In [1]:

```
# https://arxiv.org/pdf/1608.06993.pdf

from IPython.display import IFrame, YouTubeVideo
YouTubeVideo(id = '-W6y8xnd--U', width = 600)
```

Out[1]:

In [2]:

```
import tensorflow as tf
```

The default version of TensorFlow in Colab will soon switch to TensorFlow 2.x.
We recommend you upgrade now or ensure your notebook will continue to use TensorFlow 1.x via the `%tensorflow_version 1.x` magic: more info.

In [3]:

```
# Load CIFAR-10 Dataset

(X_train, Y_train), (X_test, Y_test) = tf.keras.datasets.cifar10.load_data()
image_height, image_width, channel = X_train.shape[1], X_train.shape[2], X_train.shape[3]
```

```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
170500096/170498071 [==============================] - 2s 0us/step
```

In [4]:

```
# https://stackoverflow.com/a/49961206/10219869

import numpy
print(numpy.unique(Y_train))
print(len(numpy.unique(Y_train).tolist()))
```

```
[0 1 2 3 4 5 6 7 8 9]
10
```

In [0]:

```
# Y_train to OHE
Y_train = tf.keras.utils.to_categorical(y = Y_train, num_classes = len(numpy.unique(Y_train).tolist()))
Y_test = tf.keras.utils.to_categorical(y = Y_test, num_classes = len(numpy.unique(Y_test).tolist()))
```

In [6]:

```
print('The shape of X_train is:',X_train.shape)
print('The shape of X_test is:',X_test.shape)
print('The shape of Y_train is:',Y_train.shape)
print('The shape of Y_test is:',Y_test.shape)
```

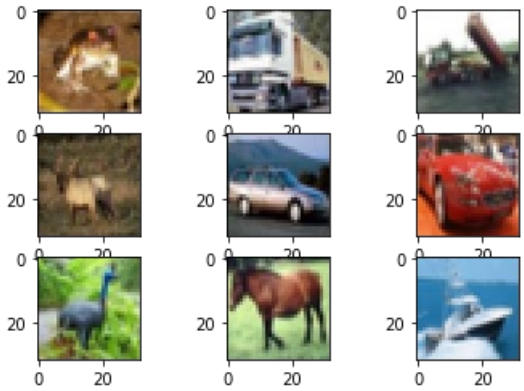
```
The shape of X_train is: (50000, 32, 32, 3)
The shape of X_test is: (10000, 32, 32, 3)
The shape of Y_train is: (50000, 10)
```

The shape of Y_test is: (10000, 10)

In [7]:

```
# https://machinelearningmastery.com/image-augmentation-deep-learning-keras/

import matplotlib.pyplot as plt
for i in range(0, 9):
  plt.subplot(330 + 1 + i)
  plt.imshow(X_train[i])
plt.show()
```



In [0]:

```
"""ImageDataGenerator(featurewise_center=False, samplewise_center=False, featurewise_std_normalization=False,
                      samplewise_std_normalization=False, zca_whitening=False, zca_epsilon=1e-06, rotation_range=0,
                      width_shift_range=0.0, height_shift_range=0.0, brightness_range=None, shear_range=0.0, zoom_range=0.0,
                      channel_shift_range=0.0, fill_mode='nearest', cval=0.0, horizontal_flip=False, vertical_flip=False,
                      rescale=None, preprocessing_function=None, data_format='channels_last', validation_split=0.0,
                      interpolation_order=1, dtype='float32')
"""
batch_size = 128

datagen = tf.keras.preprocessing.image.ImageDataGenerator(featurewise_center= False, samplewise_center=False,
                                  featurewise_std_normalization= False, samplewise_std_normalization=False,
                                  zca_whitening=False, zca_epsilon=1e-06, rotation_range= 0, width_shift_range=0.1,
                                  height_shift_range=0.1, brightness_range=None, shear_range=0.0, zoom_range=0.0,
                                  channel_shift_range=0.0, fill_mode='nearest', cval=0.0, horizontal_flip= True,
                                  vertical_flip=False, rescale=None, preprocessing_function=None,
                                  data_format= None, validation_split=0.0, dtype='float32')

"""datagen_test = tf.keras.preprocessing.image.ImageDataGenerator(rescale= 1./255.)"""

datagen.fit(X_train)

train_datagen = datagen.flow(x = X_train, y = Y_train, batch_size = batch_size)
test_datagen = datagen.flow(x = X_test, y = Y_test, batch_size = batch_size)
```

In [0]:

```
compression = 0.5
num_filter = 42

# Dense Block

def dense_block(input, num_filter, dropout_rate = 0):
  global compression
  temp = input

  for _ in range(10):
    Batch_Norm = tf.keras.layers.BatchNormalization()(temp)
    Relu = tf.keras.layers.Activation('relu')(Batch_Norm)
    Conv2D = tf.keras.layers.Conv2D(filters= int(num_filter * compression), kernel_size = (3, 3), padding= 'same',)(Relu)
    if dropout_rate > 0:
      Conv2D = tf.keras.layers.Dropout(dropout_rate)(Conv2D)
    Concat = tf.keras.layers.Concatenate(axis= -1)([temp, Conv2D])
    temp = Concat

  return temp



# Transition Block
```

```
def transition_block(input, num_filter, dropout_rate = 0):
  global compression

  Batch_Norm = tf.keras.layers.BatchNormalization()(input)
  Relu = tf.keras.layers.Activation('relu')(Batch_Norm)
  Conv2D_Bottle_Neck = tf.keras.layers.Conv2D(filters= int(num_filter * compression), kernel_size = (1, 1), padding= 'same',)(Relu)
  if dropout_rate > 0:
     Conv2D_Bottle_Neck = tf.keras.layers.Dropout(dropout_rate)(Conv2D_Bottle_Neck)
  Average_pooling = tf.keras.layers.AveragePooling2D(pool_size = (2, 2), strides= 2)(Conv2D_Bottle_Neck)

  return Average_pooling


# Output Layer

def output_layer(input):
  global compression

  Batch_Norm = tf.keras.layers.BatchNormalization()(input)
  Relu = tf.keras.layers.Activation('relu')(Batch_Norm)
  Average_pooling = tf.keras.layers.AveragePooling2D(pool_size = (2, 2))(Relu)
  Conv = tf.keras.layers.Conv2D(filters= 10, kernel_size = (3, 3), padding= 'same', activation = 'softmax')(Average_pooling)
  Global_Max_pooling = tf.keras.layers.GlobalMaxPooling2D()(Conv)
  output = tf.keras.layers.Activation('softmax')(Global_Max_pooling)

  return output
```

In [0]:

```
Input = tf.keras.layers.Input(shape = (image_height, image_width, channel))
First_Conv2D = tf.keras.layers.Conv2D(filters= num_filter, kernel_size = (3, 3), padding= 'same')(Input)

First_Block = dense_block(First_Conv2D, num_filter, dropout_rate=0)
First_Transition = transition_block(First_Block, num_filter, dropout_rate=0)

Second_Block = dense_block(First_Transition, num_filter, dropout_rate=0)
Second_Transition = transition_block(Second_Block, num_filter, dropout_rate=0)

Third_Block = dense_block(Second_Transition, num_filter, dropout_rate=0)
Third_Transition = transition_block(Third_Block, num_filter, dropout_rate=0)

Last_Block = dense_block(Third_Transition, num_filter, dropout_rate=0)
output = output_layer(input = Last_Block)
```

In [22]:

```
model = tf.keras.models.Model(inputs = [Input], outputs = [output])
model.summary()
```

Model: "model_2"

Layer (type)	Output Shape	Param #	Connected to
input_4 (InputLayer)	[(None, 32, 32, 3)]	0	
conv2d_135 (Conv2D)	(None, 32, 32, 42)	1176	input_4[0][0]
batch_normalization_132 (BatchN	(None, 32, 32, 42)	168	conv2d_135[0][0]
activation_135 (Activation)	(None, 32, 32, 42)	0	batch_normalization_132[0][0]
conv2d_136 (Conv2D)	(None, 32, 32, 21)	7959	activation_135[0][0]
concatenate_120 (Concatenate)	(None, 32, 32, 63)	0	conv2d_135[0][0] conv2d_136[0][0]
batch_normalization_133 (BatchN	(None, 32, 32, 63)	252	concatenate_120[0][0]
activation_136 (Activation)	(None, 32, 32, 63)	0	batch_normalization_133[0][0]
conv2d_137 (Conv2D)	(None, 32, 32, 21)	11928	activation_136[0][0]
concatenate_121 (Concatenate)	(None, 32, 32, 84)	0	concatenate_120[0][0] conv2d_137[0][0]
batch_normalization_134 (BatchN	(None, 32, 32, 84)	336	concatenate_121[0][0]
activation_137 (Activation)	(None, 32, 32, 84)	0	batch_normalization_134[0][0]

conv2d_138 (Conv2D)	(None, 32, 32, 21)	15897	activation_137[0][0]
concatenate_122 (Concatenate)	(None, 32, 32, 105)	0	concatenate_121[0][0] conv2d_138[0][0]
batch_normalization_135 (BatchN	(None, 32, 32, 105)	420	concatenate_122[0][0]
activation_138 (Activation)	(None, 32, 32, 105)	0	batch_normalization_135[0][0]
conv2d_139 (Conv2D)	(None, 32, 32, 21)	19866	activation_138[0][0]
concatenate_123 (Concatenate)	(None, 32, 32, 126)	0	concatenate_122[0][0] conv2d_139[0][0]
batch_normalization_136 (BatchN	(None, 32, 32, 126)	504	concatenate_123[0][0]
activation_139 (Activation)	(None, 32, 32, 126)	0	batch_normalization_136[0][0]
conv2d_140 (Conv2D)	(None, 32, 32, 21)	23835	activation_139[0][0]
concatenate_124 (Concatenate)	(None, 32, 32, 147)	0	concatenate_123[0][0] conv2d_140[0][0]
batch_normalization_137 (BatchN	(None, 32, 32, 147)	588	concatenate_124[0][0]
activation_140 (Activation)	(None, 32, 32, 147)	0	batch_normalization_137[0][0]
conv2d_141 (Conv2D)	(None, 32, 32, 21)	27804	activation_140[0][0]
concatenate_125 (Concatenate)	(None, 32, 32, 168)	0	concatenate_124[0][0] conv2d_141[0][0]
batch_normalization_138 (BatchN	(None, 32, 32, 168)	672	concatenate_125[0][0]
activation_141 (Activation)	(None, 32, 32, 168)	0	batch_normalization_138[0][0]
conv2d_142 (Conv2D)	(None, 32, 32, 21)	31773	activation_141[0][0]
concatenate_126 (Concatenate)	(None, 32, 32, 189)	0	concatenate_125[0][0] conv2d_142[0][0]
batch_normalization_139 (BatchN	(None, 32, 32, 189)	756	concatenate_126[0][0]
activation_142 (Activation)	(None, 32, 32, 189)	0	batch_normalization_139[0][0]
conv2d_143 (Conv2D)	(None, 32, 32, 21)	35742	activation_142[0][0]
concatenate_127 (Concatenate)	(None, 32, 32, 210)	0	concatenate_126[0][0] conv2d_143[0][0]
batch_normalization_140 (BatchN	(None, 32, 32, 210)	840	concatenate_127[0][0]
activation_143 (Activation)	(None, 32, 32, 210)	0	batch_normalization_140[0][0]
conv2d_144 (Conv2D)	(None, 32, 32, 21)	39711	activation_143[0][0]
concatenate_128 (Concatenate)	(None, 32, 32, 231)	0	concatenate_127[0][0] conv2d_144[0][0]
batch_normalization_141 (BatchN	(None, 32, 32, 231)	924	concatenate_128[0][0]
activation_144 (Activation)	(None, 32, 32, 231)	0	batch_normalization_141[0][0]
conv2d_145 (Conv2D)	(None, 32, 32, 21)	43680	activation_144[0][0]
concatenate_129 (Concatenate)	(None, 32, 32, 252)	0	concatenate_128[0][0] conv2d_145[0][0]
batch_normalization_142 (BatchN	(None, 32, 32, 252)	1008	concatenate_129[0][0]
activation_145 (Activation)	(None, 32, 32, 252)	0	batch_normalization_142[0][0]
conv2d_146 (Conv2D)	(None, 32, 32, 21)	5313	activation_145[0][0]
average_pooling2d_12 (AveragePo	(None, 16, 16, 21)	0	conv2d_146[0][0]
batch_normalization_143 (BatchN	(None, 16, 16, 21)	84	average_pooling2d_12[0][0]
activation_146 (Activation)	(None, 16, 16, 21)	0	batch_normalization_143[0][0]
conv2d_147 (Conv2D)	(None, 16, 16, 21)	3990	activation_146[0][0]
concatenate_130 (Concatenate)	(None, 16, 16, 42)	0	average_pooling2d_12[0][0]

concatenate_130 (Concatenate) (None, 16, 16, 42) 0 average_pooling2d_12[0][0]
conv2d_147[0][0]

batch_normalization_144 (BatchN (None, 16, 16, 42) 168 concatenate_130[0][0]

activation_147 (Activation) (None, 16, 16, 42) 0 batch_normalization_144[0][0]

conv2d_148 (Conv2D) (None, 16, 16, 21) 7959 activation_147[0][0]

concatenate_131 (Concatenate) (None, 16, 16, 63) 0 concatenate_130[0][0]
conv2d_148[0][0]

batch_normalization_145 (BatchN (None, 16, 16, 63) 252 concatenate_131[0][0]

activation_148 (Activation) (None, 16, 16, 63) 0 batch_normalization_145[0][0]

conv2d_149 (Conv2D) (None, 16, 16, 21) 11928 activation_148[0][0]

concatenate_132 (Concatenate) (None, 16, 16, 84) 0 concatenate_131[0][0]
conv2d_149[0][0]

batch_normalization_146 (BatchN (None, 16, 16, 84) 336 concatenate_132[0][0]

activation_149 (Activation) (None, 16, 16, 84) 0 batch_normalization_146[0][0]

conv2d_150 (Conv2D) (None, 16, 16, 21) 15897 activation_149[0][0]

concatenate_133 (Concatenate) (None, 16, 16, 105) 0 concatenate_132[0][0]
conv2d_150[0][0]

batch_normalization_147 (BatchN (None, 16, 16, 105) 420 concatenate_133[0][0]

activation_150 (Activation) (None, 16, 16, 105) 0 batch_normalization_147[0][0]

conv2d_151 (Conv2D) (None, 16, 16, 21) 19866 activation_150[0][0]

concatenate_134 (Concatenate) (None, 16, 16, 126) 0 concatenate_133[0][0]
conv2d_151[0][0]

batch_normalization_148 (BatchN (None, 16, 16, 126) 504 concatenate_134[0][0]

activation_151 (Activation) (None, 16, 16, 126) 0 batch_normalization_148[0][0]

conv2d_152 (Conv2D) (None, 16, 16, 21) 23835 activation_151[0][0]

concatenate_135 (Concatenate) (None, 16, 16, 147) 0 concatenate_134[0][0]
conv2d_152[0][0]

batch_normalization_149 (BatchN (None, 16, 16, 147) 588 concatenate_135[0][0]

activation_152 (Activation) (None, 16, 16, 147) 0 batch_normalization_149[0][0]

conv2d_153 (Conv2D) (None, 16, 16, 21) 27804 activation_152[0][0]

concatenate_136 (Concatenate) (None, 16, 16, 168) 0 concatenate_135[0][0]
conv2d_153[0][0]

batch_normalization_150 (BatchN (None, 16, 16, 168) 672 concatenate_136[0][0]

activation_153 (Activation) (None, 16, 16, 168) 0 batch_normalization_150[0][0]

conv2d_154 (Conv2D) (None, 16, 16, 21) 31773 activation_153[0][0]

concatenate_137 (Concatenate) (None, 16, 16, 189) 0 concatenate_136[0][0]
conv2d_154[0][0]

batch_normalization_151 (BatchN (None, 16, 16, 189) 756 concatenate_137[0][0]

activation_154 (Activation) (None, 16, 16, 189) 0 batch_normalization_151[0][0]

conv2d_155 (Conv2D) (None, 16, 16, 21) 35742 activation_154[0][0]

concatenate_138 (Concatenate) (None, 16, 16, 210) 0 concatenate_137[0][0]
conv2d_155[0][0]

batch_normalization_152 (BatchN (None, 16, 16, 210) 840 concatenate_138[0][0]

activation_155 (Activation) (None, 16, 16, 210) 0 batch_normalization_152[0][0]

conv2d_156 (Conv2D) (None, 16, 16, 21) 39711 activation_155[0][0]

concatenate_139 (Concatenate) (None, 16, 16, 231) 0 concatenate_138[0][0]
conv2d_156[0][0]

batch_normalization_153 (BatchN (None, 16, 16, 231) 924 concatenate_139[0][0]

activation_156 (Activation) (None, 16, 16, 231) 0 batch_normalization_153[0][0]

conv2d_157 (Conv2D) (None, 16, 16, 21) 4872 activation_156[0][0]

average_pooling2d_13 (AveragePo (None, 8, 8, 21) 0 conv2d_157[0][0]

batch_normalization_154 (BatchN (None, 8, 8, 21) 84 average_pooling2d_13[0][0]

activation_157 (Activation) (None, 8, 8, 21) 0 batch_normalization_154[0][0]

conv2d_158 (Conv2D) (None, 8, 8, 21) 3990 activation_157[0][0]

concatenate_140 (Concatenate) (None, 8, 8, 42) 0 average_pooling2d_13[0][0]
conv2d_158[0][0]

batch_normalization_155 (BatchN (None, 8, 8, 42) 168 concatenate_140[0][0]

activation_158 (Activation) (None, 8, 8, 42) 0 batch_normalization_155[0][0]

conv2d_159 (Conv2D) (None, 8, 8, 21) 7959 activation_158[0][0]

concatenate_141 (Concatenate) (None, 8, 8, 63) 0 concatenate_140[0][0]
conv2d_159[0][0]

batch_normalization_156 (BatchN (None, 8, 8, 63) 252 concatenate_141[0][0]

activation_159 (Activation) (None, 8, 8, 63) 0 batch_normalization_156[0][0]

conv2d_160 (Conv2D) (None, 8, 8, 21) 11928 activation_159[0][0]

concatenate_142 (Concatenate) (None, 8, 8, 84) 0 concatenate_141[0][0]
conv2d_160[0][0]

batch_normalization_157 (BatchN (None, 8, 8, 84) 336 concatenate_142[0][0]

activation_160 (Activation) (None, 8, 8, 84) 0 batch_normalization_157[0][0]

conv2d_161 (Conv2D) (None, 8, 8, 21) 15897 activation_160[0][0]

concatenate_143 (Concatenate) (None, 8, 8, 105) 0 concatenate_142[0][0]
conv2d_161[0][0]

batch_normalization_158 (BatchN (None, 8, 8, 105) 420 concatenate_143[0][0]

activation_161 (Activation) (None, 8, 8, 105) 0 batch_normalization_158[0][0]

conv2d_162 (Conv2D) (None, 8, 8, 21) 19866 activation_161[0][0]

concatenate_144 (Concatenate) (None, 8, 8, 126) 0 concatenate_143[0][0]
conv2d_162[0][0]

batch_normalization_159 (BatchN (None, 8, 8, 126) 504 concatenate_144[0][0]

activation_162 (Activation) (None, 8, 8, 126) 0 batch_normalization_159[0][0]

conv2d_163 (Conv2D) (None, 8, 8, 21) 23835 activation_162[0][0]

concatenate_145 (Concatenate) (None, 8, 8, 147) 0 concatenate_144[0][0]
conv2d_163[0][0]

batch_normalization_160 (BatchN (None, 8, 8, 147) 588 concatenate_145[0][0]

activation_163 (Activation) (None, 8, 8, 147) 0 batch_normalization_160[0][0]

conv2d_164 (Conv2D) (None, 8, 8, 21) 27804 activation_163[0][0]

concatenate_146 (Concatenate) (None, 8, 8, 168) 0 concatenate_145[0][0]
conv2d_164[0][0]

batch_normalization_161 (BatchN (None, 8, 8, 168) 672 concatenate_146[0][0]

activation_164 (Activation) (None, 8, 8, 168) 0 batch_normalization_161[0][0]

conv2d_165 (Conv2D) (None, 8, 8, 21) 31773 activation_164[0][0]

concatenate_147 (Concatenate) (None, 8, 8, 189) 0 concatenate_146[0][0]
conv2d_165[0][0]

batch_normalization_162 (BatchN (None, 8, 8, 189) 756 concatenate_147[0][0]

activation_165 (Activation)	(None, 8, 8, 189)	0	batch_normalization_162[0][0]
conv2d_166 (Conv2D)	(None, 8, 8, 21)	35742	activation_165[0][0]
concatenate_148 (Concatenate)	(None, 8, 8, 210)	0	concatenate_147[0][0] conv2d_166[0][0]
batch_normalization_163 (BatchN	(None, 8, 8, 210)	840	concatenate_148[0][0]
activation_166 (Activation)	(None, 8, 8, 210)	0	batch_normalization_163[0][0]
conv2d_167 (Conv2D)	(None, 8, 8, 21)	39711	activation_166[0][0]
concatenate_149 (Concatenate)	(None, 8, 8, 231)	0	concatenate_148[0][0] conv2d_167[0][0]
batch_normalization_164 (BatchN	(None, 8, 8, 231)	924	concatenate_149[0][0]
activation_167 (Activation)	(None, 8, 8, 231)	0	batch_normalization_164[0][0]
conv2d_168 (Conv2D)	(None, 8, 8, 21)	4872	activation_167[0][0]
average_pooling2d_14 (AveragePo	(None, 4, 4, 21)	0	conv2d_168[0][0]
batch_normalization_165 (BatchN	(None, 4, 4, 21)	84	average_pooling2d_14[0][0]
activation_168 (Activation)	(None, 4, 4, 21)	0	batch_normalization_165[0][0]
conv2d_169 (Conv2D)	(None, 4, 4, 21)	3990	activation_168[0][0]
concatenate_150 (Concatenate)	(None, 4, 4, 42)	0	average_pooling2d_14[0][0] conv2d_169[0][0]
batch_normalization_166 (BatchN	(None, 4, 4, 42)	168	concatenate_150[0][0]
activation_169 (Activation)	(None, 4, 4, 42)	0	batch_normalization_166[0][0]
conv2d_170 (Conv2D)	(None, 4, 4, 21)	7959	activation_169[0][0]
concatenate_151 (Concatenate)	(None, 4, 4, 63)	0	concatenate_150[0][0] conv2d_170[0][0]
batch_normalization_167 (BatchN	(None, 4, 4, 63)	252	concatenate_151[0][0]
activation_170 (Activation)	(None, 4, 4, 63)	0	batch_normalization_167[0][0]
conv2d_171 (Conv2D)	(None, 4, 4, 21)	11928	activation_170[0][0]
concatenate_152 (Concatenate)	(None, 4, 4, 84)	0	concatenate_151[0][0] conv2d_171[0][0]
batch_normalization_168 (BatchN	(None, 4, 4, 84)	336	concatenate_152[0][0]
activation_171 (Activation)	(None, 4, 4, 84)	0	batch_normalization_168[0][0]
conv2d_172 (Conv2D)	(None, 4, 4, 21)	15897	activation_171[0][0]
concatenate_153 (Concatenate)	(None, 4, 4, 105)	0	concatenate_152[0][0] conv2d_172[0][0]
batch_normalization_169 (BatchN	(None, 4, 4, 105)	420	concatenate_153[0][0]
activation_172 (Activation)	(None, 4, 4, 105)	0	batch_normalization_169[0][0]
conv2d_173 (Conv2D)	(None, 4, 4, 21)	19866	activation_172[0][0]
concatenate_154 (Concatenate)	(None, 4, 4, 126)	0	concatenate_153[0][0] conv2d_173[0][0]
batch_normalization_170 (BatchN	(None, 4, 4, 126)	504	concatenate_154[0][0]
activation_173 (Activation)	(None, 4, 4, 126)	0	batch_normalization_170[0][0]
conv2d_174 (Conv2D)	(None, 4, 4, 21)	23835	activation_173[0][0]
concatenate_155 (Concatenate)	(None, 4, 4, 147)	0	concatenate_154[0][0] conv2d_174[0][0]
batch_normalization_171 (BatchN	(None, 4, 4, 147)	588	concatenate_155[0][0]
activation_174 (Activation)	(None, 4, 4, 147)	0	batch_normalization_171[0][0]

```
conv2d_175 (Conv2D)             (None, 4, 4, 21)     27804       activation_174[0][0]
__________________________________________________________________________________________________
concatenate_156 (Concatenate)   (None, 4, 4, 168)    0           concatenate_155[0][0]
                                                                 conv2d_175[0][0]
__________________________________________________________________________________________________
batch_normalization_172 (BatchN (None, 4, 4, 168)    672         concatenate_156[0][0]
__________________________________________________________________________________________________
activation_175 (Activation)     (None, 4, 4, 168)    0           batch_normalization_172[0][0]
__________________________________________________________________________________________________
conv2d_176 (Conv2D)             (None, 4, 4, 21)     31773       activation_175[0][0]
__________________________________________________________________________________________________
concatenate_157 (Concatenate)   (None, 4, 4, 189)    0           concatenate_156[0][0]
                                                                 conv2d_176[0][0]
__________________________________________________________________________________________________
batch_normalization_173 (BatchN (None, 4, 4, 189)    756         concatenate_157[0][0]
__________________________________________________________________________________________________
activation_176 (Activation)     (None, 4, 4, 189)    0           batch_normalization_173[0][0]
__________________________________________________________________________________________________
conv2d_177 (Conv2D)             (None, 4, 4, 21)     35742       activation_176[0][0]
__________________________________________________________________________________________________
concatenate_158 (Concatenate)   (None, 4, 4, 210)    0           concatenate_157[0][0]
                                                                 conv2d_177[0][0]
__________________________________________________________________________________________________
batch_normalization_174 (BatchN (None, 4, 4, 210)    840         concatenate_158[0][0]
__________________________________________________________________________________________________
activation_177 (Activation)     (None, 4, 4, 210)    0           batch_normalization_174[0][0]
__________________________________________________________________________________________________
conv2d_178 (Conv2D)             (None, 4, 4, 21)     39711       activation_177[0][0]
__________________________________________________________________________________________________
concatenate_159 (Concatenate)   (None, 4, 4, 231)    0           concatenate_158[0][0]
                                                                 conv2d_178[0][0]
__________________________________________________________________________________________________
batch_normalization_175 (BatchN (None, 4, 4, 231)    924         concatenate_159[0][0]
__________________________________________________________________________________________________
activation_178 (Activation)     (None, 4, 4, 231)    0           batch_normalization_175[0][0]
__________________________________________________________________________________________________
average_pooling2d_15 (AveragePo (None, 2, 2, 231)    0           activation_178[0][0]
__________________________________________________________________________________________________
conv2d_179 (Conv2D)             (None, 2, 2, 10)     20800       average_pooling2d_15[0][0]
__________________________________________________________________________________________________
global_max_pooling2d_2 (GlobalM (None, 10)           0           conv2d_179[0][0]
__________________________________________________________________________________________________
activation_179 (Activation)     (None, 10)           0           global_max_pooling2d_2[0][0]
==================================================================================================
Total params: 973,843
Trainable params: 962,293
Non-trainable params: 11,550
__________________________________________________________________________________________________
```

In [0]:

```
# determine loss function and optimizer

model.compile(loss = 'categorical_crossentropy', optimizer= tf.keras.optimizers.Adam(learning_rate = 0.001), metrics=['accuracy'], )
```

In [24]:

```
# Resource Exaustion Error, https://github.com/tensorflow/models/issues/1993
batch_size = 128
history = model.fit_generator(generator = train_datagen , steps_per_epoch = numpy.floor(len(X_train) / batch_size), epochs= 200,
                              validation_data = test_datagen  )
```

```
Epoch 1/200
389/390 [============================>.] - ETA: 0s - loss: 1.9382 - acc: 0.3853Epoch 1/200
390/390 [==============================] - 79s 203ms/step - loss: 1.9381 - acc: 0.3856 - val_loss: 2.1845 - val_acc: 0.2135
Epoch 2/200
389/390 [============================>.] - ETA: 0s - loss: 1.8288 - acc: 0.4957Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.8287 - acc: 0.4956 - val_loss: 1.9634 - val_acc: 0.3894
Epoch 3/200
389/390 [============================>.] - ETA: 0s - loss: 1.7715 - acc: 0.5739Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.7715 - acc: 0.5739 - val_loss: 1.8381 - val_acc: 0.5090
Epoch 4/200
389/390 [============================>.] - ETA: 0s - loss: 1.7342 - acc: 0.6278Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.7341 - acc: 0.6280 - val_loss: 1.7700 - val_acc: 0.5879
Epoch 5/200
389/390 [============================>.] - ETA: 0s - loss: 1.6999 - acc: 0.6650Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.6999 - acc: 0.6651 - val_loss: 1.7660 - val_acc: 0.5884
Epoch 6/200
389/390 [============================>.] - ETA: 0s - loss: 1.6790 - acc: 0.6856Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.6790 - acc: 0.6856 - val_loss: 1.7192 - val_acc: 0.6485
```

Epoch 7/200
389/390 [============================>.] - ETA: 0s - loss: 1.6659 - acc: 0.7001Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.6658 - acc: 0.7002 - val_loss: 1.8189 - val_acc: 0.5402
Epoch 8/200
389/390 [============================>.] - ETA: 0s - loss: 1.6530 - acc: 0.7198Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.6531 - acc: 0.7197 - val_loss: 1.7481 - val_acc: 0.6132
Epoch 9/200
389/390 [============================>.] - ETA: 0s - loss: 1.6421 - acc: 0.7337Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.6420 - acc: 0.7339 - val_loss: 1.6667 - val_acc: 0.6935
Epoch 10/200
389/390 [============================>.] - ETA: 0s - loss: 1.6333 - acc: 0.7468Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.6333 - acc: 0.7470 - val_loss: 1.6868 - val_acc: 0.6762
Epoch 11/200
389/390 [============================>.] - ETA: 0s - loss: 1.6275 - acc: 0.7564Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.6275 - acc: 0.7564 - val_loss: 1.7352 - val_acc: 0.6433
Epoch 12/200
389/390 [============================>.] - ETA: 0s - loss: 1.6231 - acc: 0.7654Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.6230 - acc: 0.7655 - val_loss: 1.6951 - val_acc: 0.6732
Epoch 13/200
389/390 [============================>.] - ETA: 0s - loss: 1.6155 - acc: 0.7746Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.6155 - acc: 0.7747 - val_loss: 1.6424 - val_acc: 0.7489
Epoch 14/200
389/390 [============================>.] - ETA: 0s - loss: 1.6103 - acc: 0.7912Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.6103 - acc: 0.7911 - val_loss: 1.6675 - val_acc: 0.7282
Epoch 15/200
389/390 [============================>.] - ETA: 0s - loss: 1.6058 - acc: 0.7965Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.6058 - acc: 0.7966 - val_loss: 1.6660 - val_acc: 0.7272
Epoch 16/200
389/390 [============================>.] - ETA: 0s - loss: 1.5999 - acc: 0.8096Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.5998 - acc: 0.8098 - val_loss: 1.6340 - val_acc: 0.7710
Epoch 17/200
389/390 [============================>.] - ETA: 0s - loss: 1.5954 - acc: 0.8128Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5953 - acc: 0.8129 - val_loss: 1.6480 - val_acc: 0.7513
Epoch 18/200
389/390 [============================>.] - ETA: 0s - loss: 1.5963 - acc: 0.8134Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5964 - acc: 0.8133 - val_loss: 1.6422 - val_acc: 0.7568
Epoch 19/200
389/390 [============================>.] - ETA: 0s - loss: 1.5902 - acc: 0.8208Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5902 - acc: 0.8209 - val_loss: 1.6336 - val_acc: 0.7739
Epoch 20/200
389/390 [============================>.] - ETA: 0s - loss: 1.5874 - acc: 0.8237Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.5874 - acc: 0.8237 - val_loss: 1.6338 - val_acc: 0.7686
Epoch 21/200
389/390 [============================>.] - ETA: 0s - loss: 1.5834 - acc: 0.8299Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.5834 - acc: 0.8299 - val_loss: 1.6321 - val_acc: 0.7675
Epoch 22/200
389/390 [============================>.] - ETA: 0s - loss: 1.5844 - acc: 0.8308Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5845 - acc: 0.8307 - val_loss: 1.6300 - val_acc: 0.7839
Epoch 23/200
389/390 [============================>.] - ETA: 0s - loss: 1.5792 - acc: 0.8385Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5792 - acc: 0.8386 - val_loss: 1.6211 - val_acc: 0.7864
Epoch 24/200
389/390 [============================>.] - ETA: 0s - loss: 1.5744 - acc: 0.8440Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5744 - acc: 0.8440 - val_loss: 1.6179 - val_acc: 0.7918
Epoch 25/200
389/390 [============================>.] - ETA: 0s - loss: 1.5733 - acc: 0.8432Epoch 1/200
390/390 [==============================] - 63s 160ms/step - loss: 1.5732 - acc: 0.8434 - val_loss: 1.6214 - val_acc: 0.7845
Epoch 26/200
389/390 [============================>.] - ETA: 0s - loss: 1.5720 - acc: 0.8459Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5721 - acc: 0.8459 - val_loss: 1.6181 - val_acc: 0.7890
Epoch 27/200
389/390 [============================>.] - ETA: 0s - loss: 1.5703 - acc: 0.8478Epoch 1/200
390/390 [==============================] - 63s 160ms/step - loss: 1.5703 - acc: 0.8479 - val_loss: 1.6823 - val_acc: 0.7179
Epoch 28/200
389/390 [============================>.] - ETA: 0s - loss: 1.5651 - acc: 0.8553Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.5651 - acc: 0.8553 - val_loss: 1.6267 - val_acc: 0.7636
Epoch 29/200
389/390 [============================>.] - ETA: 0s - loss: 1.5632 - acc: 0.8582Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5631 - acc: 0.8582 - val_loss: 1.6005 - val_acc: 0.8161
Epoch 30/200
389/390 [============================>.] - ETA: 0s - loss: 1.5638 - acc: 0.8583Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.5639 - acc: 0.8582 - val_loss: 1.6263 - val_acc: 0.7735
Epoch 31/200
389/390 [============================>.] - ETA: 0s - loss: 1.5598 - acc: 0.8638Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5597 - acc: 0.8638 - val_loss: 1.6428 - val_acc: 0.7626
Epoch 32/200
389/390 [============================>.] - ETA: 0s - loss: 1.5590 - acc: 0.8648Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5591 - acc: 0.8648 - val_loss: 1.6167 - val_acc: 0.7997
Epoch 33/200
389/390 [============================>.] - ETA: 0s - loss: 1.5565 - acc: 0.8670Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5565 - acc: 0.8669 - val_loss: 1.6218 - val_acc: 0.7886
Epoch 34/200

389/390 [==============================>.] - ETA: 0s - loss: 1.5533 - acc: 0.8732Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5533 - acc: 0.8733 - val_loss: 1.5948 - val_acc: 0.8214
Epoch 35/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5534 - acc: 0.8727Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5534 - acc: 0.8727 - val_loss: 1.5900 - val_acc: 0.8271
Epoch 36/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5538 - acc: 0.8727Epoch 1/200
390/390 [==============================] - 63s 160ms/step - loss: 1.5538 - acc: 0.8727 - val_loss: 1.5865 - val_acc: 0.8285
Epoch 37/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5504 - acc: 0.8765Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5503 - acc: 0.8766 - val_loss: 1.6261 - val_acc: 0.7893
Epoch 38/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5493 - acc: 0.8773Epoch 1/200
390/390 [==============================] - 63s 160ms/step - loss: 1.5493 - acc: 0.8773 - val_loss: 1.5987 - val_acc: 0.8117
Epoch 39/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5500 - acc: 0.8759Epoch 1/200
390/390 [==============================] - 63s 160ms/step - loss: 1.5501 - acc: 0.8758 - val_loss: 1.6256 - val_acc: 0.7912
Epoch 40/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5473 - acc: 0.8806Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5473 - acc: 0.8806 - val_loss: 1.5973 - val_acc: 0.8154
Epoch 41/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5465 - acc: 0.8814Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5464 - acc: 0.8814 - val_loss: 1.5870 - val_acc: 0.8380
Epoch 42/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5436 - acc: 0.8845Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5437 - acc: 0.8844 - val_loss: 1.5768 - val_acc: 0.8452
Epoch 43/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5432 - acc: 0.8858Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5432 - acc: 0.8857 - val_loss: 1.5806 - val_acc: 0.8416
Epoch 44/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5409 - acc: 0.8882Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5409 - acc: 0.8881 - val_loss: 1.6459 - val_acc: 0.7655
Epoch 45/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5411 - acc: 0.8885Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5412 - acc: 0.8885 - val_loss: 1.6039 - val_acc: 0.7931
Epoch 46/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5401 - acc: 0.8897Epoch 1/200
390/390 [==============================] - 63s 163ms/step - loss: 1.5401 - acc: 0.8897 - val_loss: 1.5884 - val_acc: 0.8296
Epoch 47/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5395 - acc: 0.8903Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5395 - acc: 0.8902 - val_loss: 1.5727 - val_acc: 0.8459
Epoch 48/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5378 - acc: 0.8921Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5378 - acc: 0.8920 - val_loss: 1.6062 - val_acc: 0.8102
Epoch 49/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5369 - acc: 0.8937Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5369 - acc: 0.8936 - val_loss: 1.5633 - val_acc: 0.8607
Epoch 50/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5330 - acc: 0.8972Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5330 - acc: 0.8973 - val_loss: 1.5751 - val_acc: 0.8484
Epoch 51/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5350 - acc: 0.8965Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5350 - acc: 0.8964 - val_loss: 1.6052 - val_acc: 0.8074
Epoch 52/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5318 - acc: 0.9001Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5317 - acc: 0.9001 - val_loss: 1.6030 - val_acc: 0.8069
Epoch 53/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5324 - acc: 0.9004Epoch 1/200
390/390 [==============================] - 63s 163ms/step - loss: 1.5324 - acc: 0.9004 - val_loss: 1.5957 - val_acc: 0.8229
Epoch 54/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5303 - acc: 0.9006Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5303 - acc: 0.9006 - val_loss: 1.5730 - val_acc: 0.8469
Epoch 55/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5309 - acc: 0.9017Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5309 - acc: 0.9017 - val_loss: 1.5834 - val_acc: 0.8345
Epoch 56/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5298 - acc: 0.9048Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5298 - acc: 0.9047 - val_loss: 1.5730 - val_acc: 0.8485
Epoch 57/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5288 - acc: 0.9048Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5288 - acc: 0.9049 - val_loss: 1.5806 - val_acc: 0.8414
Epoch 58/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5280 - acc: 0.9051Epoch 1/200
390/390 [==============================] - 63s 163ms/step - loss: 1.5279 - acc: 0.9052 - val_loss: 1.5971 - val_acc: 0.8213
Epoch 59/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5269 - acc: 0.9064Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5269 - acc: 0.9063 - val_loss: 1.5876 - val_acc: 0.8293
Epoch 60/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5268 - acc: 0.9077Epoch 1/200
390/390 [==============================] - 64s 163ms/step - loss: 1.5267 - acc: 0.9079 - val_loss: 1.5839 - val_acc: 0.8345
Epoch 61/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5257 - acc: 0.9098Epoch 1/200
390/390 [==============================] - 63s 163ms/step - loss: 1.5257 - acc: 0.9098 - val_loss: 1.5688 - val_acc: 0.8521

Epoch 62/200
389/390 [============================>.] - ETA: 0s - loss: 1.5246 - acc: 0.9095Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5246 - acc: 0.9095 - val_loss: 1.5742 - val_acc: 0.8488
Epoch 63/200
389/390 [============================>.] - ETA: 0s - loss: 1.5244 - acc: 0.9100Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5244 - acc: 0.9100 - val_loss: 1.5790 - val_acc: 0.8436
Epoch 64/200
389/390 [============================>.] - ETA: 0s - loss: 1.5237 - acc: 0.9131Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5238 - acc: 0.9129 - val_loss: 1.5760 - val_acc: 0.8418
Epoch 65/200
389/390 [============================>.] - ETA: 0s - loss: 1.5231 - acc: 0.9133Epoch 1/200
390/390 [==============================] - 63s 163ms/step - loss: 1.5231 - acc: 0.9134 - val_loss: 1.5728 - val_acc: 0.8481
Epoch 66/200
389/390 [============================>.] - ETA: 0s - loss: 1.5232 - acc: 0.9113Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5233 - acc: 0.9112 - val_loss: 1.5927 - val_acc: 0.8280
Epoch 67/200
389/390 [============================>.] - ETA: 0s - loss: 1.5207 - acc: 0.9158Epoch 1/200
390/390 [==============================] - 63s 163ms/step - loss: 1.5207 - acc: 0.9158 - val_loss: 1.5564 - val_acc: 0.8702
Epoch 68/200
389/390 [============================>.] - ETA: 0s - loss: 1.5220 - acc: 0.9123Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5219 - acc: 0.9123 - val_loss: 1.5692 - val_acc: 0.8577
Epoch 69/200
389/390 [============================>.] - ETA: 0s - loss: 1.5200 - acc: 0.9166Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5200 - acc: 0.9166 - val_loss: 1.5595 - val_acc: 0.8653
Epoch 70/200
389/390 [============================>.] - ETA: 0s - loss: 1.5196 - acc: 0.9185Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5196 - acc: 0.9185 - val_loss: 1.5705 - val_acc: 0.8576
Epoch 71/200
389/390 [============================>.] - ETA: 0s - loss: 1.5172 - acc: 0.9205Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5171 - acc: 0.9205 - val_loss: 1.5571 - val_acc: 0.8677
Epoch 72/200
389/390 [============================>.] - ETA: 0s - loss: 1.5182 - acc: 0.9185Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5182 - acc: 0.9185 - val_loss: 1.5569 - val_acc: 0.8704
Epoch 73/200
389/390 [============================>.] - ETA: 0s - loss: 1.5160 - acc: 0.9216Epoch 1/200
390/390 [==============================] - 63s 163ms/step - loss: 1.5160 - acc: 0.9217 - val_loss: 1.5638 - val_acc: 0.8673
Epoch 74/200
389/390 [============================>.] - ETA: 0s - loss: 1.5162 - acc: 0.9214Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5162 - acc: 0.9214 - val_loss: 1.5868 - val_acc: 0.8395
Epoch 75/200
389/390 [============================>.] - ETA: 0s - loss: 1.5157 - acc: 0.9235Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5157 - acc: 0.9235 - val_loss: 1.5624 - val_acc: 0.8644
Epoch 76/200
389/390 [============================>.] - ETA: 0s - loss: 1.5146 - acc: 0.9223Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5146 - acc: 0.9223 - val_loss: 1.5599 - val_acc: 0.8658
Epoch 77/200
389/390 [============================>.] - ETA: 0s - loss: 1.5162 - acc: 0.9235Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5161 - acc: 0.9236 - val_loss: 1.5559 - val_acc: 0.8710
Epoch 78/200
389/390 [============================>.] - ETA: 0s - loss: 1.5147 - acc: 0.9243Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5146 - acc: 0.9244 - val_loss: 1.5693 - val_acc: 0.8580
Epoch 79/200
389/390 [============================>.] - ETA: 0s - loss: 1.5129 - acc: 0.9268Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5129 - acc: 0.9268 - val_loss: 1.5724 - val_acc: 0.8537
Epoch 80/200
389/390 [============================>.] - ETA: 0s - loss: 1.5131 - acc: 0.9276Epoch 1/200
390/390 [==============================] - 63s 163ms/step - loss: 1.5130 - acc: 0.9276 - val_loss: 1.5685 - val_acc: 0.8599
Epoch 81/200
389/390 [============================>.] - ETA: 0s - loss: 1.5140 - acc: 0.9257Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5140 - acc: 0.9256 - val_loss: 1.5862 - val_acc: 0.8413
Epoch 82/200
389/390 [============================>.] - ETA: 0s - loss: 1.5134 - acc: 0.9261Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5133 - acc: 0.9262 - val_loss: 1.5721 - val_acc: 0.8575
Epoch 83/200
389/390 [============================>.] - ETA: 0s - loss: 1.5123 - acc: 0.9276Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5122 - acc: 0.9276 - val_loss: 1.5570 - val_acc: 0.8671
Epoch 84/200
389/390 [============================>.] - ETA: 0s - loss: 1.5112 - acc: 0.9289Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5113 - acc: 0.9289 - val_loss: 1.5554 - val_acc: 0.8723
Epoch 85/200
389/390 [============================>.] - ETA: 0s - loss: 1.5097 - acc: 0.9316Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5097 - acc: 0.9316 - val_loss: 1.5532 - val_acc: 0.8759
Epoch 86/200
389/390 [============================>.] - ETA: 0s - loss: 1.5076 - acc: 0.9321Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.5076 - acc: 0.9321 - val_loss: 1.5661 - val_acc: 0.8642
Epoch 87/200
389/390 [============================>.] - ETA: 0s - loss: 1.5088 - acc: 0.9338Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5087 - acc: 0.9339 - val_loss: 1.5543 - val_acc: 0.8757
Epoch 88/200
389/390 [============================>.] - ETA: 0s - loss: 1.5096 - acc: 0.9300Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5097 - acc: 0.9300 - val_loss: 1.5564 - val_acc: 0.8745
Epoch 89/200

389/390 [==============================>.] - ETA: 0s - loss: 1.5084 - acc: 0.9341Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5084 - acc: 0.9340 - val_loss: 1.5605 - val_acc: 0.8664
Epoch 90/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5092 - acc: 0.9314Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5092 - acc: 0.9314 - val_loss: 1.5577 - val_acc: 0.8680
Epoch 91/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5075 - acc: 0.9338Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5075 - acc: 0.9337 - val_loss: 1.5604 - val_acc: 0.8614
Epoch 92/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5090 - acc: 0.9332Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.5090 - acc: 0.9332 - val_loss: 1.5560 - val_acc: 0.8740
Epoch 93/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5058 - acc: 0.9365Epoch 1/200
390/390 [==============================] - 63s 160ms/step - loss: 1.5058 - acc: 0.9366 - val_loss: 1.5587 - val_acc: 0.8692
Epoch 94/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5063 - acc: 0.9345Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5063 - acc: 0.9345 - val_loss: 1.5621 - val_acc: 0.8685
Epoch 95/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5067 - acc: 0.9359Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5067 - acc: 0.9359 - val_loss: 1.5499 - val_acc: 0.8830
Epoch 96/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5074 - acc: 0.9354Epoch 1/200
390/390 [==============================] - 63s 160ms/step - loss: 1.5073 - acc: 0.9355 - val_loss: 1.5738 - val_acc: 0.8553
Epoch 97/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5065 - acc: 0.9350Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.5065 - acc: 0.9350 - val_loss: 1.5590 - val_acc: 0.8705
Epoch 98/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5034 - acc: 0.9407Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.5034 - acc: 0.9407 - val_loss: 1.5535 - val_acc: 0.8787
Epoch 99/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5030 - acc: 0.9398Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.5031 - acc: 0.9398 - val_loss: 1.5560 - val_acc: 0.8705
Epoch 100/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5048 - acc: 0.9380Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5048 - acc: 0.9379 - val_loss: 1.5526 - val_acc: 0.8783
Epoch 101/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5049 - acc: 0.9375Epoch 1/200
390/390 [==============================] - 63s 160ms/step - loss: 1.5049 - acc: 0.9374 - val_loss: 1.5589 - val_acc: 0.8683
Epoch 102/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5026 - acc: 0.9406Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5026 - acc: 0.9407 - val_loss: 1.5511 - val_acc: 0.8797
Epoch 103/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5032 - acc: 0.9403Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5033 - acc: 0.9402 - val_loss: 1.5671 - val_acc: 0.8611
Epoch 104/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5032 - acc: 0.9399Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5032 - acc: 0.9398 - val_loss: 1.5623 - val_acc: 0.8718
Epoch 105/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5012 - acc: 0.9425Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5012 - acc: 0.9426 - val_loss: 1.5570 - val_acc: 0.8710
Epoch 106/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5025 - acc: 0.9416Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5026 - acc: 0.9417 - val_loss: 1.5539 - val_acc: 0.8761
Epoch 107/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5012 - acc: 0.9436Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.5011 - acc: 0.9436 - val_loss: 1.5678 - val_acc: 0.8613
Epoch 108/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5012 - acc: 0.9440Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.5012 - acc: 0.9441 - val_loss: 1.5507 - val_acc: 0.8802
Epoch 109/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5011 - acc: 0.9444Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.5012 - acc: 0.9443 - val_loss: 1.5572 - val_acc: 0.8772
Epoch 110/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5003 - acc: 0.9446Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.5003 - acc: 0.9445 - val_loss: 1.5614 - val_acc: 0.8717
Epoch 111/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5010 - acc: 0.9448Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.5009 - acc: 0.9448 - val_loss: 1.5662 - val_acc: 0.8628
Epoch 112/200
389/390 [==============================>.] - ETA: 0s - loss: 1.4995 - acc: 0.9455Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4994 - acc: 0.9456 - val_loss: 1.5567 - val_acc: 0.8717
Epoch 113/200
389/390 [==============================>.] - ETA: 0s - loss: 1.4995 - acc: 0.9447Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4995 - acc: 0.9447 - val_loss: 1.5486 - val_acc: 0.8847
Epoch 114/200
389/390 [==============================>.] - ETA: 0s - loss: 1.5001 - acc: 0.9443Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.5001 - acc: 0.9442 - val_loss: 1.5514 - val_acc: 0.8799
Epoch 115/200
389/390 [==============================>.] - ETA: 0s - loss: 1.4979 - acc: 0.9476Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4979 - acc: 0.9476 - val_loss: 1.5558 - val_acc: 0.8769
Epoch 116/200
389/390 [==============================>.] - ETA: 0s - loss: 1.4987 - acc: 0.9467Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4986 - acc: 0.9468 - val_loss: 1.5498 - val_acc: 0.8866

Epoch 117/200
389/390 [============================>.] - ETA: 0s - loss: 1.4994 - acc: 0.9447Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4994 - acc: 0.9448 - val_loss: 1.5538 - val_acc: 0.8767
Epoch 118/200
389/390 [============================>.] - ETA: 0s - loss: 1.4984 - acc: 0.9474Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4984 - acc: 0.9473 - val_loss: 1.5437 - val_acc: 0.8918
Epoch 119/200
389/390 [============================>.] - ETA: 0s - loss: 1.4967 - acc: 0.9492Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4967 - acc: 0.9492 - val_loss: 1.5631 - val_acc: 0.8647
Epoch 120/200
389/390 [============================>.] - ETA: 0s - loss: 1.4975 - acc: 0.9477Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4975 - acc: 0.9477 - val_loss: 1.5563 - val_acc: 0.8777
Epoch 121/200
389/390 [============================>.] - ETA: 0s - loss: 1.4956 - acc: 0.9503Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.4957 - acc: 0.9503 - val_loss: 1.5483 - val_acc: 0.8900
Epoch 122/200
389/390 [============================>.] - ETA: 0s - loss: 1.4963 - acc: 0.9501Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.4964 - acc: 0.9501 - val_loss: 1.5478 - val_acc: 0.8886
Epoch 123/200
389/390 [============================>.] - ETA: 0s - loss: 1.4945 - acc: 0.9529Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4945 - acc: 0.9529 - val_loss: 1.5610 - val_acc: 0.8708
Epoch 124/200
389/390 [============================>.] - ETA: 0s - loss: 1.4960 - acc: 0.9497Epoch 1/200
390/390 [==============================] - 63s 160ms/step - loss: 1.4960 - acc: 0.9497 - val_loss: 1.5538 - val_acc: 0.8750
Epoch 125/200
389/390 [============================>.] - ETA: 0s - loss: 1.4962 - acc: 0.9501Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4962 - acc: 0.9501 - val_loss: 1.5424 - val_acc: 0.8939
Epoch 126/200
389/390 [============================>.] - ETA: 0s - loss: 1.4934 - acc: 0.9547Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4934 - acc: 0.9546 - val_loss: 1.5594 - val_acc: 0.8753
Epoch 127/200
389/390 [============================>.] - ETA: 0s - loss: 1.4962 - acc: 0.9509Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4961 - acc: 0.9509 - val_loss: 1.5419 - val_acc: 0.8934
Epoch 128/200
389/390 [============================>.] - ETA: 0s - loss: 1.4954 - acc: 0.9514Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4954 - acc: 0.9514 - val_loss: 1.5593 - val_acc: 0.8675
Epoch 129/200
389/390 [============================>.] - ETA: 0s - loss: 1.4956 - acc: 0.9512Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.4956 - acc: 0.9512 - val_loss: 1.5550 - val_acc: 0.8783
Epoch 130/200
389/390 [============================>.] - ETA: 0s - loss: 1.4946 - acc: 0.9531Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.4946 - acc: 0.9531 - val_loss: 1.5514 - val_acc: 0.8843
Epoch 131/200
389/390 [============================>.] - ETA: 0s - loss: 1.4933 - acc: 0.9535Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4933 - acc: 0.9536 - val_loss: 1.5667 - val_acc: 0.8613
Epoch 132/200
389/390 [============================>.] - ETA: 0s - loss: 1.4942 - acc: 0.9527Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4943 - acc: 0.9527 - val_loss: 1.5513 - val_acc: 0.8835
Epoch 133/200
389/390 [============================>.] - ETA: 0s - loss: 1.4943 - acc: 0.9537Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4943 - acc: 0.9538 - val_loss: 1.5613 - val_acc: 0.8671
Epoch 134/200
389/390 [============================>.] - ETA: 0s - loss: 1.4941 - acc: 0.9528Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4941 - acc: 0.9529 - val_loss: 1.5476 - val_acc: 0.8845
Epoch 135/200
389/390 [============================>.] - ETA: 0s - loss: 1.4937 - acc: 0.9534Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4937 - acc: 0.9535 - val_loss: 1.5546 - val_acc: 0.8767
Epoch 136/200
389/390 [============================>.] - ETA: 0s - loss: 1.4939 - acc: 0.9531Epoch 1/200
390/390 [==============================] - 63s 160ms/step - loss: 1.4939 - acc: 0.9531 - val_loss: 1.5475 - val_acc: 0.8853
Epoch 137/200
389/390 [============================>.] - ETA: 0s - loss: 1.4916 - acc: 0.9569Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4917 - acc: 0.9568 - val_loss: 1.5486 - val_acc: 0.8852
Epoch 138/200
389/390 [============================>.] - ETA: 0s - loss: 1.4929 - acc: 0.9542Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4929 - acc: 0.9542 - val_loss: 1.5667 - val_acc: 0.8578
Epoch 139/200
389/390 [============================>.] - ETA: 0s - loss: 1.4915 - acc: 0.9562Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.4915 - acc: 0.9562 - val_loss: 1.5576 - val_acc: 0.8744
Epoch 140/200
389/390 [============================>.] - ETA: 0s - loss: 1.4922 - acc: 0.9571Epoch 1/200
390/390 [==============================] - 63s 162ms/step - loss: 1.4922 - acc: 0.9570 - val_loss: 1.5659 - val_acc: 0.8647
Epoch 141/200
389/390 [============================>.] - ETA: 0s - loss: 1.4932 - acc: 0.9547Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.4932 - acc: 0.9548 - val_loss: 1.5486 - val_acc: 0.8834
Epoch 142/200
389/390 [============================>.] - ETA: 0s - loss: 1.4909 - acc: 0.9564Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4908 - acc: 0.9563 - val_loss: 1.5419 - val_acc: 0.8930
Epoch 143/200
389/390 [============================>.] - ETA: 0s - loss: 1.4924 - acc: 0.9562Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4923 - acc: 0.9562 - val_loss: 1.5502 - val_acc: 0.8841
Epoch 144/200
389/390 [============================>.] - ETA: 0s - loss: 1.4918 - acc: 0.9573Epoch 1/200

389/390 [============================>.] - ETA: 0s - loss: 1.4918 - acc: 0.9573Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4918 - acc: 0.9574 - val_loss: 1.5442 - val_acc: 0.8853
Epoch 145/200
389/390 [============================>.] - ETA: 0s - loss: 1.4912 - acc: 0.9565Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4912 - acc: 0.9565 - val_loss: 1.5524 - val_acc: 0.8825
Epoch 146/200
389/390 [============================>.] - ETA: 0s - loss: 1.4888 - acc: 0.9598Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4888 - acc: 0.9598 - val_loss: 1.5500 - val_acc: 0.8846
Epoch 147/200
389/390 [============================>.] - ETA: 0s - loss: 1.4893 - acc: 0.9604Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4894 - acc: 0.9603 - val_loss: 1.5598 - val_acc: 0.8732
Epoch 148/200
389/390 [============================>.] - ETA: 0s - loss: 1.4902 - acc: 0.9587Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4902 - acc: 0.9587 - val_loss: 1.5540 - val_acc: 0.8794
Epoch 149/200
389/390 [============================>.] - ETA: 0s - loss: 1.4895 - acc: 0.9598Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4895 - acc: 0.9598 - val_loss: 1.5831 - val_acc: 0.8403
Epoch 150/200
389/390 [============================>.] - ETA: 0s - loss: 1.4899 - acc: 0.9580Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4899 - acc: 0.9580 - val_loss: 1.5440 - val_acc: 0.8918
Epoch 151/200
389/390 [============================>.] - ETA: 0s - loss: 1.4893 - acc: 0.9590Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4893 - acc: 0.9590 - val_loss: 1.5509 - val_acc: 0.8849
Epoch 152/200
389/390 [============================>.] - ETA: 0s - loss: 1.4882 - acc: 0.9613Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4882 - acc: 0.9613 - val_loss: 1.5528 - val_acc: 0.8837
Epoch 153/200
389/390 [============================>.] - ETA: 0s - loss: 1.4892 - acc: 0.9593Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4893 - acc: 0.9592 - val_loss: 1.5514 - val_acc: 0.8833
Epoch 154/200
389/390 [============================>.] - ETA: 0s - loss: 1.4893 - acc: 0.9585Epoch 1/200
390/390 [==============================] - 61s 158ms/step - loss: 1.4893 - acc: 0.9586 - val_loss: 1.5461 - val_acc: 0.8896
Epoch 155/200
389/390 [============================>.] - ETA: 0s - loss: 1.4895 - acc: 0.9601Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4896 - acc: 0.9601 - val_loss: 1.5421 - val_acc: 0.8944
Epoch 156/200
389/390 [============================>.] - ETA: 0s - loss: 1.4881 - acc: 0.9606Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4881 - acc: 0.9606 - val_loss: 1.5711 - val_acc: 0.8623
Epoch 157/200
389/390 [============================>.] - ETA: 0s - loss: 1.4874 - acc: 0.9632Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4874 - acc: 0.9632 - val_loss: 1.5468 - val_acc: 0.8916
Epoch 158/200
389/390 [============================>.] - ETA: 0s - loss: 1.4874 - acc: 0.9634Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4873 - acc: 0.9635 - val_loss: 1.5427 - val_acc: 0.8959
Epoch 159/200
389/390 [============================>.] - ETA: 0s - loss: 1.4880 - acc: 0.9618Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4880 - acc: 0.9618 - val_loss: 1.5428 - val_acc: 0.8920
Epoch 160/200
389/390 [============================>.] - ETA: 0s - loss: 1.4878 - acc: 0.9620Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4878 - acc: 0.9620 - val_loss: 1.5451 - val_acc: 0.8910
Epoch 161/200
389/390 [============================>.] - ETA: 0s - loss: 1.4880 - acc: 0.9609Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4881 - acc: 0.9609 - val_loss: 1.5560 - val_acc: 0.8792
Epoch 162/200
389/390 [============================>.] - ETA: 0s - loss: 1.4879 - acc: 0.9622Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4879 - acc: 0.9621 - val_loss: 1.5490 - val_acc: 0.8838
Epoch 163/200
389/390 [============================>.] - ETA: 0s - loss: 1.4868 - acc: 0.9622Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4869 - acc: 0.9621 - val_loss: 1.5501 - val_acc: 0.8852
Epoch 164/200
389/390 [============================>.] - ETA: 0s - loss: 1.4864 - acc: 0.9648Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4863 - acc: 0.9649 - val_loss: 1.5435 - val_acc: 0.8930
Epoch 165/200
389/390 [============================>.] - ETA: 0s - loss: 1.4881 - acc: 0.9613Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4881 - acc: 0.9613 - val_loss: 1.5461 - val_acc: 0.8903
Epoch 166/200
389/390 [============================>.] - ETA: 0s - loss: 1.4885 - acc: 0.9610Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4885 - acc: 0.9610 - val_loss: 1.5418 - val_acc: 0.8926
Epoch 167/200
389/390 [============================>.] - ETA: 0s - loss: 1.4869 - acc: 0.9644Epoch 1/200
390/390 [==============================] - 61s 158ms/step - loss: 1.4868 - acc: 0.9644 - val_loss: 1.5514 - val_acc: 0.8812
Epoch 168/200
389/390 [============================>.] - ETA: 0s - loss: 1.4875 - acc: 0.9632Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4875 - acc: 0.9631 - val_loss: 1.5535 - val_acc: 0.8760
Epoch 169/200
389/390 [============================>.] - ETA: 0s - loss: 1.4853 - acc: 0.9655Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4852 - acc: 0.9655 - val_loss: 1.5386 - val_acc: 0.9013
Epoch 170/200
389/390 [============================>.] - ETA: 0s - loss: 1.4850 - acc: 0.9664Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4850 - acc: 0.9665 - val_loss: 1.5566 - val_acc: 0.8818
Epoch 171/200
389/390 [============================>.] - ETA: 0s - loss: 1.4865 - acc: 0.9645Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4866 - acc: 0.9645 - val_loss: 1.5404 - val_acc: 0.8978

Epoch 172/200
389/390 [============================>.] - ETA: 0s - loss: 1.4871 - acc: 0.9635Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4872 - acc: 0.9633 - val_loss: 1.5441 - val_acc: 0.8929
Epoch 173/200
389/390 [============================>.] - ETA: 0s - loss: 1.4873 - acc: 0.9627Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4873 - acc: 0.9627 - val_loss: 1.5508 - val_acc: 0.8867
Epoch 174/200
389/390 [============================>.] - ETA: 0s - loss: 1.4861 - acc: 0.9649Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4861 - acc: 0.9650 - val_loss: 1.5448 - val_acc: 0.8968
Epoch 175/200
389/390 [============================>.] - ETA: 0s - loss: 1.4849 - acc: 0.9664Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4849 - acc: 0.9665 - val_loss: 1.5532 - val_acc: 0.8817
Epoch 176/200
389/390 [============================>.] - ETA: 0s - loss: 1.4857 - acc: 0.9637Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4856 - acc: 0.9637 - val_loss: 1.5459 - val_acc: 0.8908
Epoch 177/200
389/390 [============================>.] - ETA: 0s - loss: 1.4845 - acc: 0.9664Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4844 - acc: 0.9664 - val_loss: 1.5443 - val_acc: 0.8938
Epoch 178/200
389/390 [============================>.] - ETA: 0s - loss: 1.4849 - acc: 0.9664Epoch 1/200
390/390 [==============================] - 62s 158ms/step - loss: 1.4848 - acc: 0.9665 - val_loss: 1.5413 - val_acc: 0.8928
Epoch 179/200
389/390 [============================>.] - ETA: 0s - loss: 1.4838 - acc: 0.9672Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4838 - acc: 0.9672 - val_loss: 1.5441 - val_acc: 0.8943
Epoch 180/200
389/390 [============================>.] - ETA: 0s - loss: 1.4851 - acc: 0.9671Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4850 - acc: 0.9670 - val_loss: 1.5401 - val_acc: 0.8992
Epoch 181/200
389/390 [============================>.] - ETA: 0s - loss: 1.4854 - acc: 0.9660Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4855 - acc: 0.9660 - val_loss: 1.5437 - val_acc: 0.8947
Epoch 182/200
389/390 [============================>.] - ETA: 0s - loss: 1.4854 - acc: 0.9661Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4854 - acc: 0.9661 - val_loss: 1.5472 - val_acc: 0.8912
Epoch 183/200
389/390 [============================>.] - ETA: 0s - loss: 1.4841 - acc: 0.9676Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4841 - acc: 0.9676 - val_loss: 1.5368 - val_acc: 0.9034
Epoch 184/200
389/390 [============================>.] - ETA: 0s - loss: 1.4844 - acc: 0.9677Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4844 - acc: 0.9677 - val_loss: 1.5508 - val_acc: 0.8846
Epoch 185/200
389/390 [============================>.] - ETA: 0s - loss: 1.4844 - acc: 0.9661Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4844 - acc: 0.9661 - val_loss: 1.5499 - val_acc: 0.8895
Epoch 186/200
389/390 [============================>.] - ETA: 0s - loss: 1.4849 - acc: 0.9663Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.4849 - acc: 0.9663 - val_loss: 1.5430 - val_acc: 0.8960
Epoch 187/200
389/390 [============================>.] - ETA: 0s - loss: 1.4832 - acc: 0.9680Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4832 - acc: 0.9680 - val_loss: 1.5521 - val_acc: 0.8888
Epoch 188/200
389/390 [============================>.] - ETA: 0s - loss: 1.4838 - acc: 0.9689Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4837 - acc: 0.9689 - val_loss: 1.5443 - val_acc: 0.8926
Epoch 189/200
389/390 [============================>.] - ETA: 0s - loss: 1.4823 - acc: 0.9699Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4823 - acc: 0.9699 - val_loss: 1.5519 - val_acc: 0.8858
Epoch 190/200
389/390 [============================>.] - ETA: 0s - loss: 1.4830 - acc: 0.9691Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4830 - acc: 0.9691 - val_loss: 1.5493 - val_acc: 0.8846
Epoch 191/200
389/390 [============================>.] - ETA: 0s - loss: 1.4839 - acc: 0.9683Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4839 - acc: 0.9683 - val_loss: 1.5430 - val_acc: 0.8982
Epoch 192/200
389/390 [============================>.] - ETA: 0s - loss: 1.4834 - acc: 0.9689Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4834 - acc: 0.9689 - val_loss: 1.5442 - val_acc: 0.8963
Epoch 193/200
389/390 [============================>.] - ETA: 0s - loss: 1.4841 - acc: 0.9673Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4841 - acc: 0.9673 - val_loss: 1.5450 - val_acc: 0.8929
Epoch 194/200
389/390 [============================>.] - ETA: 0s - loss: 1.4823 - acc: 0.9703Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4823 - acc: 0.9703 - val_loss: 1.5447 - val_acc: 0.8914
Epoch 195/200
389/390 [============================>.] - ETA: 0s - loss: 1.4838 - acc: 0.9676Epoch 1/200
390/390 [==============================] - 62s 159ms/step - loss: 1.4838 - acc: 0.9676 - val_loss: 1.5498 - val_acc: 0.8824
Epoch 196/200
389/390 [============================>.] - ETA: 0s - loss: 1.4813 - acc: 0.9705Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4813 - acc: 0.9705 - val_loss: 1.5456 - val_acc: 0.8893
Epoch 197/200
389/390 [============================>.] - ETA: 0s - loss: 1.4817 - acc: 0.9706Epoch 1/200
390/390 [==============================] - 62s 160ms/step - loss: 1.4817 - acc: 0.9706 - val_loss: 1.5385 - val_acc: 0.9024
Epoch 198/200
389/390 [============================>.] - ETA: 0s - loss: 1.4826 - acc: 0.9703Epoch 1/200
390/390 [==============================] - 63s 161ms/step - loss: 1.4826 - acc: 0.9703 - val_loss: 1.5406 - val_acc: 0.8969
Epoch 199/200
389/390 [============================>.] - ETA: 0s - loss: 1.4831 - acc: 0.9686Epoch 1/200

390/390 [==============================] - 63s 161ms/step - loss: 1.4831 - acc: 0.9686 - val_loss: 1.5337 - val_acc: 0.9045
Epoch 200/200
389/390 [============================>.] - ETA: 0s - loss: 1.4809 - acc: 0.9729Epoch 1/200
390/390 [==============================] - 63s 160ms/step - loss: 1.4810 - acc: 0.9728 - val_loss: 1.5400 - val_acc: 0.9010

In [0]:

```
# We save the model

model.save('model_dense')
```

In [28]:

```
import matplotlib.pyplot as plt

score = model.evaluate(x= X_test, y= Y_test)
print('Test Loss:', score[0])
print()
print('Test Accuracy:', score[1])

def plt_dynamic(x, val_y, test_y, ax, color='b'):
  ax.plot(x, val_y, 'b', label = 'Validation_loss')
  ax.plot(x, test_y, 'r', label = 'Test_loss')
  plt.grid()
  plt.legend()
  fig.canvas.draw()

fig, ax = plt.subplots(1, 1, figsize = (12, 8))
ax.set_xlabel('Epoch')
ax.set_ylabel('Categorical Cross Entropy')
plt.title('Our Own Dense Network')

x = list(range(1, 201))
val_y = history.history['val_loss']
test_y = history.history['loss']

plt_dynamic(x, val_y, test_y, ax)
```

10000/10000 [==============================] - 5s 500us/sample - loss: 1.5389 - acc: 0.9023
Test Loss: 1.5389170993804933

Test Accuracy: 0.9023