	activation_4[0][0]
concatenate_4 (Concatenate)	(None, 32, 32, 57)	0	concatenate_3[0][0] conv2d_5[0][0]
batch_normalization_v1_5 (Batch	(None, 32, 32, 57)	228	concatenate_4[0][0]
activation_5 (Activation)	(None, 32, 32, 57)	0	batch_normalization_v1_5[0][0]
conv2d_6 (Conv2D)	(None, 32, 32, 5)	7125	activation_5[0][0]
concatenate_5 (Concatenate)	(None, 32, 32, 62)	0	concatenate_4[0][0] conv2d_6[0][0]
batch_normalization_v1_6 (Batch	(None, 32, 32, 62)	248	concatenate_5[0][0]
activation_6 (Activation)	(None, 32, 32, 62)	0	batch_normalization_v1_6[0][0]
conv2d_7 (Conv2D)	(None, 32, 32, 5)	7750	activation_6[0][0]
concatenate_6 (Concatenate)	(None, 32, 32, 67)	0	concatenate_5[0][0] conv2d_7[0][0]
batch_normalization_v1_7 (Batch	(None, 32, 32, 67)	268	concatenate_6[0][0]
activation_7 (Activation)	(None, 32, 32, 67)	0	batch_normalization_v1_7[0][0]
conv2d_8 (Conv2D)	(None, 32, 32, 5)	8375	activation_7[0][0]
concatenate_7 (Concatenate)	(None, 32, 32, 72)	0	concatenate_6[0][0] conv2d_8[0][0]
batch_normalization_v1_8 (Batch	(None, 32, 32, 72)	288	concatenate_7[0][0]
activation_8 (Activation)	(None, 32, 32, 72)	0	batch_normalization_v1_8[0][0]
conv2d_9 (Conv2D)	(None, 32, 32, 5)	9000	activation_8[0][0]
concatenate_8 (Concatenate)	(None, 32, 32, 77)	0	concatenate_7[0][0] conv2d_9[0][0]
batch_normalization_v1_9 (Batch	(None, 32, 32, 77)	308	concatenate_8[0][0]
activation_9 (Activation)	(None, 32, 32, 77)	0	batch_normalization_v1_9[0][0]
conv2d_10 (Conv2D)	(None, 32, 32, 5)	9625	activation_9[0][0]
concatenate_9 (Concatenate)	(None, 32, 32, 82)	0	concatenate_8[0][0] conv2d_10[0][0]
batch_normalization_v1_10 (Batc	(None, 32, 32, 82)	328	concatenate_9[0][0]
activation_10 (Activation)	(None, 32, 32, 82)	0	batch_normalization_v1_10[0][0]
conv2d_11 (Conv2D)	(None, 32, 32, 5)	10250	activation_10[0][0]
concatenate_10 (Concatenate)	(None, 32, 32, 87)	0	concatenate_9[0][0] conv2d_11[0][0]
batch_normalization_v1_11 (Batc	(None, 32, 32, 87)	348	concatenate_10[0][0]
activation_11 (Activation)	(None, 32, 32, 87)	0	batch_normalization_v1_11[0][0]
conv2d_12 (Conv2D)	(None, 32, 32, 5)	10875	activation_11[0][0]
concatenate_11 (Concatenate)	(None, 32, 32, 92)	0	concatenate_10[0][0] conv2d_12[0][0]
batch_normalization_v1_12 (Batc	(None, 32, 32, 92)	368	concatenate_11[0][0]
activation_12 (Activation)	(None, 32, 32, 92)	0	batch_normalization_v1_12[0][0]
conv2d_13 (Conv2D)	(None, 32, 32, 32)	73600	activation_12[0][0]

average_pooling2d (AveragePooli	(None, 16, 16, 32)	0	conv2d_13[0][0]
batch_normalization_v1_13 (Batc	(None, 16, 16, 32)	128	average_pooling2d[0][0]
activation_13 (Activation)	(None, 16, 16, 32)	0	batch_normalization_v1_13[0][0]
conv2d_14 (Conv2D)	(None, 16, 16, 5)	4000	activation_13[0][0]
concatenate_12 (Concatenate)	(None, 16, 16, 37)	0	average_pooling2d[0][0] conv2d_14[0][0]
batch_normalization_v1_14 (Batc	(None, 16, 16, 37)	148	concatenate_12[0][0]
activation_14 (Activation)	(None, 16, 16, 37)	0	batch_normalization_v1_14[0][0]
conv2d_15 (Conv2D)	(None, 16, 16, 5)	4625	activation_14[0][0]
concatenate_13 (Concatenate)	(None, 16, 16, 42)	0	concatenate_12[0][0] conv2d_15[0][0]
batch_normalization_v1_15 (Batc	(None, 16, 16, 42)	168	concatenate_13[0][0]
activation_15 (Activation)	(None, 16, 16, 42)	0	batch_normalization_v1_15[0][0]
conv2d_16 (Conv2D)	(None, 16, 16, 5)	5250	activation_15[0][0]
concatenate_14 (Concatenate)	(None, 16, 16, 47)	0	concatenate_13[0][0] conv2d_16[0][0]
batch_normalization_v1_16 (Batc	(None, 16, 16, 47)	188	concatenate_14[0][0]
activation_16 (Activation)	(None, 16, 16, 47)	0	batch_normalization_v1_16[0][0]
conv2d_17 (Conv2D)	(None, 16, 16, 5)	5875	activation_16[0][0]
concatenate_15 (Concatenate)	(None, 16, 16, 52)	0	concatenate_14[0][0] conv2d_17[0][0]
batch_normalization_v1_17 (Batc	(None, 16, 16, 52)	208	concatenate_15[0][0]
activation_17 (Activation)	(None, 16, 16, 52)	0	batch_normalization_v1_17[0][0]
conv2d_18 (Conv2D)	(None, 16, 16, 5)	6500	activation_17[0][0]
concatenate_16 (Concatenate)	(None, 16, 16, 57)	0	concatenate_15[0][0] conv2d_18[0][0]
batch_normalization_v1_18 (Batc	(None, 16, 16, 57)	228	concatenate_16[0][0]
activation_18 (Activation)	(None, 16, 16, 57)	0	batch_normalization_v1_18[0][0]
conv2d_19 (Conv2D)	(None, 16, 16, 5)	7125	activation_18[0][0]
concatenate_17 (Concatenate)	(None, 16, 16, 62)	0	concatenate_16[0][0] conv2d_19[0][0]
batch_normalization_v1_19 (Batc	(None, 16, 16, 62)	248	concatenate_17[0][0]
activation_19 (Activation)	(None, 16, 16, 62)	0	batch_normalization_v1_19[0][0]
conv2d_20 (Conv2D)	(None, 16, 16, 5)	7750	activation_19[0][0]
concatenate_18 (Concatenate)	(None, 16, 16, 67)	0	concatenate_17[0][0] conv2d_20[0][0]
batch_normalization_v1_20 (Batc	(None, 16, 16, 67)	268	concatenate_18[0][0]
activation_20 (Activation)	(None, 16, 16, 67)	0	batch_normalization_v1_20[0][0]
conv2d_21 (Conv2D)	(None, 16, 16, 5)	8375	activation_20[0][0]
concatenate_19 (Concatenate)	(None, 16, 16, 72)	0	concatenate_18[0][0] conv2d_21[0][0]
batch_normalization_v1_21 (Batc	(None, 16, 16, 72)	288	concatenate_19[0][0]

activation_21 (Activation)	(None, 16, 16, 72)	0	batch_normalization_v1_21[0][0]
conv2d_22 (Conv2D)	(None, 16, 16, 5)	9000	activation_21[0][0]
concatenate_20 (Concatenate)	(None, 16, 16, 77)	0	concatenate_19[0][0] conv2d_22[0][0]
batch_normalization_v1_22 (Batc	(None, 16, 16, 77)	308	concatenate_20[0][0]
activation_22 (Activation)	(None, 16, 16, 77)	0	batch_normalization_v1_22[0][0]
conv2d_23 (Conv2D)	(None, 16, 16, 5)	9625	activation_22[0][0]
concatenate_21 (Concatenate)	(None, 16, 16, 82)	0	concatenate_20[0][0] conv2d_23[0][0]
batch_normalization_v1_23 (Batc	(None, 16, 16, 82)	328	concatenate_21[0][0]
activation_23 (Activation)	(None, 16, 16, 82)	0	batch_normalization_v1_23[0][0]
conv2d_24 (Conv2D)	(None, 16, 16, 5)	10250	activation_23[0][0]
concatenate_22 (Concatenate)	(None, 16, 16, 87)	0	concatenate_21[0][0] conv2d_24[0][0]
batch_normalization_v1_24 (Batc	(None, 16, 16, 87)	348	concatenate_22[0][0]
activation_24 (Activation)	(None, 16, 16, 87)	0	batch_normalization_v1_24[0][0]
conv2d_25 (Conv2D)	(None, 16, 16, 5)	10875	activation_24[0][0]
concatenate_23 (Concatenate)	(None, 16, 16, 92)	0	concatenate_22[0][0] conv2d_25[0][0]
batch_normalization_v1_25 (Batc	(None, 16, 16, 92)	368	concatenate_23[0][0]
activation_25 (Activation)	(None, 16, 16, 92)	0	batch_normalization_v1_25[0][0]
conv2d_26 (Conv2D)	(None, 16, 16, 16)	36800	activation_25[0][0]
average_pooling2d_1 (AveragePoo	(None, 8, 8, 16)	0	conv2d_26[0][0]
batch_normalization_v1_26 (Batc	(None, 8, 8, 16)	64	average_pooling2d_1[0][0]
activation_26 (Activation)	(None, 8, 8, 16)	0	batch_normalization_v1_26[0][0]
conv2d_27 (Conv2D)	(None, 8, 8, 6)	2400	activation_26[0][0]
concatenate_24 (Concatenate)	(None, 8, 8, 22)	0	average_pooling2d_1[0][0] conv2d_27[0][0]
batch_normalization_v1_27 (Batc	(None, 8, 8, 22)	88	concatenate_24[0][0]
activation_27 (Activation)	(None, 8, 8, 22)	0	batch_normalization_v1_27[0][0]
conv2d_28 (Conv2D)	(None, 8, 8, 6)	3300	activation_27[0][0]
concatenate_25 (Concatenate)	(None, 8, 8, 28)	0	concatenate_24[0][0] conv2d_28[0][0]
batch_normalization_v1_28 (Batc	(None, 8, 8, 28)	112	concatenate_25[0][0]
activation_28 (Activation)	(None, 8, 8, 28)	0	batch_normalization_v1_28[0][0]
conv2d_29 (Conv2D)	(None, 8, 8, 6)	4200	activation_28[0][0]
concatenate_26 (Concatenate)	(None, 8, 8, 34)	0	concatenate_25[0][0] conv2d_29[0][0]
batch_normalization_v1_29 (Batc	(None, 8, 8, 34)	136	concatenate_26[0][0]
activation_29 (Activation)	(None, 8, 8, 34)	0	batch_normalization_v1_29[0][0]
conv2d_30 (Conv2D)	(None, 8, 8, 6)	5100	activation_29[0][0]
concatenate_27 (Concatenate)	(None, 8, 8, 40)	0	concatenate_26[0][0] conv2d_30[0][0]

batch_normalization_v1_30 (Batc	(None, 8, 8, 40)	160	concatenate_27[0][0]
activation_30 (Activation)	(None, 8, 8, 40)	0	batch_normalization_v1_30[0][0]
conv2d_31 (Conv2D)	(None, 8, 8, 6)	6000	activation_30[0][0]
concatenate_28 (Concatenate)	(None, 8, 8, 46)	0	concatenate_27[0][0] conv2d_31[0][0]
batch_normalization_v1_31 (Batc	(None, 8, 8, 46)	184	concatenate_28[0][0]
activation_31 (Activation)	(None, 8, 8, 46)	0	batch_normalization_v1_31[0][0]
conv2d_32 (Conv2D)	(None, 8, 8, 6)	6900	activation_31[0][0]
concatenate_29 (Concatenate)	(None, 8, 8, 52)	0	concatenate_28[0][0] conv2d_32[0][0]
batch_normalization_v1_32 (Batc	(None, 8, 8, 52)	208	concatenate_29[0][0]
activation_32 (Activation)	(None, 8, 8, 52)	0	batch_normalization_v1_32[0][0]
conv2d_33 (Conv2D)	(None, 8, 8, 6)	7800	activation_32[0][0]
concatenate_30 (Concatenate)	(None, 8, 8, 58)	0	concatenate_29[0][0] conv2d_33[0][0]
batch_normalization_v1_33 (Batc	(None, 8, 8, 58)	232	concatenate_30[0][0]
activation_33 (Activation)	(None, 8, 8, 58)	0	batch_normalization_v1_33[0][0]
conv2d_34 (Conv2D)	(None, 8, 8, 6)	8700	activation_33[0][0]
concatenate_31 (Concatenate)	(None, 8, 8, 64)	0	concatenate_30[0][0] conv2d_34[0][0]
batch_normalization_v1_34 (Batc	(None, 8, 8, 64)	256	concatenate_31[0][0]
activation_34 (Activation)	(None, 8, 8, 64)	0	batch_normalization_v1_34[0][0]
conv2d_35 (Conv2D)	(None, 8, 8, 6)	9600	activation_34[0][0]
concatenate_32 (Concatenate)	(None, 8, 8, 70)	0	concatenate_31[0][0] conv2d_35[0][0]
batch_normalization_v1_35 (Batc	(None, 8, 8, 70)	280	concatenate_32[0][0]
activation_35 (Activation)	(None, 8, 8, 70)	0	batch_normalization_v1_35[0][0]
conv2d_36 (Conv2D)	(None, 8, 8, 6)	10500	activation_35[0][0]
concatenate_33 (Concatenate)	(None, 8, 8, 76)	0	concatenate_32[0][0] conv2d_36[0][0]
batch_normalization_v1_36 (Batc	(None, 8, 8, 76)	304	concatenate_33[0][0]
activation_36 (Activation)	(None, 8, 8, 76)	0	batch_normalization_v1_36[0][0]
conv2d_37 (Conv2D)	(None, 8, 8, 6)	11400	activation_36[0][0]
concatenate_34 (Concatenate)	(None, 8, 8, 82)	0	concatenate_33[0][0] conv2d_37[0][0]
batch_normalization_v1_37 (Batc	(None, 8, 8, 82)	328	concatenate_34[0][0]
activation_37 (Activation)	(None, 8, 8, 82)	0	batch_normalization_v1_37[0][0]
conv2d_38 (Conv2D)	(None, 8, 8, 6)	12300	activation_37[0][0]
concatenate_35 (Concatenate)	(None, 8, 8, 88)	0	concatenate_34[0][0] conv2d_38[0][0]
batch_normalization_v1_38 (Batc	(None, 8, 8, 88)	352	concatenate_35[0][0]
activation_38 (Activation)	(None, 8, 8, 88)	0	batch_normalization_v1_38[0][0]

conv2d_39 (Conv2D)	(None, 8, 8, 16)	35200	activation_38[0][0]
average_pooling2d_2 (AveragePoo	(None, 4, 4, 16)	0	conv2d_39[0][0]
batch_normalization_v1_39 (Batc	(None, 4, 4, 16)	64	average_pooling2d_2[0][0]
activation_39 (Activation)	(None, 4, 4, 16)	0	batch_normalization_v1_39[0][0]
conv2d_40 (Conv2D)	(None, 4, 4, 6)	2400	activation_39[0][0]
concatenate_36 (Concatenate)	(None, 4, 4, 22)	0	average_pooling2d_2[0][0] conv2d_40[0][0]
batch_normalization_v1_40 (Batc	(None, 4, 4, 22)	88	concatenate_36[0][0]
activation_40 (Activation)	(None, 4, 4, 22)	0	batch_normalization_v1_40[0][0]
conv2d_41 (Conv2D)	(None, 4, 4, 6)	3300	activation_40[0][0]
concatenate_37 (Concatenate)	(None, 4, 4, 28)	0	concatenate_36[0][0] conv2d_41[0][0]
batch_normalization_v1_41 (Batc	(None, 4, 4, 28)	112	concatenate_37[0][0]
activation_41 (Activation)	(None, 4, 4, 28)	0	batch_normalization_v1_41[0][0]
conv2d_42 (Conv2D)	(None, 4, 4, 6)	4200	activation_41[0][0]
concatenate_38 (Concatenate)	(None, 4, 4, 34)	0	concatenate_37[0][0] conv2d_42[0][0]
batch_normalization_v1_42 (Batc	(None, 4, 4, 34)	136	concatenate_38[0][0]
activation_42 (Activation)	(None, 4, 4, 34)	0	batch_normalization_v1_42[0][0]
conv2d_43 (Conv2D)	(None, 4, 4, 6)	5100	activation_42[0][0]
concatenate_39 (Concatenate)	(None, 4, 4, 40)	0	concatenate_38[0][0] conv2d_43[0][0]
batch_normalization_v1_43 (Batc	(None, 4, 4, 40)	160	concatenate_39[0][0]
activation_43 (Activation)	(None, 4, 4, 40)	0	batch_normalization_v1_43[0][0]
conv2d_44 (Conv2D)	(None, 4, 4, 6)	6000	activation_43[0][0]
concatenate_40 (Concatenate)	(None, 4, 4, 46)	0	concatenate_39[0][0] conv2d_44[0][0]
batch_normalization_v1_44 (Batc	(None, 4, 4, 46)	184	concatenate_40[0][0]
activation_44 (Activation)	(None, 4, 4, 46)	0	batch_normalization_v1_44[0][0]
conv2d_45 (Conv2D)	(None, 4, 4, 6)	6900	activation_44[0][0]
concatenate_41 (Concatenate)	(None, 4, 4, 52)	0	concatenate_40[0][0] conv2d_45[0][0]
batch_normalization_v1_45 (Batc	(None, 4, 4, 52)	208	concatenate_41[0][0]
activation_45 (Activation)	(None, 4, 4, 52)	0	batch_normalization_v1_45[0][0]
conv2d_46 (Conv2D)	(None, 4, 4, 6)	7800	activation_45[0][0]
concatenate_42 (Concatenate)	(None, 4, 4, 58)	0	concatenate_41[0][0] conv2d_46[0][0]
batch_normalization_v1_46 (Batc	(None, 4, 4, 58)	232	concatenate_42[0][0]
activation_46 (Activation)	(None, 4, 4, 58)	0	batch_normalization_v1_46[0][0]
conv2d_47 (Conv2D)	(None, 4, 4, 6)	8700	activation_46[0][0]
concatenate_43 (Concatenate)	(None, 4, 4, 64)	0	concatenate_42[0][0] conv2d_47[0][0]
batch_normalization_v1_47 (Batc	(None, 4, 4, 64)	256	concatenate_43[0][0]

```
activation_47 (Activation)       (None, 4, 4, 64)      0           batch_normalization_v1_47[0][0]
__________________________________________________________________________________________________
conv2d_48 (Conv2D)               (None, 4, 4, 6)       9600        activation_47[0][0]
__________________________________________________________________________________________________
concatenate_44 (Concatenate)     (None, 4, 4, 70)      0           concatenate_43[0][0]
                                                                   conv2d_48[0][0]
__________________________________________________________________________________________________
batch_normalization_v1_48 (Batc (None, 4, 4, 70)      280         concatenate_44[0][0]
__________________________________________________________________________________________________
activation_48 (Activation)       (None, 4, 4, 70)      0           batch_normalization_v1_48[0][0]
__________________________________________________________________________________________________
conv2d_49 (Conv2D)               (None, 4, 4, 6)       10500       activation_48[0][0]
__________________________________________________________________________________________________
concatenate_45 (Concatenate)     (None, 4, 4, 76)      0           concatenate_44[0][0]
                                                                   conv2d_49[0][0]
__________________________________________________________________________________________________
batch_normalization_v1_49 (Batc (None, 4, 4, 76)      304         concatenate_45[0][0]
__________________________________________________________________________________________________
activation_49 (Activation)       (None, 4, 4, 76)      0           batch_normalization_v1_49[0][0]
__________________________________________________________________________________________________
conv2d_50 (Conv2D)               (None, 4, 4, 6)       11400       activation_49[0][0]
__________________________________________________________________________________________________
concatenate_46 (Concatenate)     (None, 4, 4, 82)      0           concatenate_45[0][0]
                                                                   conv2d_50[0][0]
__________________________________________________________________________________________________
batch_normalization_v1_50 (Batc (None, 4, 4, 82)      328         concatenate_46[0][0]
__________________________________________________________________________________________________
activation_50 (Activation)       (None, 4, 4, 82)      0           batch_normalization_v1_50[0][0]
__________________________________________________________________________________________________
conv2d_51 (Conv2D)               (None, 4, 4, 6)       12300       activation_50[0][0]
__________________________________________________________________________________________________
concatenate_47 (Concatenate)     (None, 4, 4, 88)      0           concatenate_46[0][0]
                                                                   conv2d_51[0][0]
__________________________________________________________________________________________________
batch_normalization_v1_51 (Batc (None, 4, 4, 88)      352         concatenate_47[0][0]
__________________________________________________________________________________________________
activation_51 (Activation)       (None, 4, 4, 88)      0           batch_normalization_v1_51[0][0]
__________________________________________________________________________________________________
max_pooling2d (MaxPooling2D)     (None, 2, 2, 88)      0           activation_51[0][0]
__________________________________________________________________________________________________
conv2d_52 (Conv2D)               (None, 1, 1, 10)      3530        max_pooling2d[0][0]
__________________________________________________________________________________________________
flatten (Flatten)                (None, 10)            0           conv2d_52[0][0]
==================================================================================================
Total params: 516,750
Trainable params: 510,822
Non-trainable params: 5,928
__________________________________________________________________________________________________
```

In [11]:

```
# determine Loss function and Optimizer
#a=keras.optimizers.Adam(learning_rate=0.001, beta_1=0.9, beta_2=0.999, amsgrad=False)
model.compile(loss='categorical_crossentropy',
              optimizer='Adam', metrics=['accuracy'])
```

In [13]:

```
def summarize_diagnostics(history):
    # plot loss
    pyplot.subplot(121)
    pyplot.title('Cross Entropy Loss')
    pyplot.plot(history.history['loss'], color='blue', label='train')
    pyplot.plot(history.history['val_loss'], color='orange', label='test')
    pyplot.show()


# run the test harness for evaluating a model
def run_test_harness():

    # define model
    # create data generator
    datagen = ImageDataGenerator(width_shift_range=0.1, height_shift_range=0.1, horizontal_flip=Tru
e)
```

```
    # prepare iterator
    it_train = datagen.flow(X_train, y_train, batch_size=60)
    # fit model
    steps = int(X_train.shape[0] / 39)
    history = model.fit_generator(it_train, steps_per_epoch=steps, epochs=200, validation_data=(X_t
est, y_test), verbose=1)
    # evaluate model
    _, acc = model.evaluate(X_test, y_test, verbose=0)
    print('> %.3f' % (acc * 100.0))
    # learning curves
    summarize_diagnostics(history)

# entry point, run the test harness
run_test_harness()
```

```
Epoch 1/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 1.1354 - acc: 0.58700s - los
s: 1.1351 - acc: 0.587
834/834 [==============================] - 473s 567ms/step - loss: 1.5155 - acc: 0.4424 -
val_loss: 1.1356 - val_acc: 0.5870
Epoch 2/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 1.2174 - acc: 0.6069
834/834 [==============================] - 472s 566ms/step - loss: 1.0230 - acc: 0.6337 -
val_loss: 1.2175 - val_acc: 0.6069
Epoch 3/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 1.0541 - acc: 0.6593
834/834 [==============================] - 480s 575ms/step - loss: 0.8244 - acc: 0.7094 -
val_loss: 1.0544 - val_acc: 0.6593
Epoch 4/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.8890 - acc: 0.7024
834/834 [==============================] - 492s 590ms/step - loss: 0.7119 - acc: 0.7505 -
val_loss: 0.8894 - val_acc: 0.7024
Epoch 5/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.7166 - acc: 0.7549
834/834 [==============================] - 480s 575ms/step - loss: 0.6386 - acc: 0.7766 -
val_loss: 0.7168 - val_acc: 0.7549
Epoch 6/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.7537 - acc: 0.7492
834/834 [==============================] - 480s 576ms/step - loss: 0.5874 - acc: 0.7945 -
val_loss: 0.7538 - val_acc: 0.7492
Epoch 7/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6768 - acc: 0.7707
834/834 [==============================] - 479s 574ms/step - loss: 0.5394 - acc: 0.8137 -
val_loss: 0.6772 - val_acc: 0.7707
Epoch 8/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.7362 - acc: 0.7661
834/834 [==============================] - 481s 577ms/step - loss: 0.5073 - acc: 0.8259 -
val_loss: 0.7368 - val_acc: 0.7661
Epoch 9/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.6417 - acc: 0.7787
834/834 [==============================] - 479s 574ms/step - loss: 0.4746 - acc: 0.8372 -
val_loss: 0.6421 - val_acc: 0.7787
Epoch 10/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.5711 - acc: 0.8113
834/834 [==============================] - 483s 580ms/step - loss: 0.4458 - acc: 0.8461 -
val_loss: 0.5715 - val_acc: 0.8113
Epoch 11/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.6493 - acc: 0.7828
834/834 [==============================] - 481s 576ms/step - loss: 0.4247 - acc: 0.8529 -
val_loss: 0.6496 - val_acc: 0.7828
Epoch 12/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.5485 - acc: 0.8191
834/834 [==============================] - 483s 579ms/step - loss: 0.4053 - acc: 0.8616 -
val_loss: 0.5488 - val_acc: 0.8191
Epoch 13/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4963 - acc: 0.8348
834/834 [==============================] - 479s 575ms/step - loss: 0.3890 - acc: 0.8665 -
val_loss: 0.4969 - val_acc: 0.8348
Epoch 14/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.7014 - acc: 0.7853
834/834 [==============================] - 480s 576ms/step - loss: 0.3682 - acc: 0.8727 -
val_loss: 0.7019 - val_acc: 0.7853
Epoch 15/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5631 - acc: 0.8072
834/834 [==============================] - 478s 573ms/step - loss: 0.3538 - acc: 0.8779 -
val_loss: 0.5632 - val_acc: 0.8072
Epoch 16/200
```

```
Epoch 16/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5635 - acc: 0.8176
834/834 [==============================] - 483s 579ms/step - loss: 0.3380 - acc: 0.8833 -
val_loss: 0.5640 - val_acc: 0.8176
Epoch 17/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.6366 - acc: 0.8033
834/834 [==============================] - 482s 578ms/step - loss: 0.3254 - acc: 0.8880 -
val_loss: 0.6372 - val_acc: 0.8033
Epoch 18/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.4180 - acc: 0.86253s - los
s:
834/834 [==============================] - 478s 573ms/step - loss: 0.3123 - acc: 0.8925 -
val_loss: 0.4185 - val_acc: 0.8625
Epoch 19/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5023 - acc: 0.83674s -
834/834 [==============================] - 480s 576ms/step - loss: 0.3030 - acc: 0.8945 -
val_loss: 0.5026 - val_acc: 0.8367
Epoch 20/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.7203 - acc: 0.7853
834/834 [==============================] - 482s 578ms/step - loss: 0.2940 - acc: 0.8978 -
val_loss: 0.7206 - val_acc: 0.7853
Epoch 21/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4552 - acc: 0.8546
834/834 [==============================] - 482s 578ms/step - loss: 0.2850 - acc: 0.9012 -
val_loss: 0.4555 - val_acc: 0.8546
Epoch 22/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5610 - acc: 0.8186
834/834 [==============================] - 477s 572ms/step - loss: 0.2762 - acc: 0.9055 -
val_loss: 0.5611 - val_acc: 0.8186
Epoch 23/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5169 - acc: 0.8409
834/834 [==============================] - 488s 585ms/step - loss: 0.2656 - acc: 0.9081 -
val_loss: 0.5173 - val_acc: 0.8409
Epoch 24/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4558 - acc: 0.8516
834/834 [==============================] - 484s 580ms/step - loss: 0.2579 - acc: 0.9100 -
val_loss: 0.4568 - val_acc: 0.8516
Epoch 25/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.4826 - acc: 0.8514
834/834 [==============================] - 482s 577ms/step - loss: 0.2497 - acc: 0.9137 -
val_loss: 0.4828 - val_acc: 0.8514
Epoch 26/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5597 - acc: 0.8248
834/834 [==============================] - 478s 573ms/step - loss: 0.2417 - acc: 0.9149 -
val_loss: 0.5601 - val_acc: 0.8248
Epoch 27/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4846 - acc: 0.8521
834/834 [==============================] - 485s 581ms/step - loss: 0.2361 - acc: 0.9173 -
val_loss: 0.4855 - val_acc: 0.8521
Epoch 28/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4264 - acc: 0.8663
834/834 [==============================] - 487s 584ms/step - loss: 0.2232 - acc: 0.9216 -
val_loss: 0.4269 - val_acc: 0.8663
Epoch 29/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.4487 - acc: 0.8577
834/834 [==============================] - 491s 588ms/step - loss: 0.2267 - acc: 0.9209 -
val_loss: 0.4489 - val_acc: 0.8577
Epoch 30/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4225 - acc: 0.8692
834/834 [==============================] - 490s 588ms/step - loss: 0.2179 - acc: 0.9224 -
val_loss: 0.4232 - val_acc: 0.8692
Epoch 31/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5095 - acc: 0.84682s - los
s: 0.5115 - - ETA: 0s - loss: 0.5079 - acc: 0.847 - ETA: 0s - loss: 0.5089 - acc: 0.8
834/834 [==============================] - 488s 585ms/step - loss: 0.2112 - acc: 0.9266 -
val_loss: 0.5098 - val_acc: 0.8468
Epoch 32/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4418 - acc: 0.8665
834/834 [==============================] - 485s 582ms/step - loss: 0.2046 - acc: 0.9284 -
val_loss: 0.4420 - val_acc: 0.8665
Epoch 33/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5283 - acc: 0.8510
834/834 [==============================] - 485s 581ms/step - loss: 0.2032 - acc: 0.9291 -
val_loss: 0.5291 - val_acc: 0.8510
Epoch 34/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4338 - acc: 0.8665
834/834 [==============================] - 483s 579ms/step - loss: 0.1922 - acc: 0.9327 -
val_loss: 0.4341 - val_acc: 0.8665
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val_loss: 0.4341 - val_acc: 0.8665
Epoch 35/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5994 - acc: 0.8407
834/834 [==============================] - 482s 578ms/step - loss: 0.1911 - acc: 0.9327 -
val_loss: 0.6002 - val_acc: 0.8407
Epoch 36/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.6383 - acc: 0.8244
834/834 [==============================] - 482s 578ms/step - loss: 0.1840 - acc: 0.9348 -
val_loss: 0.6388 - val_acc: 0.8244
Epoch 37/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4109 - acc: 0.8733
834/834 [==============================] - 489s 586ms/step - loss: 0.1851 - acc: 0.9349 -
val_loss: 0.4114 - val_acc: 0.8733
Epoch 38/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.5417 - acc: 0.8488
834/834 [==============================] - 493s 592ms/step - loss: 0.1765 - acc: 0.9382 -
val_loss: 0.5423 - val_acc: 0.8488
Epoch 39/200
10000/10000 [==============================] - 33s 3ms/sample - loss: 0.4320 - acc: 0.8721
834/834 [==============================] - 496s 594ms/step - loss: 0.1743 - acc: 0.9382 -
val_loss: 0.4324 - val_acc: 0.8721
Epoch 40/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.4778 - acc: 0.8604
834/834 [==============================] - 498s 597ms/step - loss: 0.1703 - acc: 0.9390 -
val_loss: 0.4782 - val_acc: 0.8604
Epoch 41/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5225 - acc: 0.86360s - los
s: 0.5215 - acc: 0.863
834/834 [==============================] - 486s 583ms/step - loss: 0.1665 - acc: 0.9416 -
val_loss: 0.5229 - val_acc: 0.8636
Epoch 42/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4806 - acc: 0.8642
834/834 [==============================] - 483s 579ms/step - loss: 0.1630 - acc: 0.9416 -
val_loss: 0.4814 - val_acc: 0.8642
Epoch 43/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4818 - acc: 0.8623
834/834 [==============================] - 481s 577ms/step - loss: 0.1563 - acc: 0.9444 -
val_loss: 0.4822 - val_acc: 0.8623
Epoch 44/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5034 - acc: 0.8605
834/834 [==============================] - 480s 576ms/step - loss: 0.1550 - acc: 0.9442 -
val_loss: 0.5040 - val_acc: 0.8605
Epoch 45/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4948 - acc: 0.8689
834/834 [==============================] - 478s 573ms/step - loss: 0.1501 - acc: 0.9475 -
val_loss: 0.4955 - val_acc: 0.8689
Epoch 46/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5386 - acc: 0.8556
834/834 [==============================] - 478s 573ms/step - loss: 0.1511 - acc: 0.9474 -
val_loss: 0.5386 - val_acc: 0.8556
Epoch 47/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5122 - acc: 0.8624
834/834 [==============================] - 484s 580ms/step - loss: 0.1454 - acc: 0.9484 -
val_loss: 0.5123 - val_acc: 0.8624
Epoch 48/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4817 - acc: 0.8680
834/834 [==============================] - 488s 585ms/step - loss: 0.1466 - acc: 0.9476 -
val_loss: 0.4822 - val_acc: 0.8680
Epoch 49/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5050 - acc: 0.8641
834/834 [==============================] - 483s 579ms/step - loss: 0.1396 - acc: 0.9504 -
val_loss: 0.5057 - val_acc: 0.8641
Epoch 50/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4834 - acc: 0.8685
834/834 [==============================] - 475s 570ms/step - loss: 0.1384 - acc: 0.9503 -
val_loss: 0.4839 - val_acc: 0.8685
Epoch 51/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4766 - acc: 0.8660
834/834 [==============================] - 476s 571ms/step - loss: 0.1359 - acc: 0.9520 -
val_loss: 0.4766 - val_acc: 0.8660
Epoch 52/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4718 - acc: 0.874510s - ET
A: 4s - loss: 0.471 - ETA: 2s - loss: 0.4756 - acc - ETA: 0s - loss: 0.4730 - acc: 0.
834/834 [==============================] - 478s 573ms/step - loss: 0.1340 - acc: 0.9525 -
val_loss: 0.4720 - val_acc: 0.8745
Epoch 53/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.5459 - acc: 0.8579
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834/834 [==============================] - 480s 575ms/step - loss: 0.1285 - acc: 0.9547 -
val_loss: 0.5460 - val_acc: 0.8579
Epoch 54/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4677 - acc: 0.8713
834/834 [==============================] - 478s 573ms/step - loss: 0.1271 - acc: 0.9548 -
val_loss: 0.4682 - val_acc: 0.8713
Epoch 55/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4871 - acc: 0.8711
834/834 [==============================] - 477s 572ms/step - loss: 0.1258 - acc: 0.9555 -
val_loss: 0.4871 - val_acc: 0.8711
Epoch 56/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4521 - acc: 0.8758
834/834 [==============================] - 476s 571ms/step - loss: 0.1258 - acc: 0.9560 -
val_loss: 0.4525 - val_acc: 0.8758
Epoch 57/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4420 - acc: 0.8817
834/834 [==============================] - 477s 572ms/step - loss: 0.1222 - acc: 0.9564 -
val_loss: 0.4426 - val_acc: 0.8817
Epoch 58/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4124 - acc: 0.8815
834/834 [==============================] - 476s 571ms/step - loss: 0.1197 - acc: 0.9569 -
val_loss: 0.4131 - val_acc: 0.8815
Epoch 59/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4801 - acc: 0.8749
834/834 [==============================] - 476s 570ms/step - loss: 0.1159 - acc: 0.9590 -
val_loss: 0.4807 - val_acc: 0.8749
Epoch 60/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.5386 - acc: 0.8555
834/834 [==============================] - 481s 577ms/step - loss: 0.1172 - acc: 0.9584 -
val_loss: 0.5385 - val_acc: 0.8555
Epoch 61/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4748 - acc: 0.8778
834/834 [==============================] - 471s 565ms/step - loss: 0.1141 - acc: 0.9601 -
val_loss: 0.4754 - val_acc: 0.8778
Epoch 62/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4929 - acc: 0.8717
834/834 [==============================] - 479s 575ms/step - loss: 0.1141 - acc: 0.9605 -
val_loss: 0.4936 - val_acc: 0.8717
Epoch 63/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4725 - acc: 0.8788
834/834 [==============================] - 477s 571ms/step - loss: 0.1073 - acc: 0.9606 -
val_loss: 0.4730 - val_acc: 0.8788
Epoch 64/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.6130 - acc: 0.8516
834/834 [==============================] - 476s 571ms/step - loss: 0.1047 - acc: 0.9632 -
val_loss: 0.6139 - val_acc: 0.8516
Epoch 65/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4945 - acc: 0.8760
834/834 [==============================] - 478s 574ms/step - loss: 0.1123 - acc: 0.9602 -
val_loss: 0.4948 - val_acc: 0.8760
Epoch 66/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4492 - acc: 0.8826
834/834 [==============================] - 473s 567ms/step - loss: 0.1104 - acc: 0.9603 -
val_loss: 0.4502 - val_acc: 0.8826
Epoch 67/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5108 - acc: 0.8725
834/834 [==============================] - 477s 572ms/step - loss: 0.0993 - acc: 0.9642 -
val_loss: 0.5109 - val_acc: 0.8725
Epoch 68/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4773 - acc: 0.8763
834/834 [==============================] - 478s 573ms/step - loss: 0.1017 - acc: 0.9638 -
val_loss: 0.4778 - val_acc: 0.8763
Epoch 69/200
10000/10000 [==============================] - 29s 3ms/sample - loss: 0.4811 - acc: 0.8731
834/834 [==============================] - 473s 568ms/step - loss: 0.1027 - acc: 0.9621 -
val_loss: 0.4810 - val_acc: 0.8731
Epoch 70/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4897 - acc: 0.8758
834/834 [==============================] - 471s 565ms/step - loss: 0.1011 - acc: 0.9649 -
val_loss: 0.4897 - val_acc: 0.8758
Epoch 71/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4807 - acc: 0.8790
834/834 [==============================] - 470s 564ms/step - loss: 0.0957 - acc: 0.9661 -
val_loss: 0.4810 - val_acc: 0.8790
Epoch 72/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4896 - acc: 0.8804
834/834 [==============================] - 473s 567ms/step - loss: 0.0996 - acc: 0.9648 -
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val_loss: 0.4896 - val_acc: 0.8804
Epoch 73/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4724 - acc: 0.8785
834/834 [==============================] - 471s 564ms/step - loss: 0.0965 - acc: 0.9657 -
val_loss: 0.4722 - val_acc: 0.8785
Epoch 74/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5481 - acc: 0.8689
834/834 [==============================] - 469s 562ms/step - loss: 0.0933 - acc: 0.9676 -
val_loss: 0.5477 - val_acc: 0.8689
Epoch 75/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5854 - acc: 0.8680
834/834 [==============================] - 469s 562ms/step - loss: 0.0909 - acc: 0.9677 -
val_loss: 0.5860 - val_acc: 0.8680
Epoch 76/200
10000/10000 [==============================] - 29s 3ms/sample - loss: 0.5507 - acc: 0.8739
834/834 [==============================] - 464s 556ms/step - loss: 0.0905 - acc: 0.9679 -
val_loss: 0.5514 - val_acc: 0.8739
Epoch 77/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4472 - acc: 0.8808
834/834 [==============================] - 467s 560ms/step - loss: 0.0902 - acc: 0.9671 -
val_loss: 0.4474 - val_acc: 0.8808
Epoch 78/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5737 - acc: 0.8641
834/834 [==============================] - 470s 564ms/step - loss: 0.0888 - acc: 0.9685 -
val_loss: 0.5742 - val_acc: 0.8641
Epoch 79/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5309 - acc: 0.8758
834/834 [==============================] - 475s 570ms/step - loss: 0.0913 - acc: 0.9673 -
val_loss: 0.5319 - val_acc: 0.8758
Epoch 80/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5261 - acc: 0.8779
834/834 [==============================] - 476s 570ms/step - loss: 0.0883 - acc: 0.9690 -
val_loss: 0.5266 - val_acc: 0.8779
Epoch 81/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5856 - acc: 0.8674
834/834 [==============================] - 475s 569ms/step - loss: 0.0855 - acc: 0.9692 -
val_loss: 0.5861 - val_acc: 0.8674
Epoch 82/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.4893 - acc: 0.8834
834/834 [==============================] - 475s 569ms/step - loss: 0.0869 - acc: 0.9698 -
val_loss: 0.4905 - val_acc: 0.8834
Epoch 83/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4965 - acc: 0.8821
834/834 [==============================] - 478s 574ms/step - loss: 0.0846 - acc: 0.9694 -
val_loss: 0.4968 - val_acc: 0.8821
Epoch 84/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4882 - acc: 0.8830
834/834 [==============================] - 486s 583ms/step - loss: 0.0848 - acc: 0.9699 -
val_loss: 0.4892 - val_acc: 0.8830
Epoch 85/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5922 - acc: 0.8655
834/834 [==============================] - 484s 580ms/step - loss: 0.0819 - acc: 0.9708 -
val_loss: 0.5920 - val_acc: 0.8655
Epoch 86/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5571 - acc: 0.8734
834/834 [==============================] - 484s 581ms/step - loss: 0.0811 - acc: 0.9708 -
val_loss: 0.5573 - val_acc: 0.8734
Epoch 87/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.6007 - acc: 0.8627
834/834 [==============================] - 484s 580ms/step - loss: 0.0809 - acc: 0.9715 -
val_loss: 0.6012 - val_acc: 0.8627
Epoch 88/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4840 - acc: 0.8880
834/834 [==============================] - 485s 582ms/step - loss: 0.0794 - acc: 0.9727 -
val_loss: 0.4848 - val_acc: 0.8880
Epoch 89/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5115 - acc: 0.88186s - los
s:  - ETA: 3s - loss: 0.
834/834 [==============================] - 483s 580ms/step - loss: 0.0795 - acc: 0.9718 -
val_loss: 0.5120 - val_acc: 0.8818
Epoch 90/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4863 - acc: 0.88910s - los
s: 0.4873 - acc: 0.88
834/834 [==============================] - 482s 578ms/step - loss: 0.0760 - acc: 0.9734 -
val_loss: 0.4863 - val_acc: 0.8891
Epoch 91/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5387 - acc: 0.8740
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834/834 [==============================] - 487s 584ms/step - loss: 0.0799 - acc: 0.9718 -
val_loss: 0.5391 - val_acc: 0.8740
Epoch 92/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5967 - acc: 0.86461s - los
s: 0.5981 - acc:
834/834 [==============================] - 484s 581ms/step - loss: 0.0753 - acc: 0.9732 -
val_loss: 0.5980 - val_acc: 0.8646
Epoch 93/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5567 - acc: 0.8738
834/834 [==============================] - 481s 577ms/step - loss: 0.0788 - acc: 0.9714 -
val_loss: 0.5567 - val_acc: 0.8738
Epoch 94/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.4814 - acc: 0.8871
834/834 [==============================] - 482s 578ms/step - loss: 0.0753 - acc: 0.9730 -
val_loss: 0.4817 - val_acc: 0.8871
Epoch 95/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5195 - acc: 0.8832
834/834 [==============================] - 484s 581ms/step - loss: 0.0725 - acc: 0.9749 -
val_loss: 0.5201 - val_acc: 0.8832
Epoch 96/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5195 - acc: 0.8824
834/834 [==============================] - 481s 577ms/step - loss: 0.0729 - acc: 0.9741 -
val_loss: 0.5198 - val_acc: 0.8824
Epoch 97/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5481 - acc: 0.87612s - los
s: 0.5501
834/834 [==============================] - 480s 576ms/step - loss: 0.0756 - acc: 0.9734 -
val_loss: 0.5494 - val_acc: 0.8761
Epoch 98/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5205 - acc: 0.8832
834/834 [==============================] - 482s 577ms/step - loss: 0.0673 - acc: 0.9761 -
val_loss: 0.5207 - val_acc: 0.8832
Epoch 99/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5195 - acc: 0.8847
834/834 [==============================] - 485s 582ms/step - loss: 0.0719 - acc: 0.9749 -
val_loss: 0.5199 - val_acc: 0.8847
Epoch 100/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5595 - acc: 0.8764
834/834 [==============================] - 481s 576ms/step - loss: 0.0688 - acc: 0.9758 -
val_loss: 0.5597 - val_acc: 0.8764
Epoch 101/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5404 - acc: 0.87973s - los
s: 0.5
834/834 [==============================] - 481s 576ms/step - loss: 0.0705 - acc: 0.9755 -
val_loss: 0.5412 - val_acc: 0.8797
Epoch 102/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5498 - acc: 0.8801
834/834 [==============================] - 481s 576ms/step - loss: 0.0693 - acc: 0.9758 -
val_loss: 0.5498 - val_acc: 0.8801
Epoch 103/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5212 - acc: 0.8859
834/834 [==============================] - 483s 579ms/step - loss: 0.0674 - acc: 0.9762 -
val_loss: 0.5219 - val_acc: 0.8859
Epoch 104/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.6052 - acc: 0.8737
834/834 [==============================] - 483s 579ms/step - loss: 0.0661 - acc: 0.9766 -
val_loss: 0.6057 - val_acc: 0.8737
Epoch 105/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5651 - acc: 0.87883s - los
s:
834/834 [==============================] - 480s 576ms/step - loss: 0.0669 - acc: 0.9766 -
val_loss: 0.5660 - val_acc: 0.8788
Epoch 106/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5283 - acc: 0.8872
834/834 [==============================] - 479s 575ms/step - loss: 0.0656 - acc: 0.9758 -
val_loss: 0.5289 - val_acc: 0.8872
Epoch 107/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.7342 - acc: 0.8538
834/834 [==============================] - 481s 577ms/step - loss: 0.0647 - acc: 0.9769 -
val_loss: 0.7351 - val_acc: 0.8538
Epoch 108/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.6231 - acc: 0.8707
834/834 [==============================] - 480s 575ms/step - loss: 0.0628 - acc: 0.9773 -
val_loss: 0.6237 - val_acc: 0.8707
Epoch 109/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5415 - acc: 0.8821
834/834 [==============================] - 479s 574ms/step - loss: 0.0638 - acc: 0.9778 -
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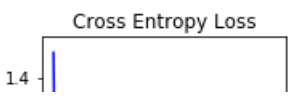
val_loss: 0.5436 - val_acc: 0.8821
Epoch 110/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5349 - acc: 0.8787
834/834 [==============================] - 480s 576ms/step - loss: 0.0678 - acc: 0.9761 -
val_loss: 0.5356 - val_acc: 0.8787
Epoch 111/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5273 - acc: 0.8872
834/834 [==============================] - 482s 578ms/step - loss: 0.0620 - acc: 0.9780 -
val_loss: 0.5274 - val_acc: 0.8872
Epoch 112/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.5520 - acc: 0.8831
834/834 [==============================] - 484s 580ms/step - loss: 0.0633 - acc: 0.9775 -
val_loss: 0.5519 - val_acc: 0.8831
Epoch 113/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.6407 - acc: 0.8693
834/834 [==============================] - 491s 588ms/step - loss: 0.0629 - acc: 0.9783 -
val_loss: 0.6416 - val_acc: 0.8693
Epoch 114/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5496 - acc: 0.8806
834/834 [==============================] - 489s 587ms/step - loss: 0.0622 - acc: 0.9780 -
val_loss: 0.5508 - val_acc: 0.8806
Epoch 115/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.6007 - acc: 0.8734
834/834 [==============================] - 483s 580ms/step - loss: 0.0647 - acc: 0.9775 -
val_loss: 0.6010 - val_acc: 0.8734
Epoch 116/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5154 - acc: 0.8871
834/834 [==============================] - 481s 576ms/step - loss: 0.0593 - acc: 0.9796 -
val_loss: 0.5161 - val_acc: 0.8871
Epoch 117/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.6489 - acc: 0.8675
834/834 [==============================] - 479s 575ms/step - loss: 0.0605 - acc: 0.9781 -
val_loss: 0.6491 - val_acc: 0.8675
Epoch 118/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5772 - acc: 0.8741
834/834 [==============================] - 479s 575ms/step - loss: 0.0609 - acc: 0.9782 -
val_loss: 0.5784 - val_acc: 0.8741
Epoch 119/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.5835 - acc: 0.8716
834/834 [==============================] - 496s 594ms/step - loss: 0.0600 - acc: 0.9791 -
val_loss: 0.5844 - val_acc: 0.8716
Epoch 120/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.5768 - acc: 0.8791
834/834 [==============================] - 492s 590ms/step - loss: 0.0584 - acc: 0.9790 -
val_loss: 0.5771 - val_acc: 0.8791
Epoch 121/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5301 - acc: 0.8834
834/834 [==============================] - 484s 580ms/step - loss: 0.0590 - acc: 0.9796 -
val_loss: 0.5310 - val_acc: 0.8834
Epoch 122/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5776 - acc: 0.8737
834/834 [==============================] - 476s 571ms/step - loss: 0.0621 - acc: 0.9778 -
val_loss: 0.5784 - val_acc: 0.8737
Epoch 123/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5128 - acc: 0.8878
834/834 [==============================] - 477s 571ms/step - loss: 0.0578 - acc: 0.9798 -
val_loss: 0.5135 - val_acc: 0.8878
Epoch 124/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5371 - acc: 0.8821
834/834 [==============================] - 476s 571ms/step - loss: 0.0590 - acc: 0.9802 -
val_loss: 0.5376 - val_acc: 0.8821
Epoch 125/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5250 - acc: 0.8854
834/834 [==============================] - 474s 568ms/step - loss: 0.0569 - acc: 0.9804 -
val_loss: 0.5258 - val_acc: 0.8854
Epoch 126/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6675 - acc: 0.8679
834/834 [==============================] - 474s 569ms/step - loss: 0.0562 - acc: 0.9803 -
val_loss: 0.6696 - val_acc: 0.8679
Epoch 127/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5188 - acc: 0.8880
834/834 [==============================] - 478s 573ms/step - loss: 0.0541 - acc: 0.9804 -
val_loss: 0.5202 - val_acc: 0.8880
Epoch 128/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5260 - acc: 0.8853
834/834 [==============================] - 475s 570ms/step - loss: 0.0601 - acc: 0.9790 -
val_loss: 0.5266 - val_acc: 0.8853
```

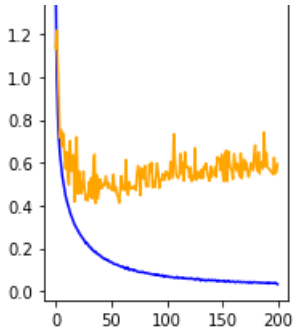
```
Epoch 129/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5574 - acc: 0.8816
834/834 [==============================] - 474s 568ms/step - loss: 0.0591 - acc: 0.9786 -
val_loss: 0.5582 - val_acc: 0.8816
Epoch 130/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5359 - acc: 0.8877
834/834 [==============================] - 474s 568ms/step - loss: 0.0556 - acc: 0.9805 -
val_loss: 0.5360 - val_acc: 0.8877
Epoch 131/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5275 - acc: 0.8870
834/834 [==============================] - 476s 570ms/step - loss: 0.0498 - acc: 0.9829 -
val_loss: 0.5279 - val_acc: 0.8870
Epoch 132/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5682 - acc: 0.88340s - los
s: 0.5682 - acc: 0.8
834/834 [==============================] - 477s 572ms/step - loss: 0.0550 - acc: 0.9808 -
val_loss: 0.5685 - val_acc: 0.8834
Epoch 133/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5263 - acc: 0.8893
834/834 [==============================] - 474s 569ms/step - loss: 0.0541 - acc: 0.9814 -
val_loss: 0.5269 - val_acc: 0.8893
Epoch 134/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5840 - acc: 0.88190s - los
s: 0.5855 - acc: 0.8
834/834 [==============================] - 475s 569ms/step - loss: 0.0514 - acc: 0.9823 -
val_loss: 0.5845 - val_acc: 0.8819
Epoch 135/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5730 - acc: 0.8814
834/834 [==============================] - 476s 571ms/step - loss: 0.0533 - acc: 0.9815 -
val_loss: 0.5734 - val_acc: 0.8814
Epoch 136/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5965 - acc: 0.8786
834/834 [==============================] - 474s 569ms/step - loss: 0.0491 - acc: 0.9825 -
val_loss: 0.5976 - val_acc: 0.8786
Epoch 137/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5453 - acc: 0.8848
834/834 [==============================] - 473s 567ms/step - loss: 0.0520 - acc: 0.9818 -
val_loss: 0.5460 - val_acc: 0.8848
Epoch 138/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5328 - acc: 0.88891s - los
s: 0.5370 - a
834/834 [==============================] - 474s 569ms/step - loss: 0.0547 - acc: 0.9813 -
val_loss: 0.5331 - val_acc: 0.8889
Epoch 139/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5150 - acc: 0.8896
834/834 [==============================] - 475s 570ms/step - loss: 0.0514 - acc: 0.9821 -
val_loss: 0.5158 - val_acc: 0.8896
Epoch 140/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5822 - acc: 0.8824
834/834 [==============================] - 470s 564ms/step - loss: 0.0500 - acc: 0.9827 -
val_loss: 0.5830 - val_acc: 0.8824
Epoch 141/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5333 - acc: 0.8898
834/834 [==============================] - 468s 561ms/step - loss: 0.0536 - acc: 0.9815 -
val_loss: 0.5342 - val_acc: 0.8898
Epoch 142/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5492 - acc: 0.8856
834/834 [==============================] - 467s 560ms/step - loss: 0.0511 - acc: 0.9823 -
val_loss: 0.5499 - val_acc: 0.8856
Epoch 143/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5567 - acc: 0.8908
834/834 [==============================] - 469s 562ms/step - loss: 0.0501 - acc: 0.9820 -
val_loss: 0.5575 - val_acc: 0.8908
Epoch 144/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5787 - acc: 0.8777
834/834 [==============================] - 470s 564ms/step - loss: 0.0531 - acc: 0.9810 -
val_loss: 0.5798 - val_acc: 0.8777
Epoch 145/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5328 - acc: 0.89023s - los
s:
834/834 [==============================] - 467s 560ms/step - loss: 0.0502 - acc: 0.9818 -
val_loss: 0.5335 - val_acc: 0.8902
Epoch 146/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6252 - acc: 0.8767
834/834 [==============================] - 468s 561ms/step - loss: 0.0460 - acc: 0.9839 -
val_loss: 0.6268 - val_acc: 0.8767
Epoch 147/200
```

```
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6151 - acc: 0.8817
834/834 [==============================] - 469s 562ms/step - loss: 0.0516 - acc: 0.9820 -
val_loss: 0.6168 - val_acc: 0.8817
Epoch 148/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6186 - acc: 0.8804
834/834 [==============================] - 470s 564ms/step - loss: 0.0485 - acc: 0.9833 -
val_loss: 0.6197 - val_acc: 0.8804
Epoch 149/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5637 - acc: 0.8889
834/834 [==============================] - 467s 560ms/step - loss: 0.0485 - acc: 0.9833 -
val_loss: 0.5647 - val_acc: 0.8889
Epoch 150/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6387 - acc: 0.8724
834/834 [==============================] - 469s 563ms/step - loss: 0.0474 - acc: 0.9834 -
val_loss: 0.6394 - val_acc: 0.8724
Epoch 151/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5410 - acc: 0.8842
834/834 [==============================] - 471s 565ms/step - loss: 0.0479 - acc: 0.9834 -
val_loss: 0.5420 - val_acc: 0.8842
Epoch 152/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5122 - acc: 0.8922
834/834 [==============================] - 468s 561ms/step - loss: 0.0503 - acc: 0.9825 -
val_loss: 0.5132 - val_acc: 0.8922
Epoch 153/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6354 - acc: 0.87583s - los
s: 0.
834/834 [==============================] - 466s 559ms/step - loss: 0.0445 - acc: 0.9841 -
val_loss: 0.6366 - val_acc: 0.8758
Epoch 154/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6555 - acc: 0.8739
834/834 [==============================] - 468s 561ms/step - loss: 0.0444 - acc: 0.9842 -
val_loss: 0.6568 - val_acc: 0.8739
Epoch 155/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5127 - acc: 0.8903
834/834 [==============================] - 469s 563ms/step - loss: 0.0482 - acc: 0.9834 -
val_loss: 0.5131 - val_acc: 0.8903
Epoch 156/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6535 - acc: 0.8786
834/834 [==============================] - 470s 563ms/step - loss: 0.0501 - acc: 0.9829 -
val_loss: 0.6538 - val_acc: 0.8786
Epoch 157/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5971 - acc: 0.881710s - lo
s
834/834 [==============================] - 468s 561ms/step - loss: 0.0439 - acc: 0.9840 -
val_loss: 0.5976 - val_acc: 0.8817
Epoch 158/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5744 - acc: 0.8837
834/834 [==============================] - 469s 562ms/step - loss: 0.0447 - acc: 0.9838 -
val_loss: 0.5743 - val_acc: 0.8837
Epoch 159/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5644 - acc: 0.88910s - los
s: 0.5652 - acc: 0
834/834 [==============================] - 466s 558ms/step - loss: 0.0446 - acc: 0.9843 -
val_loss: 0.5655 - val_acc: 0.8891
Epoch 160/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5232 - acc: 0.8921
834/834 [==============================] - 466s 559ms/step - loss: 0.0464 - acc: 0.9839 -
val_loss: 0.5239 - val_acc: 0.8921
Epoch 161/200
10000/10000 [==============================] - 32s 3ms/sample - loss: 0.6407 - acc: 0.8786
834/834 [==============================] - 478s 573ms/step - loss: 0.0458 - acc: 0.9840 -
val_loss: 0.6417 - val_acc: 0.8786
Epoch 162/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.6017 - acc: 0.8851
834/834 [==============================] - 479s 574ms/step - loss: 0.0417 - acc: 0.9852 -
val_loss: 0.6040 - val_acc: 0.8851
Epoch 163/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5643 - acc: 0.8930
834/834 [==============================] - 482s 577ms/step - loss: 0.0427 - acc: 0.9853 -
val_loss: 0.5655 - val_acc: 0.8930
Epoch 164/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5948 - acc: 0.8849
834/834 [==============================] - 486s 583ms/step - loss: 0.0467 - acc: 0.9837 -
val_loss: 0.5959 - val_acc: 0.8849
Epoch 165/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5588 - acc: 0.88701s - los
s: 0.5637 - acc
```

```
834/834 [==============================] - 473s 567ms/step - loss: 0.0445 - acc: 0.9841 -
val_loss: 0.5593 - val_acc: 0.8870
Epoch 166/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5356 - acc: 0.8933
834/834 [==============================] - 469s 563ms/step - loss: 0.0427 - acc: 0.9852 -
val_loss: 0.5362 - val_acc: 0.8933
Epoch 167/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6431 - acc: 0.88122s - los
s: 0.647
834/834 [==============================] - 468s 561ms/step - loss: 0.0451 - acc: 0.9846 -
val_loss: 0.6437 - val_acc: 0.8812
Epoch 168/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5264 - acc: 0.8904
834/834 [==============================] - 468s 561ms/step - loss: 0.0422 - acc: 0.9851 -
val_loss: 0.5267 - val_acc: 0.8904
Epoch 169/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5656 - acc: 0.8901
834/834 [==============================] - 465s 558ms/step - loss: 0.0429 - acc: 0.9851 -
val_loss: 0.5667 - val_acc: 0.8901
Epoch 170/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6155 - acc: 0.8809
834/834 [==============================] - 468s 561ms/step - loss: 0.0439 - acc: 0.9844 -
val_loss: 0.6164 - val_acc: 0.8809
Epoch 171/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5674 - acc: 0.8864
834/834 [==============================] - 474s 568ms/step - loss: 0.0431 - acc: 0.9844 -
val_loss: 0.5675 - val_acc: 0.8864
Epoch 172/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6003 - acc: 0.8839
834/834 [==============================] - 474s 568ms/step - loss: 0.0419 - acc: 0.9852 -
val_loss: 0.6014 - val_acc: 0.8839
Epoch 173/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5629 - acc: 0.8911
834/834 [==============================] - 467s 561ms/step - loss: 0.0433 - acc: 0.9847 -
val_loss: 0.5641 - val_acc: 0.8911
Epoch 174/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5339 - acc: 0.8935
834/834 [==============================] - 466s 559ms/step - loss: 0.0398 - acc: 0.9859 -
val_loss: 0.5342 - val_acc: 0.8935
Epoch 175/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5547 - acc: 0.8901
834/834 [==============================] - 472s 565ms/step - loss: 0.0445 - acc: 0.9843 -
val_loss: 0.5555 - val_acc: 0.8901
Epoch 176/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5982 - acc: 0.8878
834/834 [==============================] - 474s 569ms/step - loss: 0.0408 - acc: 0.9856 -
val_loss: 0.5991 - val_acc: 0.8878
Epoch 177/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5808 - acc: 0.8883
834/834 [==============================] - 470s 563ms/step - loss: 0.0391 - acc: 0.9861 -
val_loss: 0.5823 - val_acc: 0.8883
Epoch 178/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5623 - acc: 0.8889
834/834 [==============================] - 470s 564ms/step - loss: 0.0434 - acc: 0.9853 -
val_loss: 0.5634 - val_acc: 0.8889
Epoch 179/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6388 - acc: 0.8773
834/834 [==============================] - 471s 564ms/step - loss: 0.0421 - acc: 0.9853 -
val_loss: 0.6386 - val_acc: 0.8773
Epoch 180/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6809 - acc: 0.8739
834/834 [==============================] - 472s 566ms/step - loss: 0.0430 - acc: 0.9846 -
val_loss: 0.6819 - val_acc: 0.8739
Epoch 181/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5757 - acc: 0.8883
834/834 [==============================] - 469s 563ms/step - loss: 0.0412 - acc: 0.9855 -
val_loss: 0.5768 - val_acc: 0.8883
Epoch 182/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5634 - acc: 0.8918
834/834 [==============================] - 466s 558ms/step - loss: 0.0407 - acc: 0.9856 -
val_loss: 0.5637 - val_acc: 0.8918
Epoch 183/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6496 - acc: 0.8784
834/834 [==============================] - 467s 560ms/step - loss: 0.0407 - acc: 0.9862 -
val_loss: 0.6493 - val_acc: 0.8784
Epoch 184/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5490 - acc: 0.8924
```

```
834/834 [==============================] - 467s 560ms/step - loss: 0.0416 - acc: 0.9857 -
val_loss: 0.5489 - val_acc: 0.8924
Epoch 185/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.6042 - acc: 0.88873s - los
s: 0.6
834/834 [==============================] - 472s 566ms/step - loss: 0.0386 - acc: 0.9862 -
val_loss: 0.6051 - val_acc: 0.8887
Epoch 186/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5888 - acc: 0.8876
834/834 [==============================] - 474s 568ms/step - loss: 0.0409 - acc: 0.9857 -
val_loss: 0.5893 - val_acc: 0.8876
Epoch 187/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5713 - acc: 0.8882
834/834 [==============================] - 474s 568ms/step - loss: 0.0399 - acc: 0.9860 -
val_loss: 0.5719 - val_acc: 0.8882
Epoch 188/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.7406 - acc: 0.8670
834/834 [==============================] - 475s 569ms/step - loss: 0.0392 - acc: 0.9858 -
val_loss: 0.7429 - val_acc: 0.8670
Epoch 189/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5844 - acc: 0.89031s - los
s: 0.5834 - acc:
834/834 [==============================] - 472s 566ms/step - loss: 0.0383 - acc: 0.9865 -
val_loss: 0.5852 - val_acc: 0.8903
Epoch 190/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6447 - acc: 0.88501s - los
s: 0.6472 - acc
834/834 [==============================] - 471s 564ms/step - loss: 0.0399 - acc: 0.9860 -
val_loss: 0.6459 - val_acc: 0.8850
Epoch 191/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5784 - acc: 0.8886
834/834 [==============================] - 473s 568ms/step - loss: 0.0366 - acc: 0.9874 -
val_loss: 0.5781 - val_acc: 0.8886
Epoch 192/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5735 - acc: 0.8924
834/834 [==============================] - 474s 568ms/step - loss: 0.0411 - acc: 0.9856 -
val_loss: 0.5742 - val_acc: 0.8924
Epoch 193/200
10000/10000 [==============================] - 31s 3ms/sample - loss: 0.5691 - acc: 0.8895
834/834 [==============================] - 468s 561ms/step - loss: 0.0370 - acc: 0.9871 -
val_loss: 0.5698 - val_acc: 0.8895
Epoch 194/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5587 - acc: 0.89204s -
834/834 [==============================] - 469s 562ms/step - loss: 0.0394 - acc: 0.9865 -
val_loss: 0.5591 - val_acc: 0.8920
Epoch 195/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5578 - acc: 0.8902
834/834 [==============================] - 474s 568ms/step - loss: 0.0386 - acc: 0.9863 -
val_loss: 0.5577 - val_acc: 0.8902
Epoch 196/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5446 - acc: 0.89633s - los
s:
834/834 [==============================] - 473s 567ms/step - loss: 0.0381 - acc: 0.9867 -
val_loss: 0.5459 - val_acc: 0.8963
Epoch 197/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6233 - acc: 0.8852
834/834 [==============================] - 467s 560ms/step - loss: 0.0377 - acc: 0.9864 -
val_loss: 0.6243 - val_acc: 0.8852
Epoch 198/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5495 - acc: 0.8933
834/834 [==============================] - 472s 566ms/step - loss: 0.0408 - acc: 0.9858 -
val_loss: 0.5501 - val_acc: 0.8933
Epoch 199/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5552 - acc: 0.89240s - los
s: 0.5539 - acc: 0.892
834/834 [==============================] - 478s 574ms/step - loss: 0.0373 - acc: 0.9873 -
val_loss: 0.5558 - val_acc: 0.8924
Epoch 200/200
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5935 - acc: 0.8873
834/834 [==============================] - 475s 569ms/step - loss: 0.0330 - acc: 0.9884 -
val_loss: 0.5940 - val_acc: 0.8873
> 88.730
```





In [17]:

```
from keras.models import load_model
#saving model weights
model.save('my_model.h5')
```

JUST CONTINUING THE MODEL FOR ANOTHER 5 EPOCHS

In [18]:

```
def summarize_diagnostics(history):
 # plot loss
 pyplot.subplot(121)
 pyplot.title('Cross Entropy Loss')
 pyplot.plot(history.history['loss'], color='blue', label='train')
 pyplot.plot(history.history['val_loss'], color='orange', label='test')
 pyplot.show()


# run the test harness for evaluating a model
def run_test_harness():

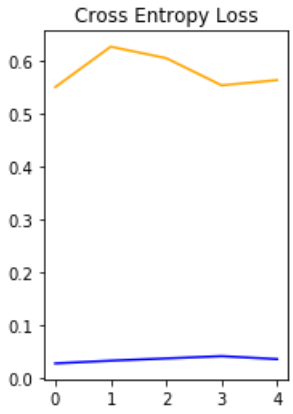
 # define model

 # create data generator
 datagen = ImageDataGenerator(width_shift_range=0.1, height_shift_range=0.1, horizontal_flip=True)
 # prepare iterator
 it_train = datagen.flow(X_train, y_train, batch_size=60)
 # fit model
 steps = int(X_train.shape[0] / 39)
 history = model.fit_generator(it_train, steps_per_epoch=steps, epochs=5, validation_data=(X_test,
y_test), verbose=1)
 # evaluate model
 _, acc = model.evaluate(X_test, y_test, verbose=0)
 print('> %.3f' % (acc * 100.0))
 # learning curves
 summarize_diagnostics(history)

# entry point, run the test harness
run_test_harness()
```

```
Epoch 1/5
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5500 - acc: 0.8941
834/834 [==============================] - 462s 554ms/step - loss: 0.0268 - acc: 0.9910 -
val_loss: 0.5499 - val_acc: 0.8941
Epoch 2/5
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6256 - acc: 0.8842
834/834 [==============================] - 472s 565ms/step - loss: 0.0319 - acc: 0.9892 -
val_loss: 0.6264 - val_acc: 0.8842
Epoch 3/5
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.6039 - acc: 0.8868
834/834 [==============================] - 472s 566ms/step - loss: 0.0362 - acc: 0.9874 -
val_loss: 0.6047 - val_acc: 0.8868
Epoch 4/5
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5519 - acc: 0.8920
834/834 [==============================] - 467s 559ms/step - loss: 0.0406 - acc: 0.9857 -
val_loss: 0.5532 - val_acc: 0.8920
Epoch 5/5
10000/10000 [==============================] - 30s 3ms/sample - loss: 0.5623 - acc: 0.8954
834/834 [==============================] - 468s 561ms/step - loss: 0.0350 - acc: 0.9877 -
```

```
val_loss: 0.5632 - val_acc: 0.8954
> 89.540
```



train_loss: 0.0350 train_acc: 0.9877

val_loss: 0.5632 val_acc: 0.8954

In [21]:

```
from prettytable import PrettyTable

conclusion= PrettyTable()
conclusion.field_names = [ "Model", 'epochs','train_loss','train acc',"test loss",'test acc']

conclusion.add_row(["model with dense layer", 75,0.1203, 0.956, 0.6271,0.843])
conclusion.add_row(["model without dense layer",205, 0.035, 0.987,0.563,0.895])


print(conclusion)
```

```
+---------------------------+--------+------------+-----------+-----------+----------+
|           Model           | epochs | train_loss | train acc | test loss | test acc |
+---------------------------+--------+------------+-----------+-----------+----------+
|   model with dense layer  |   75   |   0.1203   |   0.956   |   0.6271  |  0.843   |
| model without dense layer |  205   |   0.035    |   0.987   |   0.563   |  0.895   |
+---------------------------+--------+------------+-----------+-----------+----------+
```

Hi Team, After trying so much effort, I could only achieve 89.5% accuracy

Conclusion and Observations

Overfitting is one the problem in this assignment since dropouts was excluded.

Even tried using L2 regularization but still models are overfitting.

Loss on test data doesnot change after certain number of iterations which can be seen from plots.