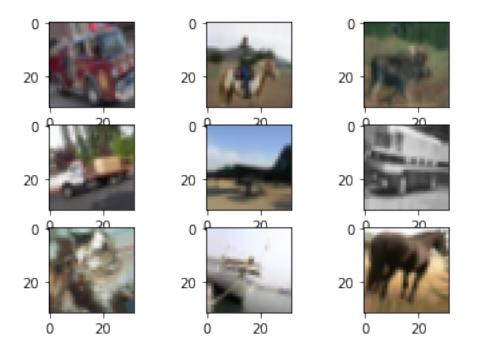# prabhudayala@gmail.com_DenseNet - cifar10

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```python
[1]: import keras
     # from keras.datasets import cifar10
     # from keras.models import Model, Sequential
     # from keras.layers import Dense, Dropout, Flatten, Input, AveragePooling2D,␣
      ↪merge, Activation
     # from keras.layers import Conv2D, MaxPooling2D, BatchNormalization
     # from keras.layers import Concatenate
     # from keras.optimizers import Adam
     from tensorflow.keras import models, layers
     from tensorflow.keras.models import Model
     from tensorflow.keras.layers import BatchNormalization, Activation, Flatten,␣
      ↪SeparableConv2D, Reshape
     from tensorflow.keras.optimizers import Adam, Adadelta
     from keras.preprocessing.image import ImageDataGenerator
     import numpy as np
     import matplotlib.pyplot as plt
     from keras import regularizers
```

Using TensorFlow backend.

```python
[2]: # this part will prevent tensorflow to allocate all the avaliable GPU Memory
     # backend
     import tensorflow as tf
     # from tensorflow import keras

     # from keras import backend as k

     # Don't pre-allocate memory; allocate as-needed
     # import tensorflow as tf
     #tf.config.gpu.set_per_process_memory_fraction(0.75)
     #tf.config.gpu.set_per_process_memory_growth(True)
     # config = tf.ConfigProto()
     # config.gpu_options.allow_growth = True

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

```
gpu_options = tf.GPUOptions(per_process_gpu_memory_fraction=0.5)
sess = tf.Session(config=tf.ConfigProto(gpu_options=gpu_options))
```

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

```
[4]: # Load CIFAR10 Data
(X_train, y_train), (X_test, y_test) = 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 = keras.utils.to_categorical(y_train, num_classes)
y_test = keras.utils.to_categorical(y_test, num_classes)
```

```
[5]: X_train.shape
```

```
[5]: (50000, 32, 32, 3)
```

```
[6]: X_test.shape
```

```
[6]: (10000, 32, 32, 3)
```

```
[7]: y_test.shape
```

```
[7]: (10000, 10)
```

```
[8]: datagen = ImageDataGenerator(
    rotation_range=15,
    horizontal_flip=True,
    width_shift_range=0.1,
    height_shift_range=0.1
    #zoom_range=0.3
    )
datagen.fit(X_train)
```

```
[9]: for X_batch, y_batch in datagen.flow(X_train, y_train, batch_size=9):
    for i in range(0, 9):
        plt.subplot(330 + 1 + i)
        plt.imshow(X_batch[i].astype(np.uint8))
    plt.show()
    break
```

0.0.1 Model without augmented data

```
[10]: # 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), (3,3),␣
      ↪use_bias=False ,padding='same')(relu)
              if dropout_rate>0:
                  Conv2D_3_3 = layers.Dropout(dropout_rate)(Conv2D_3_3)
              concat = layers.Concatenate(axis=-1)([temp,Conv2D_3_3])

              temp = concat

          return temp

      ## transition Blosck
      def transition(input, num_filter = 12, dropout_rate = 0.2):
          global compression
          BatchNorm = layers.BatchNormalization()(input)
          relu = layers.Activation('relu')(BatchNorm)
```

```python
        Conv2D_BottleNeck = layers.Conv2D(int(num_filter*compression), (1,1),
    ↪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.AveragePooling2D(pool_size=(2,2))(relu)
        #flat = layers.Flatten()(AvgPooling)
        #print(flat.shape)
        output = layers.Conv2D(10,2,activation='softmax')(AvgPooling)
        #print(output.shape)
        output = Reshape((10,))(output)
        #print(output.shape)
        #model.add(Reshape((-1, 2, 2)))
        #output = layers.Dense(num_classes, activation='softmax')(flat)
        return output
```

```python
[11]: num_filter = 30
    dropout_rate = 0.2
    l = 8
    input = layers.Input(shape=(img_height, img_width, channel,))
    First_Conv2D = layers.Conv2D(num_filter, (3,3), use_bias=False
     ↪,padding='same')(input)


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

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

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

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

```
WARNING: Logging before flag parsing goes to stderr.
W1120 19:54:55.745724 13960 deprecation.py:506] From
C:\Users\user\Anaconda3\envs\tensorflow_gpu\lib\site-
packages\tensorflow\python\ops\init_ops.py:1251: calling
VarianceScaling.__init__ (from tensorflow.python.ops.init_ops) with dtype is
deprecated and will be removed in a future version.
```

```
Instructions for updating:
Call initializer instance with the dtype argument instead of passing it to the
constructor
```

[12]:
```python
#https://arxiv.org/pdf/1608.06993.pdf
from IPython.display import IFrame, YouTubeVideo
YouTubeVideo(id='-W6y8xnd--U', width=600)
```

[12]:

[13]:
```python
model = Model(inputs=[input], outputs=[output])
model.summary()
```

```
Model: "model"

_____
_____
Layer (type)                    Output Shape         Param #     Connected to
================================================================================
====================
input_1 (InputLayer)            [(None, 32, 32, 3)]  0

_____
_____
conv2d (Conv2D)                 (None, 32, 32, 30)   810         input_1[0][0]
```

```
------------------------------------------------------------------------
------------------
batch_normalization (BatchNorma (None, 32, 32, 30)    120         conv2d[0][0]
------------------------------------------------------------------------
------------------
activation (Activation)         (None, 32, 32, 30)    0
batch_normalization[0][0]
------------------------------------------------------------------------
------------------
conv2d_1 (Conv2D)               (None, 32, 32, 15)    4050
activation[0][0]
------------------------------------------------------------------------
------------------
dropout (Dropout)               (None, 32, 32, 15)    0           conv2d_1[0][0]
------------------------------------------------------------------------
------------------
concatenate (Concatenate)       (None, 32, 32, 45)    0           conv2d[0][0]
                                                                  dropout[0][0]
------------------------------------------------------------------------
------------------
batch_normalization_1 (BatchNor (None, 32, 32, 45)    180
concatenate[0][0]
------------------------------------------------------------------------
------------------
activation_1 (Activation)       (None, 32, 32, 45)    0
batch_normalization_1[0][0]
------------------------------------------------------------------------
------------------
conv2d_2 (Conv2D)               (None, 32, 32, 15)    6075
activation_1[0][0]
------------------------------------------------------------------------
------------------
dropout_1 (Dropout)             (None, 32, 32, 15)    0           conv2d_2[0][0]
------------------------------------------------------------------------
------------------
concatenate_1 (Concatenate)     (None, 32, 32, 60)    0
concatenate[0][0]
                                                                  dropout_1[0][0]
------------------------------------------------------------------------
------------------
batch_normalization_2 (BatchNor (None, 32, 32, 60)    240
concatenate_1[0][0]
------------------------------------------------------------------------
------------------
activation_2 (Activation)       (None, 32, 32, 60)    0
batch_normalization_2[0][0]
------------------------------------------------------------------------
------------------
```

```
conv2d_3 (Conv2D)              (None, 32, 32, 15)   8100
activation_2[0][0]
_____
_____
dropout_2 (Dropout)            (None, 32, 32, 15)   0          conv2d_3[0][0]
_____
_____
concatenate_2 (Concatenate)    (None, 32, 32, 75)   0
concatenate_1[0][0]

                                                              dropout_2[0][0]
_____
_____
batch_normalization_3 (BatchNor (None, 32, 32, 75)   300
concatenate_2[0][0]
_____
_____
activation_3 (Activation)      (None, 32, 32, 75)   0
batch_normalization_3[0][0]
_____
_____
conv2d_4 (Conv2D)              (None, 32, 32, 15)   10125
activation_3[0][0]
_____
_____
dropout_3 (Dropout)            (None, 32, 32, 15)   0          conv2d_4[0][0]
_____
_____
concatenate_3 (Concatenate)    (None, 32, 32, 90)   0
concatenate_2[0][0]

                                                              dropout_3[0][0]
_____
_____
batch_normalization_4 (BatchNor (None, 32, 32, 90)   360
concatenate_3[0][0]
_____
_____
activation_4 (Activation)      (None, 32, 32, 90)   0
batch_normalization_4[0][0]
_____
_____
conv2d_5 (Conv2D)              (None, 32, 32, 15)   12150
activation_4[0][0]
_____
_____
dropout_4 (Dropout)            (None, 32, 32, 15)   0          conv2d_5[0][0]
_____
_____
concatenate_4 (Concatenate)    (None, 32, 32, 105)  0
```

```
                                                                        concatenate_3[0][0]

                                                                        dropout_4[0][0]
_____
_____
batch_normalization_5 (BatchNor (None, 32, 32, 105)  420
concatenate_4[0][0]
_____
_____
activation_5 (Activation)       (None, 32, 32, 105)  0
batch_normalization_5[0][0]
_____
_____
conv2d_6 (Conv2D)               (None, 32, 32, 15)   14175
activation_5[0][0]
_____
_____
dropout_5 (Dropout)             (None, 32, 32, 15)   0            conv2d_6[0][0]
_____
_____
concatenate_5 (Concatenate)     (None, 32, 32, 120)  0
concatenate_4[0][0]

                                                                        dropout_5[0][0]
_____
_____
batch_normalization_6 (BatchNor (None, 32, 32, 120)  480
concatenate_5[0][0]
_____
_____
activation_6 (Activation)       (None, 32, 32, 120)  0
batch_normalization_6[0][0]
_____
_____
conv2d_7 (Conv2D)               (None, 32, 32, 15)   16200
activation_6[0][0]
_____
_____
dropout_6 (Dropout)             (None, 32, 32, 15)   0            conv2d_7[0][0]
_____
_____
concatenate_6 (Concatenate)     (None, 32, 32, 135)  0
concatenate_5[0][0]

                                                                        dropout_6[0][0]
_____
_____
batch_normalization_7 (BatchNor (None, 32, 32, 135)  540
concatenate_6[0][0]
_____
_____
```

8

```
activation_7 (Activation)       (None, 32, 32, 135)  0
batch_normalization_7[0][0]
_____
_____
conv2d_8 (Conv2D)               (None, 32, 32, 15)   18225
activation_7[0][0]
_____
_____
dropout_7 (Dropout)             (None, 32, 32, 15)   0          conv2d_8[0][0]
_____
_____
concatenate_7 (Concatenate)     (None, 32, 32, 150)  0
concatenate_6[0][0]

                                                                dropout_7[0][0]
_____
_____
batch_normalization_8 (BatchNor (None, 32, 32, 150)  600
concatenate_7[0][0]
_____
_____
activation_8 (Activation)       (None, 32, 32, 150)  0
batch_normalization_8[0][0]
_____
_____
conv2d_9 (Conv2D)               (None, 32, 32, 15)   2250
activation_8[0][0]
_____
_____
dropout_8 (Dropout)             (None, 32, 32, 15)   0          conv2d_9[0][0]
_____
_____
average_pooling2d (AveragePooli (None, 16, 16, 15)   0          dropout_8[0][0]
_____
_____
batch_normalization_9 (BatchNor (None, 16, 16, 15)   60
average_pooling2d[0][0]
_____
_____
activation_9 (Activation)       (None, 16, 16, 15)   0
batch_normalization_9[0][0]
_____
_____
conv2d_10 (Conv2D)              (None, 16, 16, 15)   2025
activation_9[0][0]
_____
_____
dropout_9 (Dropout)             (None, 16, 16, 15)   0          conv2d_10[0][0]
_____
```

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------------------
concatenate_8 (Concatenate)     (None, 16, 16, 30)   0
average_pooling2d[0][0]
                                                              dropout_9[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_10 (BatchNo (None, 16, 16, 30)   120
concatenate_8[0][0]
--------------------------------------------------------------------------------
------------------
activation_10 (Activation)      (None, 16, 16, 30)   0
batch_normalization_10[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_11 (Conv2D)              (None, 16, 16, 15)   4050
activation_10[0][0]
--------------------------------------------------------------------------------
------------------
dropout_10 (Dropout)            (None, 16, 16, 15)   0          conv2d_11[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_9 (Concatenate)     (None, 16, 16, 45)   0
concatenate_8[0][0]
dropout_10[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_11 (BatchNo (None, 16, 16, 45)   180
concatenate_9[0][0]
--------------------------------------------------------------------------------
------------------
activation_11 (Activation)      (None, 16, 16, 45)   0
batch_normalization_11[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_12 (Conv2D)              (None, 16, 16, 15)   6075
activation_11[0][0]
--------------------------------------------------------------------------------
------------------
dropout_11 (Dropout)            (None, 16, 16, 15)   0          conv2d_12[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_10 (Concatenate)    (None, 16, 16, 60)   0
concatenate_9[0][0]
dropout_11[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_12 (BatchNo (None, 16, 16, 60)   240
concatenate_10[0][0]
```

```
--------------------------------------------------------------------------------
------------------
activation_12 (Activation)        (None, 16, 16, 60)    0
batch_normalization_12[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_13 (Conv2D)                (None, 16, 16, 15)    8100
activation_12[0][0]
--------------------------------------------------------------------------------
------------------
dropout_12 (Dropout)              (None, 16, 16, 15)    0          conv2d_13[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_11 (Concatenate)      (None, 16, 16, 75)    0
concatenate_10[0][0]
dropout_12[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_13 (BatchNo   (None, 16, 16, 75)    300
concatenate_11[0][0]
--------------------------------------------------------------------------------
------------------
activation_13 (Activation)        (None, 16, 16, 75)    0
batch_normalization_13[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_14 (Conv2D)                (None, 16, 16, 15)    10125
activation_13[0][0]
--------------------------------------------------------------------------------
------------------
dropout_13 (Dropout)              (None, 16, 16, 15)    0          conv2d_14[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_12 (Concatenate)      (None, 16, 16, 90)    0
concatenate_11[0][0]
dropout_13[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_14 (BatchNo   (None, 16, 16, 90)    360
concatenate_12[0][0]
--------------------------------------------------------------------------------
------------------
activation_14 (Activation)        (None, 16, 16, 90)    0
batch_normalization_14[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_15 (Conv2D)                (None, 16, 16, 15)    12150
activation_14[0][0]
```

```
--------------------------------------------------------------------------------
------------------
dropout_14 (Dropout)            (None, 16, 16, 15)   0          conv2d_15[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_13 (Concatenate)    (None, 16, 16, 105)  0
concatenate_12[0][0]
dropout_14[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_15 (BatchNo (None, 16, 16, 105)  420
concatenate_13[0][0]
--------------------------------------------------------------------------------
------------------
activation_15 (Activation)      (None, 16, 16, 105)  0
batch_normalization_15[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_16 (Conv2D)              (None, 16, 16, 15)   14175
activation_15[0][0]
--------------------------------------------------------------------------------
------------------
dropout_15 (Dropout)            (None, 16, 16, 15)   0          conv2d_16[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_14 (Concatenate)    (None, 16, 16, 120)  0
concatenate_13[0][0]
dropout_15[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_16 (BatchNo (None, 16, 16, 120)  480
concatenate_14[0][0]
--------------------------------------------------------------------------------
------------------
activation_16 (Activation)      (None, 16, 16, 120)  0
batch_normalization_16[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_17 (Conv2D)              (None, 16, 16, 15)   16200
activation_16[0][0]
--------------------------------------------------------------------------------
------------------
dropout_16 (Dropout)            (None, 16, 16, 15)   0          conv2d_17[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_15 (Concatenate)    (None, 16, 16, 135)  0
concatenate_14[0][0]
dropout_16[0][0]
```

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--------------------------------------------------------------------------------
------------------
batch_normalization_17 (BatchNo  (None, 16, 16, 135)  540
concatenate_15[0][0]
--------------------------------------------------------------------------------
------------------
activation_17 (Activation)       (None, 16, 16, 135)  0
batch_normalization_17[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_18 (Conv2D)               (None, 16, 16, 15)   2025
activation_17[0][0]
--------------------------------------------------------------------------------
------------------
dropout_17 (Dropout)             (None, 16, 16, 15)   0          conv2d_18[0][0]
--------------------------------------------------------------------------------
------------------
average_pooling2d_1 (AveragePoo  (None, 8, 8, 15)     0
dropout_17[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_18 (BatchNo  (None, 8, 8, 15)     60
average_pooling2d_1[0][0]
--------------------------------------------------------------------------------
------------------
activation_18 (Activation)       (None, 8, 8, 15)     0
batch_normalization_18[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_19 (Conv2D)               (None, 8, 8, 15)     2025
activation_18[0][0]
--------------------------------------------------------------------------------
------------------
dropout_18 (Dropout)             (None, 8, 8, 15)     0          conv2d_19[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_16 (Concatenate)     (None, 8, 8, 30)     0
average_pooling2d_1[0][0]
dropout_18[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_19 (BatchNo  (None, 8, 8, 30)     120
concatenate_16[0][0]
--------------------------------------------------------------------------------
------------------
activation_19 (Activation)       (None, 8, 8, 30)     0
batch_normalization_19[0][0]
--------------------------------------------------------------------------------
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```
------------------
conv2d_20 (Conv2D)              (None, 8, 8, 15)     4050
activation_19[0][0]
--------------------------------------------------------------------------------
------------------
dropout_19 (Dropout)            (None, 8, 8, 15)     0           conv2d_20[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_17 (Concatenate)    (None, 8, 8, 45)     0
concatenate_16[0][0]
dropout_19[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_20 (BatchNo (None, 8, 8, 45)     180
concatenate_17[0][0]
--------------------------------------------------------------------------------
------------------
activation_20 (Activation)      (None, 8, 8, 45)     0
batch_normalization_20[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_21 (Conv2D)              (None, 8, 8, 15)     6075
activation_20[0][0]
--------------------------------------------------------------------------------
------------------
dropout_20 (Dropout)            (None, 8, 8, 15)     0           conv2d_21[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_18 (Concatenate)    (None, 8, 8, 60)     0
concatenate_17[0][0]
dropout_20[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_21 (BatchNo (None, 8, 8, 60)     240
concatenate_18[0][0]
--------------------------------------------------------------------------------
------------------
activation_21 (Activation)      (None, 8, 8, 60)     0
batch_normalization_21[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_22 (Conv2D)              (None, 8, 8, 15)     8100
activation_21[0][0]
--------------------------------------------------------------------------------
------------------
dropout_21 (Dropout)            (None, 8, 8, 15)     0           conv2d_22[0][0]
--------------------------------------------------------------------------------
------------------
```

```
concatenate_19 (Concatenate)    (None, 8, 8, 75)      0
concatenate_18[0][0]
dropout_21[0][0]
_____
_____
batch_normalization_22 (BatchNo (None, 8, 8, 75)      300
concatenate_19[0][0]
_____
_____
activation_22 (Activation)      (None, 8, 8, 75)      0
batch_normalization_22[0][0]
_____
_____
conv2d_23 (Conv2D)              (None, 8, 8, 15)      10125
activation_22[0][0]
_____
_____
dropout_22 (Dropout)            (None, 8, 8, 15)      0          conv2d_23[0][0]
_____
_____
concatenate_20 (Concatenate)    (None, 8, 8, 90)      0
concatenate_19[0][0]
dropout_22[0][0]
_____
_____
batch_normalization_23 (BatchNo (None, 8, 8, 90)      360
concatenate_20[0][0]
_____
_____
activation_23 (Activation)      (None, 8, 8, 90)      0
batch_normalization_23[0][0]
_____
_____
conv2d_24 (Conv2D)              (None, 8, 8, 15)      12150
activation_23[0][0]
_____
_____
dropout_23 (Dropout)            (None, 8, 8, 15)      0          conv2d_24[0][0]
_____
_____
concatenate_21 (Concatenate)    (None, 8, 8, 105)     0
concatenate_20[0][0]
dropout_23[0][0]
_____
_____
batch_normalization_24 (BatchNo (None, 8, 8, 105)     420
concatenate_21[0][0]
_____
_____
```

```
-----------------
activation_24 (Activation)       (None, 8, 8, 105)    0
batch_normalization_24[0][0]
_____
-----------------
conv2d_25 (Conv2D)               (None, 8, 8, 15)      14175
activation_24[0][0]
_____
-----------------
dropout_24 (Dropout)             (None, 8, 8, 15)      0           conv2d_25[0][0]
_____
-----------------
concatenate_22 (Concatenate)     (None, 8, 8, 120)     0
concatenate_21[0][0]
dropout_24[0][0]
_____
-----------------
batch_normalization_25 (BatchNo  (None, 8, 8, 120)     480
concatenate_22[0][0]
_____
-----------------
activation_25 (Activation)       (None, 8, 8, 120)     0
batch_normalization_25[0][0]
_____
-----------------
conv2d_26 (Conv2D)               (None, 8, 8, 15)      16200
activation_25[0][0]
_____
-----------------
dropout_25 (Dropout)             (None, 8, 8, 15)      0           conv2d_26[0][0]
_____
-----------------
concatenate_23 (Concatenate)     (None, 8, 8, 135)     0
concatenate_22[0][0]
dropout_25[0][0]
_____
-----------------
batch_normalization_26 (BatchNo  (None, 8, 8, 135)     540
concatenate_23[0][0]
_____
-----------------
activation_26 (Activation)       (None, 8, 8, 135)     0
batch_normalization_26[0][0]
_____
-----------------
conv2d_27 (Conv2D)               (None, 8, 8, 15)      2025
activation_26[0][0]
_____
```

```
--------------------
dropout_26 (Dropout)            (None, 8, 8, 15)     0           conv2d_27[0][0]
_____
average_pooling2d_2 (AveragePoo (None, 4, 4, 15)     0
dropout_26[0][0]
_____
batch_normalization_27 (BatchNo (None, 4, 4, 15)     60
average_pooling2d_2[0][0]
_____
activation_27 (Activation)      (None, 4, 4, 15)     0
batch_normalization_27[0][0]
_____
conv2d_28 (Conv2D)              (None, 4, 4, 15)     2025
activation_27[0][0]
_____
dropout_27 (Dropout)            (None, 4, 4, 15)     0           conv2d_28[0][0]
_____
concatenate_24 (Concatenate)    (None, 4, 4, 30)     0
average_pooling2d_2[0][0]
dropout_27[0][0]
_____
batch_normalization_28 (BatchNo (None, 4, 4, 30)     120
concatenate_24[0][0]
_____
activation_28 (Activation)      (None, 4, 4, 30)     0
batch_normalization_28[0][0]
_____
conv2d_29 (Conv2D)              (None, 4, 4, 15)     4050
activation_28[0][0]
_____
dropout_28 (Dropout)            (None, 4, 4, 15)     0           conv2d_29[0][0]
_____
concatenate_25 (Concatenate)    (None, 4, 4, 45)     0
concatenate_24[0][0]
dropout_28[0][0]
_____
```

```
batch_normalization_29 (BatchNo (None, 4, 4, 45)    180
concatenate_25[0][0]
_____
_____
activation_29 (Activation)     (None, 4, 4, 45)    0
batch_normalization_29[0][0]
_____
_____
conv2d_30 (Conv2D)             (None, 4, 4, 15)    6075
activation_29[0][0]
_____
_____
dropout_29 (Dropout)           (None, 4, 4, 15)    0          conv2d_30[0][0]
_____
_____
concatenate_26 (Concatenate)   (None, 4, 4, 60)    0
concatenate_25[0][0]
dropout_29[0][0]
_____
_____
batch_normalization_30 (BatchNo (None, 4, 4, 60)    240
concatenate_26[0][0]
_____
_____
activation_30 (Activation)     (None, 4, 4, 60)    0
batch_normalization_30[0][0]
_____
_____
conv2d_31 (Conv2D)             (None, 4, 4, 15)    8100
activation_30[0][0]
_____
_____
dropout_30 (Dropout)           (None, 4, 4, 15)    0          conv2d_31[0][0]
_____
_____
concatenate_27 (Concatenate)   (None, 4, 4, 75)    0
concatenate_26[0][0]
dropout_30[0][0]
_____
_____
batch_normalization_31 (BatchNo (None, 4, 4, 75)    300
concatenate_27[0][0]
_____
_____
activation_31 (Activation)     (None, 4, 4, 75)    0
batch_normalization_31[0][0]
_____
_____
```

```
conv2d_32 (Conv2D)              (None, 4, 4, 15)     10125
activation_31[0][0]
_____
_____
dropout_31 (Dropout)            (None, 4, 4, 15)     0           conv2d_32[0][0]
_____
_____
concatenate_28 (Concatenate)    (None, 4, 4, 90)     0
concatenate_27[0][0]
dropout_31[0][0]
_____
_____
batch_normalization_32 (BatchNo (None, 4, 4, 90)     360
concatenate_28[0][0]
_____
_____
activation_32 (Activation)      (None, 4, 4, 90)     0
batch_normalization_32[0][0]
_____
_____
conv2d_33 (Conv2D)              (None, 4, 4, 15)     12150
activation_32[0][0]
_____
_____
dropout_32 (Dropout)            (None, 4, 4, 15)     0           conv2d_33[0][0]
_____
_____
concatenate_29 (Concatenate)    (None, 4, 4, 105)    0
concatenate_28[0][0]
dropout_32[0][0]
_____
_____
batch_normalization_33 (BatchNo (None, 4, 4, 105)    420
concatenate_29[0][0]
_____
_____
activation_33 (Activation)      (None, 4, 4, 105)    0
batch_normalization_33[0][0]
_____
_____
conv2d_34 (Conv2D)              (None, 4, 4, 15)     14175
activation_33[0][0]
_____
_____
dropout_33 (Dropout)            (None, 4, 4, 15)     0           conv2d_34[0][0]
_____
_____
concatenate_30 (Concatenate)    (None, 4, 4, 120)    0
```

```
                                        concatenate_29[0][0]
                                        dropout_33[0][0]
_____
_____
batch_normalization_34 (BatchNo (None, 4, 4, 120)    480
                                        concatenate_30[0][0]
_____
_____
activation_34 (Activation)      (None, 4, 4, 120)    0
                                        batch_normalization_34[0][0]
_____
_____
conv2d_35 (Conv2D)              (None, 4, 4, 15)     16200
                                        activation_34[0][0]
_____
_____
dropout_34 (Dropout)            (None, 4, 4, 15)     0          conv2d_35[0][0]
_____
_____
concatenate_31 (Concatenate)    (None, 4, 4, 135)    0
                                        concatenate_30[0][0]
                                        dropout_34[0][0]
_____
_____
batch_normalization_35 (BatchNo (None, 4, 4, 135)    540
                                        concatenate_31[0][0]
_____
_____
activation_35 (Activation)      (None, 4, 4, 135)    0
                                        batch_normalization_35[0][0]
_____
_____
average_pooling2d_3 (AveragePoo (None, 2, 2, 135)    0
                                        activation_35[0][0]
_____
_____
conv2d_36 (Conv2D)              (None, 1, 1, 10)     5410
                                        average_pooling2d_3[0][0]
_____
_____
reshape (Reshape)               (None, 10)           0          conv2d_36[0][0]
================================================================================
==================
Total params: 331,660
Trainable params: 325,990
Non-trainable params: 5,670
_____
_____
```

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

[15]: model.fit(X_train, y_train,
                batch_size=batch_size,
                epochs=epochs,
                verbose=1,
                validation_data=(X_test, y_test))
```

```
Train on 50000 samples, validate on 10000 samples

W1120 19:55:00.599825 13960 deprecation.py:323] From
C:\Users\user\Anaconda3\envs\tensorflow_gpu\lib\site-
packages\tensorflow\python\ops\math_grad.py:1250:
add_dispatch_support.<locals>.wrapper (from tensorflow.python.ops.array_ops) is
deprecated and will be removed in a future version.
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where

Epoch 1/10
50000/50000 [==============================] - 41s 823us/sample - loss: 1.5205 -
acc: 0.4386 - val_loss: 1.3896 - val_acc: 0.4965
Epoch 2/10
50000/50000 [==============================] - 36s 717us/sample - loss: 1.0982 -
acc: 0.6048 - val_loss: 1.1493 - val_acc: 0.6072
Epoch 3/10
50000/50000 [==============================] - 36s 717us/sample - loss: 0.9201 -
acc: 0.6736 - val_loss: 1.3172 - val_acc: 0.5754
Epoch 4/10
50000/50000 [==============================] - 36s 718us/sample - loss: 0.8156 -
acc: 0.7097 - val_loss: 0.9007 - val_acc: 0.7041
Epoch 5/10
50000/50000 [==============================] - 36s 718us/sample - loss: 0.7434 -
acc: 0.7369 - val_loss: 0.7686 - val_acc: 0.7362
Epoch 6/10
50000/50000 [==============================] - 36s 719us/sample - loss: 0.6893 -
acc: 0.7572 - val_loss: 1.3850 - val_acc: 0.6102
Epoch 7/10
50000/50000 [==============================] - 36s 721us/sample - loss: 0.6432 -
acc: 0.7747 - val_loss: 0.7889 - val_acc: 0.7493
Epoch 8/10
50000/50000 [==============================] - 36s 720us/sample - loss: 0.6053 -
acc: 0.7868 - val_loss: 0.7597 - val_acc: 0.7591
Epoch 9/10
50000/50000 [==============================] - 36s 720us/sample - loss: 0.5751 -
acc: 0.7984 - val_loss: 0.8693 - val_acc: 0.7273
```

```
Epoch 10/10
50000/50000 [==============================] - 36s 726us/sample - loss: 0.5535 -
acc: 0.8058 - val_loss: 0.8518 - val_acc: 0.7311
```

[15]: `<tensorflow.python.keras.callbacks.History at 0x186e83cfd68>`

[16]:
```python
# Test the model
score = model.evaluate(X_test, y_test, verbose=1)
print('Test loss:', score[0])
print('Test accuracy:', score[1])
```

```
10000/10000 [==============================] - 3s 259us/sample - loss: 0.8518 -
acc: 0.7311
Test loss: 0.8518377923488617
Test accuracy: 0.7311
```

[17]:
```python
# Save the trained weights in to .h5 format
model.save_weights("DNST_model.h5")
print("Saved model to disk")
```

```
Saved model to disk
```

0.0.2 Model with augmented data

[18]:
```python
num_filter = 30
dropout_rate = 0.2
l = 8
input = layers.Input(shape=(img_height, img_width, channel,))
First_Conv2D = layers.Conv2D(num_filter, (3,3), use_bias=False
 ↪,padding='same')(input)

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

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

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

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

[19]:
```python
model1 = Model(inputs=[input], outputs=[output])
model1.summary()
```

```
Model: "model_1"
_____
```

```
--------------------
Layer (type)                   Output Shape         Param #     Connected to
================================================================================
==================
input_2 (InputLayer)           [(None, 32, 32, 3)]  0
--------------------------------------------------------------------------------
--------------------
conv2d_37 (Conv2D)             (None, 32, 32, 30)   810         input_2[0][0]
--------------------------------------------------------------------------------
--------------------
batch_normalization_36 (BatchNo (None, 32, 32, 30)  120         conv2d_37[0][0]
--------------------------------------------------------------------------------
--------------------
activation_36 (Activation)     (None, 32, 32, 30)   0
batch_normalization_36[0][0]
--------------------------------------------------------------------------------
--------------------
conv2d_38 (Conv2D)             (None, 32, 32, 15)   4050
activation_36[0][0]
--------------------------------------------------------------------------------
--------------------
dropout_35 (Dropout)           (None, 32, 32, 15)   0           conv2d_38[0][0]
--------------------------------------------------------------------------------
--------------------
concatenate_32 (Concatenate)   (None, 32, 32, 45)   0           conv2d_37[0][0]
dropout_35[0][0]
--------------------------------------------------------------------------------
--------------------
batch_normalization_37 (BatchNo (None, 32, 32, 45)  180
concatenate_32[0][0]
--------------------------------------------------------------------------------
--------------------
activation_37 (Activation)     (None, 32, 32, 45)   0
batch_normalization_37[0][0]
--------------------------------------------------------------------------------
--------------------
conv2d_39 (Conv2D)             (None, 32, 32, 15)   6075
activation_37[0][0]
--------------------------------------------------------------------------------
--------------------
dropout_36 (Dropout)           (None, 32, 32, 15)   0           conv2d_39[0][0]
--------------------------------------------------------------------------------
--------------------
concatenate_33 (Concatenate)   (None, 32, 32, 60)   0
concatenate_32[0][0]
dropout_36[0][0]
--------------------------------------------------------------------------------
--------------------
```

```
batch_normalization_38 (BatchNo (None, 32, 32, 60)   240
concatenate_33[0][0]
_____
_____
activation_38 (Activation)      (None, 32, 32, 60)   0
batch_normalization_38[0][0]
_____
_____
conv2d_40 (Conv2D)              (None, 32, 32, 15)   8100
activation_38[0][0]
_____
_____
dropout_37 (Dropout)            (None, 32, 32, 15)   0           conv2d_40[0][0]
_____
_____
concatenate_34 (Concatenate)    (None, 32, 32, 75)   0
concatenate_33[0][0]
dropout_37[0][0]
_____
_____
batch_normalization_39 (BatchNo (None, 32, 32, 75)   300
concatenate_34[0][0]
_____
_____
activation_39 (Activation)      (None, 32, 32, 75)   0
batch_normalization_39[0][0]
_____
_____
conv2d_41 (Conv2D)              (None, 32, 32, 15)   10125
activation_39[0][0]
_____
_____
dropout_38 (Dropout)            (None, 32, 32, 15)   0           conv2d_41[0][0]
_____
_____
concatenate_35 (Concatenate)    (None, 32, 32, 90)   0
concatenate_34[0][0]
dropout_38[0][0]
_____
_____
batch_normalization_40 (BatchNo (None, 32, 32, 90)   360
concatenate_35[0][0]
_____
_____
activation_40 (Activation)      (None, 32, 32, 90)   0
batch_normalization_40[0][0]
_____
_____
```

```
conv2d_42 (Conv2D)              (None, 32, 32, 15)   12150
activation_40[0][0]
_____
_____
dropout_39 (Dropout)            (None, 32, 32, 15)   0           conv2d_42[0][0]
_____
_____
concatenate_36 (Concatenate)    (None, 32, 32, 105)  0
concatenate_35[0][0]
dropout_39[0][0]
_____
_____
batch_normalization_41 (BatchNo (None, 32, 32, 105)  420
concatenate_36[0][0]
_____
_____
activation_41 (Activation)      (None, 32, 32, 105)  0
batch_normalization_41[0][0]
_____
_____
conv2d_43 (Conv2D)              (None, 32, 32, 15)   14175
activation_41[0][0]
_____
_____
dropout_40 (Dropout)            (None, 32, 32, 15)   0           conv2d_43[0][0]
_____
_____
concatenate_37 (Concatenate)    (None, 32, 32, 120)  0
concatenate_36[0][0]
dropout_40[0][0]
_____
_____
batch_normalization_42 (BatchNo (None, 32, 32, 120)  480
concatenate_37[0][0]
_____
_____
activation_42 (Activation)      (None, 32, 32, 120)  0
batch_normalization_42[0][0]
_____
_____
conv2d_44 (Conv2D)              (None, 32, 32, 15)   16200
activation_42[0][0]
_____
_____
dropout_41 (Dropout)            (None, 32, 32, 15)   0           conv2d_44[0][0]
_____
_____
concatenate_38 (Concatenate)    (None, 32, 32, 135)  0
```

```
                                            concatenate_37[0][0]
                                            dropout_41[0][0]
_____
_____
batch_normalization_43 (BatchNo (None, 32, 32, 135)  540
                                            concatenate_38[0][0]
_____
_____
activation_43 (Activation)      (None, 32, 32, 135)  0
                                            batch_normalization_43[0][0]
_____
_____
conv2d_45 (Conv2D)              (None, 32, 32, 15)   18225
                                            activation_43[0][0]
_____
_____
dropout_42 (Dropout)            (None, 32, 32, 15)   0           conv2d_45[0][0]
_____
_____
concatenate_39 (Concatenate)    (None, 32, 32, 150)  0
                                            concatenate_38[0][0]
                                            dropout_42[0][0]
_____
_____
batch_normalization_44 (BatchNo (None, 32, 32, 150)  600
                                            concatenate_39[0][0]
_____
_____
activation_44 (Activation)      (None, 32, 32, 150)  0
                                            batch_normalization_44[0][0]
_____
_____
conv2d_46 (Conv2D)              (None, 32, 32, 15)   2250
                                            activation_44[0][0]
_____
_____
dropout_43 (Dropout)            (None, 32, 32, 15)   0           conv2d_46[0][0]
_____
_____
average_pooling2d_4 (AveragePoo (None, 16, 16, 15)   0
                                            dropout_43[0][0]
_____
_____
batch_normalization_45 (BatchNo (None, 16, 16, 15)   60
                                            average_pooling2d_4[0][0]
_____
_____
activation_45 (Activation)      (None, 16, 16, 15)   0
```

```
batch_normalization_45[0][0]
_____
_____
conv2d_47 (Conv2D)              (None, 16, 16, 15)   2025
activation_45[0][0]
_____
_____
dropout_44 (Dropout)            (None, 16, 16, 15)   0           conv2d_47[0][0]
_____
_____
concatenate_40 (Concatenate)    (None, 16, 16, 30)   0
average_pooling2d_4[0][0]
dropout_44[0][0]
_____
_____
batch_normalization_46 (BatchNo (None, 16, 16, 30)   120
concatenate_40[0][0]
_____
_____
activation_46 (Activation)      (None, 16, 16, 30)   0
batch_normalization_46[0][0]
_____
_____
conv2d_48 (Conv2D)              (None, 16, 16, 15)   4050
activation_46[0][0]
_____
_____
dropout_45 (Dropout)            (None, 16, 16, 15)   0           conv2d_48[0][0]
_____
_____
concatenate_41 (Concatenate)    (None, 16, 16, 45)   0
concatenate_40[0][0]
dropout_45[0][0]
_____
_____
batch_normalization_47 (BatchNo (None, 16, 16, 45)   180
concatenate_41[0][0]
_____
_____
activation_47 (Activation)      (None, 16, 16, 45)   0
batch_normalization_47[0][0]
_____
_____
conv2d_49 (Conv2D)              (None, 16, 16, 15)   6075
activation_47[0][0]
_____
_____
dropout_46 (Dropout)            (None, 16, 16, 15)   0           conv2d_49[0][0]
```

```
--------------------------------------------------------------------------------
------------------
concatenate_42 (Concatenate)      (None, 16, 16, 60)   0
concatenate_41[0][0]
dropout_46[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_48 (BatchNo (None, 16, 16, 60)   240
concatenate_42[0][0]
--------------------------------------------------------------------------------
------------------
activation_48 (Activation)        (None, 16, 16, 60)   0
batch_normalization_48[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_50 (Conv2D)                (None, 16, 16, 15)   8100
activation_48[0][0]
--------------------------------------------------------------------------------
------------------
dropout_47 (Dropout)              (None, 16, 16, 15)   0           conv2d_50[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_43 (Concatenate)      (None, 16, 16, 75)   0
concatenate_42[0][0]
dropout_47[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_49 (BatchNo (None, 16, 16, 75)   300
concatenate_43[0][0]
--------------------------------------------------------------------------------
------------------
activation_49 (Activation)        (None, 16, 16, 75)   0
batch_normalization_49[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_51 (Conv2D)                (None, 16, 16, 15)   10125
activation_49[0][0]
--------------------------------------------------------------------------------
------------------
dropout_48 (Dropout)              (None, 16, 16, 15)   0           conv2d_51[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_44 (Concatenate)      (None, 16, 16, 90)   0
concatenate_43[0][0]
dropout_48[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_50 (BatchNo (None, 16, 16, 90)   360
```

```
concatenate_44[0][0]
_____
_____
activation_50 (Activation)      (None, 16, 16, 90)    0
batch_normalization_50[0][0]
_____
_____
conv2d_52 (Conv2D)              (None, 16, 16, 15)    12150
activation_50[0][0]
_____
_____
dropout_49 (Dropout)            (None, 16, 16, 15)    0         conv2d_52[0][0]
_____
_____
concatenate_45 (Concatenate)    (None, 16, 16, 105)   0
concatenate_44[0][0]
dropout_49[0][0]
_____
_____
batch_normalization_51 (BatchNo (None, 16, 16, 105)   420
concatenate_45[0][0]
_____
_____
activation_51 (Activation)      (None, 16, 16, 105)   0
batch_normalization_51[0][0]
_____
_____
conv2d_53 (Conv2D)              (None, 16, 16, 15)    14175
activation_51[0][0]
_____
_____
dropout_50 (Dropout)            (None, 16, 16, 15)    0         conv2d_53[0][0]
_____
_____
concatenate_46 (Concatenate)    (None, 16, 16, 120)   0
concatenate_45[0][0]
dropout_50[0][0]
_____
_____
batch_normalization_52 (BatchNo (None, 16, 16, 120)   480
concatenate_46[0][0]
_____
_____
activation_52 (Activation)      (None, 16, 16, 120)   0
batch_normalization_52[0][0]
_____
_____
conv2d_54 (Conv2D)              (None, 16, 16, 15)    16200
```

```
                                         activation_52[0][0]
_____
_____
dropout_51 (Dropout)            (None, 16, 16, 15)   0        conv2d_54[0][0]
_____
_____
concatenate_47 (Concatenate)    (None, 16, 16, 135)  0
concatenate_46[0][0]
dropout_51[0][0]
_____
_____
batch_normalization_53 (BatchNo (None, 16, 16, 135)  540
concatenate_47[0][0]
_____
_____
activation_53 (Activation)      (None, 16, 16, 135)  0
batch_normalization_53[0][0]
_____
_____
conv2d_55 (Conv2D)              (None, 16, 16, 15)   2025
activation_53[0][0]
_____
_____
dropout_52 (Dropout)            (None, 16, 16, 15)   0        conv2d_55[0][0]
_____
_____
average_pooling2d_5 (AveragePoo (None, 8, 8, 15)     0
dropout_52[0][0]
_____
_____
batch_normalization_54 (BatchNo (None, 8, 8, 15)     60
average_pooling2d_5[0][0]
_____
_____
activation_54 (Activation)      (None, 8, 8, 15)     0
batch_normalization_54[0][0]
_____
_____
conv2d_56 (Conv2D)              (None, 8, 8, 15)     2025
activation_54[0][0]
_____
_____
dropout_53 (Dropout)            (None, 8, 8, 15)     0        conv2d_56[0][0]
_____
_____
concatenate_48 (Concatenate)    (None, 8, 8, 30)     0
average_pooling2d_5[0][0]
dropout_53[0][0]
```

```
--------------------------------------------------------------------------------
------------------
batch_normalization_55 (BatchNo (None, 8, 8, 30)     120
concatenate_48[0][0]
--------------------------------------------------------------------------------
------------------
activation_55 (Activation)      (None, 8, 8, 30)     0
batch_normalization_55[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_57 (Conv2D)              (None, 8, 8, 15)     4050
activation_55[0][0]
--------------------------------------------------------------------------------
------------------
dropout_54 (Dropout)            (None, 8, 8, 15)     0           conv2d_57[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_49 (Concatenate)    (None, 8, 8, 45)     0
concatenate_48[0][0]
dropout_54[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_56 (BatchNo (None, 8, 8, 45)     180
concatenate_49[0][0]
--------------------------------------------------------------------------------
------------------
activation_56 (Activation)      (None, 8, 8, 45)     0
batch_normalization_56[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_58 (Conv2D)              (None, 8, 8, 15)     6075
activation_56[0][0]
--------------------------------------------------------------------------------
------------------
dropout_55 (Dropout)            (None, 8, 8, 15)     0           conv2d_58[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_50 (Concatenate)    (None, 8, 8, 60)     0
concatenate_49[0][0]
dropout_55[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_57 (BatchNo (None, 8, 8, 60)     240
concatenate_50[0][0]
--------------------------------------------------------------------------------
------------------
activation_57 (Activation)      (None, 8, 8, 60)     0
batch_normalization_57[0][0]
```

```
--------------------------------------------------------------------------------
------------------
conv2d_59 (Conv2D)              (None, 8, 8, 15)     8100
activation_57[0][0]
--------------------------------------------------------------------------------
------------------
dropout_56 (Dropout)            (None, 8, 8, 15)     0           conv2d_59[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_51 (Concatenate)    (None, 8, 8, 75)     0
concatenate_50[0][0]
dropout_56[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_58 (BatchNo (None, 8, 8, 75)     300
concatenate_51[0][0]
--------------------------------------------------------------------------------
------------------
activation_58 (Activation)      (None, 8, 8, 75)     0
batch_normalization_58[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_60 (Conv2D)              (None, 8, 8, 15)     10125
activation_58[0][0]
--------------------------------------------------------------------------------
------------------
dropout_57 (Dropout)            (None, 8, 8, 15)     0           conv2d_60[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_52 (Concatenate)    (None, 8, 8, 90)     0
concatenate_51[0][0]
dropout_57[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_59 (BatchNo (None, 8, 8, 90)     360
concatenate_52[0][0]
--------------------------------------------------------------------------------
------------------
activation_59 (Activation)      (None, 8, 8, 90)     0
batch_normalization_59[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_61 (Conv2D)              (None, 8, 8, 15)     12150
activation_59[0][0]
--------------------------------------------------------------------------------
------------------
dropout_58 (Dropout)            (None, 8, 8, 15)     0           conv2d_61[0][0]
--------------------------------------------------------------------------------
```

```
------------------
concatenate_53 (Concatenate)     (None, 8, 8, 105)    0
concatenate_52[0][0]
dropout_58[0][0]
----------------------------------------------------------------------------------
------------------
batch_normalization_60 (BatchNo  (None, 8, 8, 105)    420
concatenate_53[0][0]
----------------------------------------------------------------------------------
------------------
activation_60 (Activation)       (None, 8, 8, 105)    0
batch_normalization_60[0][0]
----------------------------------------------------------------------------------
------------------
conv2d_62 (Conv2D)               (None, 8, 8, 15)     14175
activation_60[0][0]
----------------------------------------------------------------------------------
------------------
dropout_59 (Dropout)             (None, 8, 8, 15)     0          conv2d_62[0][0]
----------------------------------------------------------------------------------
------------------
concatenate_54 (Concatenate)     (None, 8, 8, 120)    0
concatenate_53[0][0]
dropout_59[0][0]
----------------------------------------------------------------------------------
------------------
batch_normalization_61 (BatchNo  (None, 8, 8, 120)    480
concatenate_54[0][0]
----------------------------------------------------------------------------------
------------------
activation_61 (Activation)       (None, 8, 8, 120)    0
batch_normalization_61[0][0]
----------------------------------------------------------------------------------
------------------
conv2d_63 (Conv2D)               (None, 8, 8, 15)     16200
activation_61[0][0]
----------------------------------------------------------------------------------
------------------
dropout_60 (Dropout)             (None, 8, 8, 15)     0          conv2d_63[0][0]
----------------------------------------------------------------------------------
------------------
concatenate_55 (Concatenate)     (None, 8, 8, 135)    0
concatenate_54[0][0]
dropout_60[0][0]
----------------------------------------------------------------------------------
------------------
batch_normalization_62 (BatchNo  (None, 8, 8, 135)    540
concatenate_55[0][0]
```

```
--------------------------------------------------------------------------------
------------------
activation_62 (Activation)       (None, 8, 8, 135)   0
batch_normalization_62[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_64 (Conv2D)               (None, 8, 8, 15)     2025
activation_62[0][0]
--------------------------------------------------------------------------------
------------------
dropout_61 (Dropout)             (None, 8, 8, 15)     0            conv2d_64[0][0]
--------------------------------------------------------------------------------
------------------
average_pooling2d_6 (AveragePoo  (None, 4, 4, 15)     0
dropout_61[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_63 (BatchNo  (None, 4, 4, 15)     60
average_pooling2d_6[0][0]
--------------------------------------------------------------------------------
------------------
activation_63 (Activation)       (None, 4, 4, 15)     0
batch_normalization_63[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_65 (Conv2D)               (None, 4, 4, 15)     2025
activation_63[0][0]
--------------------------------------------------------------------------------
------------------
dropout_62 (Dropout)             (None, 4, 4, 15)     0            conv2d_65[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_56 (Concatenate)     (None, 4, 4, 30)     0
average_pooling2d_6[0][0]
dropout_62[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_64 (BatchNo  (None, 4, 4, 30)     120
concatenate_56[0][0]
--------------------------------------------------------------------------------
------------------
activation_64 (Activation)       (None, 4, 4, 30)     0
batch_normalization_64[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_66 (Conv2D)               (None, 4, 4, 15)     4050
activation_64[0][0]
--------------------------------------------------------------------------------
------------------
```

```
------------------
dropout_63 (Dropout)            (None, 4, 4, 15)    0        conv2d_66[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_57 (Concatenate)    (None, 4, 4, 45)    0
concatenate_56[0][0]
dropout_63[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_65 (BatchNo (None, 4, 4, 45)    180
concatenate_57[0][0]
--------------------------------------------------------------------------------
------------------
activation_65 (Activation)      (None, 4, 4, 45)    0
batch_normalization_65[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_67 (Conv2D)              (None, 4, 4, 15)    6075
activation_65[0][0]
--------------------------------------------------------------------------------
------------------
dropout_64 (Dropout)            (None, 4, 4, 15)    0        conv2d_67[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_58 (Concatenate)    (None, 4, 4, 60)    0
concatenate_57[0][0]
dropout_64[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_66 (BatchNo (None, 4, 4, 60)    240
concatenate_58[0][0]
--------------------------------------------------------------------------------
------------------
activation_66 (Activation)      (None, 4, 4, 60)    0
batch_normalization_66[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_68 (Conv2D)              (None, 4, 4, 15)    8100
activation_66[0][0]
--------------------------------------------------------------------------------
------------------
dropout_65 (Dropout)            (None, 4, 4, 15)    0        conv2d_68[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_59 (Concatenate)    (None, 4, 4, 75)    0
concatenate_58[0][0]
dropout_65[0][0]
--------------------------------------------------------------------------------
```

```
------------------
batch_normalization_67 (BatchNo (None, 4, 4, 75)      300
concatenate_59[0][0]
--------------------------------------------------------------------------------
------------------
activation_67 (Activation)      (None, 4, 4, 75)      0
batch_normalization_67[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_69 (Conv2D)              (None, 4, 4, 15)      10125
activation_67[0][0]
--------------------------------------------------------------------------------
------------------
dropout_66 (Dropout)            (None, 4, 4, 15)      0           conv2d_69[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_60 (Concatenate)    (None, 4, 4, 90)      0
concatenate_59[0][0]
dropout_66[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_68 (BatchNo (None, 4, 4, 90)      360
concatenate_60[0][0]
--------------------------------------------------------------------------------
------------------
activation_68 (Activation)      (None, 4, 4, 90)      0
batch_normalization_68[0][0]
--------------------------------------------------------------------------------
------------------
conv2d_70 (Conv2D)              (None, 4, 4, 15)      12150
activation_68[0][0]
--------------------------------------------------------------------------------
------------------
dropout_67 (Dropout)            (None, 4, 4, 15)      0           conv2d_70[0][0]
--------------------------------------------------------------------------------
------------------
concatenate_61 (Concatenate)    (None, 4, 4, 105)     0
concatenate_60[0][0]
dropout_67[0][0]
--------------------------------------------------------------------------------
------------------
batch_normalization_69 (BatchNo (None, 4, 4, 105)     420
concatenate_61[0][0]
--------------------------------------------------------------------------------
------------------
activation_69 (Activation)      (None, 4, 4, 105)     0
batch_normalization_69[0][0]
--------------------------------------------------------------------------------
```

```
------------------
conv2d_71 (Conv2D)            (None, 4, 4, 15)      14175
activation_69[0][0]
_____
------------------
dropout_68 (Dropout)          (None, 4, 4, 15)      0          conv2d_71[0][0]
_____
------------------
concatenate_62 (Concatenate)  (None, 4, 4, 120)     0
concatenate_61[0][0]
dropout_68[0][0]
_____
------------------
batch_normalization_70 (BatchNo (None, 4, 4, 120)   480
concatenate_62[0][0]
_____
------------------
activation_70 (Activation)    (None, 4, 4, 120)     0
batch_normalization_70[0][0]
_____
------------------
conv2d_72 (Conv2D)            (None, 4, 4, 15)      16200
activation_70[0][0]
_____
------------------
dropout_69 (Dropout)          (None, 4, 4, 15)      0          conv2d_72[0][0]
_____
------------------
concatenate_63 (Concatenate)  (None, 4, 4, 135)     0
concatenate_62[0][0]
dropout_69[0][0]
_____
------------------
batch_normalization_71 (BatchNo (None, 4, 4, 135)   540
concatenate_63[0][0]
_____
------------------
activation_71 (Activation)    (None, 4, 4, 135)     0
batch_normalization_71[0][0]
_____
------------------
average_pooling2d_7 (AveragePoo (None, 2, 2, 135)   0
activation_71[0][0]
_____
------------------
conv2d_73 (Conv2D)            (None, 1, 1, 10)      5410
average_pooling2d_7[0][0]
_____
```

```
------------------
reshape_1 (Reshape)              (None, 10)            0            conv2d_73[0][0]
==============================================================================
==================
Total params: 331,660
Trainable params: 325,990
Non-trainable params: 5,670
_____
------------------
```

[20]:
```python
# determine Loss function and Optimizer
model1.compile(loss='categorical_crossentropy',
               optimizer=Adam(),
               metrics=['accuracy'])
```

[21]:
```python
import tensorflow
from tensorflow.keras.callbacks import ModelCheckpoint
#from tf.keras.callbacks import ModelCheckpoint
filepath="DNST_model_with_augmentation.hdf5"
checkpoint = ModelCheckpoint(filepath, monitor='val_acc', verbose=1,
 ↪save_best_only=True, mode='max')
callbacks_list = [checkpoint]
```

[22]:
```python
epochs = 300
batch_size=128
#datagen.flow(x_train, y_train, batch_size=128)
model1.fit_generator(datagen.flow(X_train, y_train, batch_size=batch_size),
                     steps_per_epoch = len(X_train) / batch_size,
                     epochs=epochs,
                     verbose=1,
                     validation_data=(X_test, y_test),callbacks=callbacks_list)
```

```
Epoch 1/300
390/390 [=============================>.] - ETA: 0s - loss: 1.5828 - acc: 0.4118
Epoch 00001: val_acc improved from -inf to 0.46860, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 60s 154ms/step - loss: 1.5822 - acc:
0.4121 - val_loss: 1.6314 - val_acc: 0.4686
Epoch 2/300
390/390 [=============================>.] - ETA: 0s - loss: 1.2251 - acc: 0.5543
Epoch 00002: val_acc improved from 0.46860 to 0.52820, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 38s 96ms/step - loss: 1.2252 - acc:
0.5544 - val_loss: 1.4968 - val_acc: 0.5282
Epoch 3/300
390/390 [=============================>.] - ETA: 0s - loss: 1.0731 - acc: 0.6153
Epoch 00003: val_acc improved from 0.52820 to 0.55770, saving model to
DNST_model_with_augmentation.hdf5
```

```
391/390 [==============================] - 38s 97ms/step - loss: 1.0732 - acc:
0.6153 - val_loss: 1.5441 - val_acc: 0.5577
Epoch 4/300
390/390 [=============================>.] - ETA: 0s - loss: 0.9887 - acc: 0.6472
Epoch 00004: val_acc improved from 0.55770 to 0.60600, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 38s 97ms/step - loss: 0.9890 - acc:
0.6471 - val_loss: 1.2903 - val_acc: 0.6060
Epoch 5/300
390/390 [=============================>.] - ETA: 0s - loss: 0.9199 - acc: 0.6712
Epoch 00005: val_acc did not improve from 0.60600
391/390 [==============================] - 38s 96ms/step - loss: 0.9198 - acc:
0.6712 - val_loss: 1.5100 - val_acc: 0.5800
Epoch 6/300
390/390 [=============================>.] - ETA: 0s - loss: 0.8743 - acc: 0.6889
Epoch 00006: val_acc improved from 0.60600 to 0.69620, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 38s 97ms/step - loss: 0.8741 - acc:
0.6890 - val_loss: 0.9544 - val_acc: 0.6962
Epoch 7/300
390/390 [=============================>.] - ETA: 0s - loss: 0.8238 - acc: 0.7086
Epoch 00007: val_acc did not improve from 0.69620
391/390 [==============================] - 38s 96ms/step - loss: 0.8233 - acc:
0.7087 - val_loss: 1.0003 - val_acc: 0.6700
Epoch 8/300
390/390 [=============================>.] - ETA: 0s - loss: 0.7861 - acc: 0.7215
Epoch 00008: val_acc improved from 0.69620 to 0.73200, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 38s 97ms/step - loss: 0.7859 - acc:
0.7216 - val_loss: 0.8216 - val_acc: 0.7320
Epoch 9/300
390/390 [=============================>.] - ETA: 0s - loss: 0.7478 - acc: 0.7353
Epoch 00009: val_acc did not improve from 0.73200
391/390 [==============================] - 38s 96ms/step - loss: 0.7479 - acc:
0.7354 - val_loss: 1.2476 - val_acc: 0.6389
Epoch 10/300
390/390 [=============================>.] - ETA: 0s - loss: 0.7116 - acc: 0.7498
Epoch 00010: val_acc did not improve from 0.73200
391/390 [==============================] - 38s 97ms/step - loss: 0.7114 - acc:
0.7499 - val_loss: 0.8482 - val_acc: 0.7251
Epoch 11/300
390/390 [=============================>.] - ETA: 0s - loss: 0.6949 - acc: 0.7547
Epoch 00011: val_acc did not improve from 0.73200
391/390 [==============================] - 38s 97ms/step - loss: 0.6951 - acc:
0.7546 - val_loss: 0.9972 - val_acc: 0.7095
Epoch 12/300
390/390 [=============================>.] - ETA: 0s - loss: 0.6679 - acc: 0.7642-
ET
```

```
Epoch 00012: val_acc improved from 0.73200 to 0.75670, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 39s 99ms/step - loss: 0.6683 - acc:
0.7641 - val_loss: 0.7583 - val_acc: 0.7567
Epoch 13/300
390/390 [=============================>.] - ETA: 0s - loss: 0.6521 - acc: 0.7722
Epoch 00013: val_acc did not improve from 0.75670
391/390 [==============================] - 38s 97ms/step - loss: 0.6522 - acc:
0.7722 - val_loss: 0.8058 - val_acc: 0.7509
Epoch 14/300
390/390 [=============================>.] - ETA: 0s - loss: 0.6283 - acc: 0.7802
Epoch 00014: val_acc improved from 0.75670 to 0.76450, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 38s 98ms/step - loss: 0.6284 - acc:
0.7801 - val_loss: 0.7538 - val_acc: 0.7645
Epoch 15/300
390/390 [=============================>.] - ETA: 0s - loss: 0.6174 - acc: 0.7837
Epoch 00015: val_acc did not improve from 0.76450
391/390 [==============================] - 39s 100ms/step - loss: 0.6176 - acc:
0.7837 - val_loss: 0.7842 - val_acc: 0.7588
Epoch 16/300
390/390 [=============================>.] - ETA: 0s - loss: 0.6084 - acc: 0.7854-
ETA:  - ETA: 1s - loss:
Epoch 00016: val_acc improved from 0.76450 to 0.78440, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 39s 100ms/step - loss: 0.6085 - acc:
0.7854 - val_loss: 0.6871 - val_acc: 0.7844
Epoch 17/300
390/390 [=============================>.] - ETA: 0s - loss: 0.5904 - acc: 0.7942
Epoch 00017: val_acc did not improve from 0.78440
391/390 [==============================] - 37s 95ms/step - loss: 0.5902 - acc:
0.7942 - val_loss: 0.9883 - val_acc: 0.7219
Epoch 18/300
390/390 [=============================>.] - ETA: 0s - loss: 0.5734 - acc: 0.8008-
ETA: 2s - lo
Epoch 00018: val_acc improved from 0.78440 to 0.79370, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 38s 97ms/step - loss: 0.5736 - acc:
0.8007 - val_loss: 0.6574 - val_acc: 0.7937
Epoch 19/300
390/390 [=============================>.] - ETA: 0s - loss: 0.5681 - acc: 0.8007
Epoch 00019: val_acc did not improve from 0.79370
391/390 [==============================] - 38s 96ms/step - loss: 0.5678 - acc:
0.8009 - val_loss: 0.7524 - val_acc: 0.7711
Epoch 20/300
390/390 [=============================>.] - ETA: 0s - loss: 0.5497 - acc: 0.8068
Epoch 00020: val_acc did not improve from 0.79370
391/390 [==============================] - 38s 96ms/step - loss: 0.5496 - acc:
```

0.8068 - val_loss: 0.6788 - val_acc: 0.7903
Epoch 21/300
390/390 [===========================>.] - ETA: 0s - loss: 0.5404 - acc: 0.8102
Epoch 00021: val_acc improved from 0.79370 to 0.80030, saving model to
DNST_model_with_augmentation.hdf5
391/390 [=============================] - 38s 97ms/step - loss: 0.5402 - acc:
0.8102 - val_loss: 0.6534 - val_acc: 0.8003
Epoch 22/300
390/390 [===========================>.] - ETA: 0s - loss: 0.5352 - acc: 0.8141
Epoch 00022: val_acc did not improve from 0.80030
391/390 [=============================] - 38s 97ms/step - loss: 0.5350 - acc:
0.8142 - val_loss: 0.8933 - val_acc: 0.7418
Epoch 23/300
390/390 [===========================>.] - ETA: 0s - loss: 0.5234 - acc: 0.8182
Epoch 00023: val_acc improved from 0.80030 to 0.81440, saving model to
DNST_model_with_augmentation.hdf5
391/390 [=============================] - 38s 97ms/step - loss: 0.5238 - acc:
0.8181 - val_loss: 0.6070 - val_acc: 0.8144
Epoch 24/300
390/390 [===========================>.] - ETA: 0s - loss: 0.5135 - acc: 0.8205
Epoch 00024: val_acc did not improve from 0.81440
391/390 [=============================] - 38s 96ms/step - loss: 0.5138 - acc:
0.8204 - val_loss: 0.7269 - val_acc: 0.7846
Epoch 25/300
390/390 [===========================>.] - ETA: 0s - loss: 0.5109 - acc: 0.8221
Epoch 00025: val_acc did not improve from 0.81440
391/390 [=============================] - 38s 97ms/step - loss: 0.5108 - acc:
0.8222 - val_loss: 0.8926 - val_acc: 0.7431
Epoch 26/300
390/390 [===========================>.] - ETA: 0s - loss: 0.5021 - acc: 0.8254
Epoch 00026: val_acc did not improve from 0.81440
391/390 [=============================] - 38s 97ms/step - loss: 0.5018 - acc:
0.8256 - val_loss: 0.6991 - val_acc: 0.7883
Epoch 27/300
390/390 [===========================>.] - ETA: 0s - loss: 0.4955 - acc: 0.8255-
ETA: 1s - loss: 0.4952 -
Epoch 00027: val_acc did not improve from 0.81440
391/390 [=============================] - 38s 97ms/step - loss: 0.4955 - acc:
0.8254 - val_loss: 0.7165 - val_acc: 0.7896
Epoch 28/300
390/390 [===========================>.] - ETA: 0s - loss: 0.4908 - acc: 0.8299
Epoch 00028: val_acc did not improve from 0.81440
391/390 [=============================] - 38s 97ms/step - loss: 0.4909 - acc:
0.8299 - val_loss: 0.9951 - val_acc: 0.7261
Epoch 29/300
390/390 [===========================>.] - ETA: 0s - loss: 0.4791 - acc: 0.8312-
ETA: 3s - loss: 0. - ETA: 1s - loss: 0.
Epoch 00029: val_acc did not improve from 0.81440

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391/390 [==============================] - 38s 97ms/step - loss: 0.4790 - acc:
0.8313 - val_loss: 1.0440 - val_acc: 0.7227
Epoch 30/300
390/390 [=============================>.] - ETA: 0s - loss: 0.4795 - acc: 0.8314
Epoch 00030: val_acc did not improve from 0.81440
391/390 [==============================] - 38s 96ms/step - loss: 0.4796 - acc:
0.8314 - val_loss: 0.6536 - val_acc: 0.8104
Epoch 31/300
390/390 [=============================>.] - ETA: 0s - loss: 0.4720 - acc: 0.8359-
Epoch 00031: val_acc did not improve from 0.81440
391/390 [==============================] - 38s 97ms/step - loss: 0.4723 - acc:
0.8358 - val_loss: 0.6199 - val_acc: 0.8133
Epoch 32/300
390/390 [=============================>.] - ETA: 0s - loss: 0.4630 - acc: 0.8388
Epoch 00032: val_acc improved from 0.81440 to 0.82650, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 38s 98ms/step - loss: 0.4633 - acc:
0.8387 - val_loss: 0.5701 - val_acc: 0.8265
Epoch 33/300
390/390 [=============================>.] - ETA: 0s - loss: 0.4573 - acc: 0.8401
Epoch 00033: val_acc did not improve from 0.82650
391/390 [==============================] - 38s 96ms/step - loss: 0.4575 - acc:
0.8401 - val_loss: 0.6803 - val_acc: 0.7946
Epoch 34/300
390/390 [=============================>.] - ETA: 0s - loss: 0.4522 - acc: 0.8420
Epoch 00034: val_acc did not improve from 0.82650
391/390 [==============================] - 38s 97ms/step - loss: 0.4523 - acc:
0.8420 - val_loss: 0.5546 - val_acc: 0.8257
Epoch 35/300
390/390 [=============================>.] - ETA: 0s - loss: 0.4452 - acc: 0.8452
Epoch 00035: val_acc did not improve from 0.82650
391/390 [==============================] - 38s 97ms/step - loss: 0.4450 - acc:
0.8452 - val_loss: 0.6944 - val_acc: 0.8068
Epoch 36/300
390/390 [=============================>.] - ETA: 0s - loss: 0.4479 - acc: 0.8435
Epoch 00036: val_acc did not improve from 0.82650
391/390 [==============================] - 38s 96ms/step - loss: 0.4478 - acc:
0.8435 - val_loss: 0.6274 - val_acc: 0.8121
Epoch 37/300
390/390 [=============================>.] - ETA: 0s - loss: 0.4398 - acc: 0.8473
Epoch 00037: val_acc did not improve from 0.82650
391/390 [==============================] - 38s 98ms/step - loss: 0.4397 - acc:
0.8473 - val_loss: 0.6816 - val_acc: 0.7983
Epoch 38/300
390/390 [=============================>.] - ETA: 0s - loss: 0.4366 - acc: 0.8484
Epoch 00038: val_acc improved from 0.82650 to 0.83090, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 39s 99ms/step - loss: 0.4366 - acc:
```

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0.8484 - val_loss: 0.5811 - val_acc: 0.8309
Epoch 39/300
390/390 [===========================>.] - ETA: 0s - loss: 0.4287 - acc: 0.8501
Epoch 00039: val_acc did not improve from 0.83090
391/390 [==============================] - 38s 96ms/step - loss: 0.4284 - acc:
0.8502 - val_loss: 0.6725 - val_acc: 0.8038
Epoch 40/300
390/390 [===========================>.] - ETA: 0s - loss: 0.4276 - acc: 0.8513
Epoch 00040: val_acc did not improve from 0.83090
391/390 [==============================] - 38s 96ms/step - loss: 0.4278 - acc:
0.8512 - val_loss: 0.8227 - val_acc: 0.7797
Epoch 41/300
390/390 [===========================>.] - ETA: 0s - loss: 0.4222 - acc: 0.8532
Epoch 00041: val_acc did not improve from 0.83090
391/390 [==============================] - 38s 96ms/step - loss: 0.4224 - acc:
0.8532 - val_loss: 0.6231 - val_acc: 0.8168
Epoch 42/300
390/390 [===========================>.] - ETA: 0s - loss: 0.4171 - acc: 0.8539
Epoch 00042: val_acc did not improve from 0.83090
391/390 [==============================] - 38s 96ms/step - loss: 0.4172 - acc:
0.8539 - val_loss: 0.6186 - val_acc: 0.8260
Epoch 43/300
390/390 [===========================>.] - ETA: 0s - loss: 0.4172 - acc: 0.8545
Epoch 00043: val_acc improved from 0.83090 to 0.85240, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 38s 97ms/step - loss: 0.4170 - acc:
0.8545 - val_loss: 0.4899 - val_acc: 0.8524
Epoch 44/300
390/390 [===========================>.] - ETA: 0s - loss: 0.4128 - acc: 0.8559-
ETA: 1s - loss: 0.412
Epoch 00044: val_acc did not improve from 0.85240
391/390 [==============================] - 38s 96ms/step - loss: 0.4128 - acc:
0.8559 - val_loss: 0.5086 - val_acc: 0.8433
Epoch 45/300
390/390 [===========================>.] - ETA: 0s - loss: 0.4080 - acc: 0.8587
Epoch 00045: val_acc did not improve from 0.85240
391/390 [==============================] - 38s 97ms/step - loss: 0.4082 - acc:
0.8586 - val_loss: 0.5788 - val_acc: 0.8274
Epoch 46/300
390/390 [===========================>.] - ETA: 0s - loss: 0.4058 - acc: 0.8578
Epoch 00046: val_acc did not improve from 0.85240
391/390 [==============================] - 38s 97ms/step - loss: 0.4061 - acc:
0.8578 - val_loss: 0.6601 - val_acc: 0.8161
Epoch 47/300
390/390 [===========================>.] - ETA: 0s - loss: 0.4041 - acc: 0.8595
Epoch 00047: val_acc did not improve from 0.85240
391/390 [==============================] - 38s 96ms/step - loss: 0.4040 - acc:
0.8596 - val_loss: 0.5143 - val_acc: 0.8487
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Epoch 48/300
390/390 [============================>.] - ETA: 0s - loss: 0.4004 - acc: 0.8602
Epoch 00048: val_acc improved from 0.85240 to 0.85550, saving model to
DNST_model_with_augmentation.hdf5
391/390 [=============================] - 38s 97ms/step - loss: 0.4007 - acc:
0.8601 - val_loss: 0.4669 - val_acc: 0.8555
Epoch 49/300
390/390 [============================>.] - ETA: 0s - loss: 0.3964 - acc: 0.8624
Epoch 00049: val_acc did not improve from 0.85550
391/390 [=============================] - 38s 96ms/step - loss: 0.3966 - acc:
0.8623 - val_loss: 0.4915 - val_acc: 0.8514
Epoch 50/300
390/390 [============================>.] - ETA: 0s - loss: 0.3939 - acc: 0.8623
Epoch 00050: val_acc did not improve from 0.85550
391/390 [=============================] - 38s 98ms/step - loss: 0.3940 - acc:
0.8623 - val_loss: 0.5701 - val_acc: 0.8324
Epoch 51/300
390/390 [============================>.] - ETA: 0s - loss: 0.3902 - acc: 0.8635
Epoch 00051: val_acc did not improve from 0.85550
391/390 [=============================] - 38s 96ms/step - loss: 0.3902 - acc:
0.8635 - val_loss: 0.5139 - val_acc: 0.8461
Epoch 52/300
390/390 [============================>.] - ETA: 0s - loss: 0.3886 - acc: 0.8642
Epoch 00052: val_acc improved from 0.85550 to 0.85950, saving model to
DNST_model_with_augmentation.hdf5
391/390 [=============================] - 38s 97ms/step - loss: 0.3891 - acc:
0.8639 - val_loss: 0.4445 - val_acc: 0.8595
Epoch 53/300
390/390 [============================>.] - ETA: 0s - loss: 0.3876 - acc: 0.8647
Epoch 00053: val_acc did not improve from 0.85950
391/390 [=============================] - 38s 96ms/step - loss: 0.3876 - acc:
0.8647 - val_loss: 0.4687 - val_acc: 0.8546
Epoch 54/300
390/390 [============================>.] - ETA: 0s - loss: 0.3845 - acc: 0.8660
Epoch 00054: val_acc did not improve from 0.85950
391/390 [=============================] - 38s 96ms/step - loss: 0.3845 - acc:
0.8661 - val_loss: 0.6479 - val_acc: 0.8074
Epoch 55/300
390/390 [============================>.] - ETA: 0s - loss: 0.3757 - acc: 0.8688
Epoch 00055: val_acc did not improve from 0.85950
391/390 [=============================] - 38s 96ms/step - loss: 0.3761 - acc:
0.8688 - val_loss: 0.5229 - val_acc: 0.8410
Epoch 56/300
390/390 [============================>.] - ETA: 0s - loss: 0.3774 - acc: 0.8675
Epoch 00056: val_acc did not improve from 0.85950
391/390 [=============================] - 38s 96ms/step - loss: 0.3773 - acc:
0.8676 - val_loss: 0.5558 - val_acc: 0.8400
Epoch 57/300
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390/390 [============================>.] - ETA: 0s - loss: 0.3695 - acc: 0.8704
Epoch 00057: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 97ms/step - loss: 0.3699 - acc:
0.8702 - val_loss: 0.4858 - val_acc: 0.8547
Epoch 58/300
390/390 [============================>.] - ETA: 0s - loss: 0.3746 - acc: 0.8675
Epoch 00058: val_acc did not improve from 0.85950
391/390 [==============================] - 39s 99ms/step - loss: 0.3745 - acc:
0.8675 - val_loss: 0.5093 - val_acc: 0.8520
Epoch 59/300
390/390 [============================>.] - ETA: 0s - loss: 0.3639 - acc: 0.8732
Epoch 00059: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 98ms/step - loss: 0.3638 - acc:
0.8732 - val_loss: 0.5298 - val_acc: 0.8477
Epoch 60/300
390/390 [============================>.] - ETA: 0s - loss: 0.3616 - acc: 0.8731
Epoch 00060: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 97ms/step - loss: 0.3616 - acc:
0.8731 - val_loss: 0.5645 - val_acc: 0.8332
Epoch 61/300
390/390 [============================>.] - ETA: 0s - loss: 0.3661 - acc: 0.8717
Epoch 00061: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 96ms/step - loss: 0.3659 - acc:
0.8717 - val_loss: 0.5021 - val_acc: 0.8563
Epoch 62/300
390/390 [============================>.] - ETA: 0s - loss: 0.3593 - acc: 0.8747
Epoch 00062: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 96ms/step - loss: 0.3590 - acc:
0.8748 - val_loss: 0.5306 - val_acc: 0.8446
Epoch 63/300
390/390 [============================>.] - ETA: 0s - loss: 0.3569 - acc: 0.8754
Epoch 00063: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 96ms/step - loss: 0.3569 - acc:
0.8754 - val_loss: 0.4908 - val_acc: 0.8561
Epoch 64/300
390/390 [============================>.] - ETA: 0s - loss: 0.3596 - acc: 0.8757
Epoch 00064: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 97ms/step - loss: 0.3596 - acc:
0.8757 - val_loss: 0.5622 - val_acc: 0.8426
Epoch 65/300
390/390 [============================>.] - ETA: 0s - loss: 0.3538 - acc: 0.8758
Epoch 00065: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 96ms/step - loss: 0.3538 - acc:
0.8758 - val_loss: 0.4931 - val_acc: 0.8501
Epoch 66/300
390/390 [============================>.] - ETA: 0s - loss: 0.3515 - acc: 0.8752
Epoch 00066: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 96ms/step - loss: 0.3515 - acc:
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0.8753 - val_loss: 0.6218 - val_acc: 0.8253
Epoch 67/300
390/390 [============================>.] - ETA: 0s - loss: 0.3525 - acc: 0.8768
Epoch 00067: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 97ms/step - loss: 0.3524 - acc:
0.8768 - val_loss: 0.5253 - val_acc: 0.8540
Epoch 68/300
390/390 [============================>.] - ETA: 0s - loss: 0.3482 - acc: 0.8777
Epoch 00068: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 98ms/step - loss: 0.3480 - acc:
0.8778 - val_loss: 0.4886 - val_acc: 0.8572
Epoch 69/300
390/390 [============================>.] - ETA: 0s - loss: 0.3497 - acc: 0.8779
Epoch 00069: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 97ms/step - loss: 0.3497 - acc:
0.8778 - val_loss: 0.5784 - val_acc: 0.8344
Epoch 70/300
390/390 [============================>.] - ETA: 0s - loss: 0.3486 - acc: 0.8783
Epoch 00070: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 96ms/step - loss: 0.3485 - acc:
0.8783 - val_loss: 0.5781 - val_acc: 0.8340
Epoch 71/300
390/390 [============================>.] - ETA: 0s - loss: 0.3404 - acc: 0.8808
Epoch 00071: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 97ms/step - loss: 0.3404 - acc:
0.8808 - val_loss: 0.6942 - val_acc: 0.8069
Epoch 72/300
390/390 [============================>.] - ETA: 0s - loss: 0.3415 - acc: 0.8813
Epoch 00072: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 97ms/step - loss: 0.3416 - acc:
0.8812 - val_loss: 0.5497 - val_acc: 0.8478
Epoch 73/300
390/390 [============================>.] - ETA: 0s - loss: 0.3363 - acc: 0.8818
Epoch 00073: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 96ms/step - loss: 0.3362 - acc:
0.8818 - val_loss: 0.5681 - val_acc: 0.8365
Epoch 74/300
390/390 [============================>.] - ETA: 0s - loss: 0.3390 - acc: 0.8789
Epoch 00074: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 97ms/step - loss: 0.3389 - acc:
0.8789 - val_loss: 0.5586 - val_acc: 0.8362
Epoch 75/300
390/390 [============================>.] - ETA: 0s - loss: 0.3344 - acc: 0.8819
Epoch 00075: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 96ms/step - loss: 0.3348 - acc:
0.8819 - val_loss: 0.5306 - val_acc: 0.8500
Epoch 76/300
390/390 [============================>.] - ETA: 0s - loss: 0.3354 - acc: 0.8811
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Epoch 00076: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 97ms/step - loss: 0.3355 - acc:
0.8810 - val_loss: 0.4782 - val_acc: 0.8595
Epoch 77/300
390/390 [=============================>.] - ETA: 0s - loss: 0.3382 - acc: 0.8827
Epoch 00077: val_acc did not improve from 0.85950
391/390 [==============================] - 38s 96ms/step - loss: 0.3381 - acc:
0.8827 - val_loss: 0.5151 - val_acc: 0.8524
Epoch 78/300
390/390 [=============================>.] - ETA: 0s - loss: 0.3320 - acc: 0.8815
Epoch 00078: val_acc improved from 0.85950 to 0.87430, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 38s 97ms/step - loss: 0.3318 - acc:
0.8815 - val_loss: 0.4415 - val_acc: 0.8743
Epoch 79/300
390/390 [=============================>.] - ETA: 0s - loss: 0.3325 - acc: 0.8840
Epoch 00079: val_acc did not improve from 0.87430
391/390 [==============================] - 38s 97ms/step - loss: 0.3330 - acc:
0.8839 - val_loss: 0.4590 - val_acc: 0.8625
Epoch 80/300
390/390 [=============================>.] - ETA: 0s - loss: 0.3340 - acc: 0.8833
Epoch 00080: val_acc did not improve from 0.87430
391/390 [==============================] - 38s 97ms/step - loss: 0.3343 - acc:
0.8831 - val_loss: 0.4768 - val_acc: 0.8615
Epoch 81/300
390/390 [=============================>.] - ETA: 0s - loss: 0.3213 - acc: 0.8884
Epoch 00081: val_acc did not improve from 0.87430
391/390 [==============================] - 38s 96ms/step - loss: 0.3216 - acc:
0.8883 - val_loss: 0.6608 - val_acc: 0.8208
Epoch 82/300
390/390 [=============================>.] - ETA: 0s - loss: 0.3244 - acc: 0.8855
Epoch 00082: val_acc did not improve from 0.87430
391/390 [==============================] - 38s 97ms/step - loss: 0.3248 - acc:
0.8854 - val_loss: 0.4598 - val_acc: 0.8683
Epoch 83/300
390/390 [=============================>.] - ETA: 0s - loss: 0.3249 - acc: 0.8869
Epoch 00083: val_acc did not improve from 0.87430
391/390 [==============================] - 38s 96ms/step - loss: 0.3252 - acc:
0.8869 - val_loss: 0.5641 - val_acc: 0.8395
Epoch 84/300
390/390 [=============================>.] - ETA: 0s - loss: 0.3204 - acc: 0.8889
Epoch 00084: val_acc did not improve from 0.87430
391/390 [==============================] - 38s 96ms/step - loss: 0.3202 - acc:
0.8889 - val_loss: 0.5420 - val_acc: 0.8431
Epoch 85/300
390/390 [=============================>.] - ETA: 0s - loss: 0.3238 - acc: 0.8859
Epoch 00085: val_acc did not improve from 0.87430
391/390 [==============================] - 38s 97ms/step - loss: 0.3238 - acc:
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0.8859 - val_loss: 0.5038 - val_acc: 0.8565
Epoch 86/300
390/390 [============================>.] - ETA: 0s - loss: 0.3196 - acc: 0.8879
Epoch 00086: val_acc did not improve from 0.87430
391/390 [==============================] - 38s 97ms/step - loss: 0.3194 - acc:
0.8879 - val_loss: 0.5657 - val_acc: 0.8461
Epoch 87/300
390/390 [============================>.] - ETA: 0s - loss: 0.3227 - acc: 0.8852
Epoch 00087: val_acc improved from 0.87430 to 0.87660, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 38s 98ms/step - loss: 0.3225 - acc:
0.8853 - val_loss: 0.4154 - val_acc: 0.8766
Epoch 88/300
390/390 [============================>.] - ETA: 0s - loss: 0.3153 - acc: 0.8910
Epoch 00088: val_acc improved from 0.87660 to 0.87770, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 39s 100ms/step - loss: 0.3152 - acc:
0.8910 - val_loss: 0.4189 - val_acc: 0.8777
Epoch 89/300
390/390 [============================>.] - ETA: 0s - loss: 0.3168 - acc: 0.8897
Epoch 00089: val_acc did not improve from 0.87770
391/390 [==============================] - 38s 98ms/step - loss: 0.3168 - acc:
0.8897 - val_loss: 0.5406 - val_acc: 0.8467
Epoch 90/300
390/390 [============================>.] - ETA: 0s - loss: 0.3142 - acc: 0.8919
Epoch 00090: val_acc did not improve from 0.87770
391/390 [==============================] - 39s 99ms/step - loss: 0.3143 - acc:
0.8918 - val_loss: 0.4971 - val_acc: 0.8576
Epoch 91/300
390/390 [============================>.] - ETA: 0s - loss: 0.3147 - acc: 0.8897
Epoch 00091: val_acc did not improve from 0.87770
391/390 [==============================] - 38s 97ms/step - loss: 0.3147 - acc:
0.8897 - val_loss: 0.5005 - val_acc: 0.8551
Epoch 92/300
390/390 [============================>.] - ETA: 0s - loss: 0.3109 - acc: 0.8930
Epoch 00092: val_acc did not improve from 0.87770
391/390 [==============================] - 38s 97ms/step - loss: 0.3110 - acc:
0.8929 - val_loss: 0.5630 - val_acc: 0.8422
Epoch 93/300
390/390 [============================>.] - ETA: 0s - loss: 0.3085 - acc: 0.8926
Epoch 00093: val_acc did not improve from 0.87770
391/390 [==============================] - 38s 97ms/step - loss: 0.3087 - acc:
0.8927 - val_loss: 0.4311 - val_acc: 0.8731
Epoch 94/300
390/390 [============================>.] - ETA: 0s - loss: 0.3079 - acc: 0.8917
Epoch 00094: val_acc did not improve from 0.87770
391/390 [==============================] - 38s 97ms/step - loss: 0.3081 - acc:
0.8916 - val_loss: 0.4066 - val_acc: 0.8756

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Epoch 95/300
390/390 [==============================>.] - ETA: 0s - loss: 0.3090 - acc: 0.8905
Epoch 00095: val_acc did not improve from 0.87770
391/390 [==============================] - 38s 98ms/step - loss: 0.3087 - acc:
0.8906 - val_loss: 0.6620 - val_acc: 0.8215
Epoch 96/300
390/390 [==============================>.] - ETA: 0s - loss: 0.3118 - acc: 0.8906-
ETA: 1s - loss:
Epoch 00096: val_acc did not improve from 0.87770
391/390 [==============================] - 38s 96ms/step - loss: 0.3117 - acc:
0.8906 - val_loss: 0.5373 - val_acc: 0.8440
Epoch 97/300
390/390 [==============================>.] - ETA: 0s - loss: 0.3055 - acc: 0.8945-
ETA: 1s - loss:
Epoch 00097: val_acc did not improve from 0.87770
391/390 [==============================] - 38s 97ms/step - loss: 0.3057 - acc:
0.8944 - val_loss: 0.4636 - val_acc: 0.8656
Epoch 98/300
390/390 [==============================>.] - ETA: 0s - loss: 0.3022 - acc: 0.8942
Epoch 00098: val_acc did not improve from 0.87770
391/390 [==============================] - 38s 97ms/step - loss: 0.3019 - acc:
0.8943 - val_loss: 0.4248 - val_acc: 0.8727
Epoch 99/300
390/390 [==============================>.] - ETA: 0s - loss: 0.3045 - acc: 0.8936-
ETA
Epoch 00099: val_acc did not improve from 0.87770
391/390 [==============================] - 38s 97ms/step - loss: 0.3045 - acc:
0.8936 - val_loss: 0.6297 - val_acc: 0.8224
Epoch 100/300
390/390 [==============================>.] - ETA: 0s - loss: 0.3024 - acc: 0.8938
Epoch 00100: val_acc did not improve from 0.87770
391/390 [==============================] - 38s 97ms/step - loss: 0.3028 - acc:
0.8936 - val_loss: 0.5426 - val_acc: 0.8517
Epoch 101/300
390/390 [==============================>.] - ETA: 0s - loss: 0.3009 - acc: 0.8951
Epoch 00101: val_acc did not improve from 0.87770
391/390 [==============================] - 38s 97ms/step - loss: 0.3008 - acc:
0.8952 - val_loss: 0.5313 - val_acc: 0.8543
Epoch 102/300
390/390 [==============================>.] - ETA: 0s - loss: 0.3010 - acc: 0.8945
Epoch 00102: val_acc did not improve from 0.87770
391/390 [==============================] - 38s 97ms/step - loss: 0.3011 - acc:
0.8945 - val_loss: 0.4794 - val_acc: 0.8612
Epoch 103/300
390/390 [==============================>.] - ETA: 0s - loss: 0.3007 - acc: 0.8942
Epoch 00103: val_acc improved from 0.87770 to 0.88230, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 38s 97ms/step - loss: 0.3006 - acc:
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0.8942 - val_loss: 0.3959 - val_acc: 0.8823
Epoch 104/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2971 - acc: 0.8962
Epoch 00104: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 97ms/step - loss: 0.2971 - acc:
0.8961 - val_loss: 0.4067 - val_acc: 0.8777
Epoch 105/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2937 - acc: 0.8986
Epoch 00105: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 97ms/step - loss: 0.2936 - acc:
0.8986 - val_loss: 0.4316 - val_acc: 0.8718
Epoch 106/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2922 - acc: 0.8981
Epoch 00106: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 97ms/step - loss: 0.2920 - acc:
0.8982 - val_loss: 0.4784 - val_acc: 0.8633
Epoch 107/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2938 - acc: 0.8959
Epoch 00107: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 97ms/step - loss: 0.2937 - acc:
0.8959 - val_loss: 0.4591 - val_acc: 0.8692
Epoch 108/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2972 - acc: 0.8963
Epoch 00108: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 97ms/step - loss: 0.2973 - acc:
0.8962 - val_loss: 0.4202 - val_acc: 0.8818
Epoch 109/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2942 - acc: 0.8960
Epoch 00109: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 97ms/step - loss: 0.2943 - acc:
0.8960 - val_loss: 0.6542 - val_acc: 0.8255
Epoch 110/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2946 - acc: 0.8978
Epoch 00110: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 97ms/step - loss: 0.2944 - acc:
0.8978 - val_loss: 0.5613 - val_acc: 0.8494
Epoch 111/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2907 - acc: 0.8971
Epoch 00111: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 96ms/step - loss: 0.2909 - acc:
0.8970 - val_loss: 0.5055 - val_acc: 0.8578
Epoch 112/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2892 - acc: 0.8979
Epoch 00112: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 97ms/step - loss: 0.2894 - acc:
0.8978 - val_loss: 0.4560 - val_acc: 0.8671
Epoch 113/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2882 - acc: 0.8980

Epoch 00113: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 96ms/step - loss: 0.2882 - acc: 0.8980 - val_loss: 0.4216 - val_acc: 0.8762
Epoch 114/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2890 - acc: 0.8981-
ETA: 5s - loss: 0 - E
Epoch 00114: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 97ms/step - loss: 0.2893 - acc: 0.8980 - val_loss: 0.4197 - val_acc: 0.8782
Epoch 115/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2888 - acc: 0.8992
Epoch 00115: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 96ms/step - loss: 0.2886 - acc: 0.8993 - val_loss: 0.3861 - val_acc: 0.8812
Epoch 116/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2862 - acc: 0.8998
Epoch 00116: val_acc did not improve from 0.88230
391/390 [==============================] - 37s 96ms/step - loss: 0.2863 - acc: 0.8997 - val_loss: 0.5531 - val_acc: 0.8425
Epoch 117/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2855 - acc: 0.9008-
ETA: 1s - loss: 0.2842
Epoch 00117: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 96ms/step - loss: 0.2854 - acc: 0.9009 - val_loss: 0.4595 - val_acc: 0.8674
Epoch 118/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2816 - acc: 0.9030
Epoch 00118: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 96ms/step - loss: 0.2816 - acc: 0.9029 - val_loss: 0.3942 - val_acc: 0.8820
Epoch 119/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2856 - acc: 0.8984
Epoch 00119: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 96ms/step - loss: 0.2854 - acc: 0.8985 - val_loss: 0.4338 - val_acc: 0.8763
Epoch 120/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2812 - acc: 0.9026
Epoch 00120: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 96ms/step - loss: 0.2811 - acc: 0.9026 - val_loss: 0.4164 - val_acc: 0.8784
Epoch 121/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2816 - acc: 0.9005
Epoch 00121: val_acc did not improve from 0.88230
391/390 [==============================] - 39s 99ms/step - loss: 0.2817 - acc: 0.9005 - val_loss: 0.4109 - val_acc: 0.8749
Epoch 122/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2796 - acc: 0.9018
Epoch 00122: val_acc did not improve from 0.88230

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391/390 [==============================] - 38s 97ms/step - loss: 0.2796 - acc:
0.9017 - val_loss: 0.4711 - val_acc: 0.8652
Epoch 123/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2822 - acc: 0.9014
Epoch 00123: val_acc did not improve from 0.88230
391/390 [==============================] - 38s 97ms/step - loss: 0.2821 - acc:
0.9015 - val_loss: 0.4497 - val_acc: 0.8705
Epoch 124/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2783 - acc: 0.9020
Epoch 00124: val_acc improved from 0.88230 to 0.88430, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 39s 100ms/step - loss: 0.2786 - acc:
0.9020 - val_loss: 0.4022 - val_acc: 0.8843
Epoch 125/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2834 - acc: 0.9006
Epoch 00125: val_acc did not improve from 0.88430
391/390 [==============================] - 38s 98ms/step - loss: 0.2833 - acc:
0.9006 - val_loss: 0.4423 - val_acc: 0.8730
Epoch 126/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2792 - acc: 0.9012
Epoch 00126: val_acc did not improve from 0.88430
391/390 [==============================] - 37s 96ms/step - loss: 0.2792 - acc:
0.9013 - val_loss: 0.4297 - val_acc: 0.8787
Epoch 127/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2748 - acc: 0.9029
Epoch 00127: val_acc did not improve from 0.88430
391/390 [==============================] - 38s 98ms/step - loss: 0.2746 - acc:
0.9029 - val_loss: 0.5026 - val_acc: 0.8655
Epoch 128/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2788 - acc: 0.9028
Epoch 00128: val_acc improved from 0.88430 to 0.89130, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 37s 95ms/step - loss: 0.2787 - acc:
0.9028 - val_loss: 0.3716 - val_acc: 0.8913
Epoch 129/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2742 - acc: 0.9032
Epoch 00129: val_acc did not improve from 0.89130
391/390 [==============================] - 37s 96ms/step - loss: 0.2745 - acc:
0.9031 - val_loss: 0.5972 - val_acc: 0.8370
Epoch 130/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2750 - acc: 0.9026
Epoch 00130: val_acc did not improve from 0.89130
391/390 [==============================] - 37s 95ms/step - loss: 0.2750 - acc:
0.9026 - val_loss: 0.4157 - val_acc: 0.8780
Epoch 131/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2759 - acc: 0.9039-
ETA: 2
Epoch 00131: val_acc did not improve from 0.89130
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391/390 [==============================] - 37s 95ms/step - loss: 0.2760 - acc: 0.9039 - val_loss: 0.3995 - val_acc: 0.8877
Epoch 132/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2670 - acc: 0.9042
Epoch 00132: val_acc did not improve from 0.89130
391/390 [==============================] - 37s 95ms/step - loss: 0.2670 - acc: 0.9043 - val_loss: 0.4830 - val_acc: 0.8720
Epoch 133/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2718 - acc: 0.9042
Epoch 00133: val_acc did not improve from 0.89130
391/390 [==============================] - 37s 95ms/step - loss: 0.2719 - acc: 0.9042 - val_loss: 0.4205 - val_acc: 0.8813
Epoch 134/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2708 - acc: 0.9051
Epoch 00134: val_acc did not improve from 0.89130
391/390 [==============================] - 37s 95ms/step - loss: 0.2711 - acc: 0.9050 - val_loss: 0.4545 - val_acc: 0.8716
Epoch 135/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2695 - acc: 0.9054
Epoch 00135: val_acc did not improve from 0.89130
391/390 [==============================] - 37s 94ms/step - loss: 0.2692 - acc: 0.9055 - val_loss: 0.4042 - val_acc: 0.8860
Epoch 136/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2709 - acc: 0.9041
Epoch 00136: val_acc did not improve from 0.89130
391/390 [==============================] - 37s 95ms/step - loss: 0.2709 - acc: 0.9041 - val_loss: 0.4557 - val_acc: 0.8721
Epoch 137/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2682 - acc: 0.9069
Epoch 00137: val_acc did not improve from 0.89130
391/390 [==============================] - 37s 95ms/step - loss: 0.2681 - acc: 0.9070 - val_loss: 0.4223 - val_acc: 0.8761
Epoch 138/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2704 - acc: 0.9067
Epoch 00138: val_acc did not improve from 0.89130
391/390 [==============================] - 38s 98ms/step - loss: 0.2702 - acc: 0.9067 - val_loss: 0.4789 - val_acc: 0.8667
Epoch 139/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2698 - acc: 0.9049
Epoch 00139: val_acc did not improve from 0.89130
391/390 [==============================] - 38s 98ms/step - loss: 0.2698 - acc: 0.9048 - val_loss: 0.4986 - val_acc: 0.8599
Epoch 140/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2634 - acc: 0.9075
Epoch 00140: val_acc did not improve from 0.89130
391/390 [==============================] - 38s 98ms/step - loss: 0.2635 - acc: 0.9076 - val_loss: 0.4867 - val_acc: 0.8668
Epoch 141/300

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390/390 [==============================>.] - ETA: 0s - loss: 0.2659 - acc: 0.9047
Epoch 00141: val_acc did not improve from 0.89130
391/390 [==============================] - 38s 98ms/step - loss: 0.2657 - acc:
0.9048 - val_loss: 0.4971 - val_acc: 0.8655
Epoch 142/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2693 - acc: 0.9052
Epoch 00142: val_acc did not improve from 0.89130
391/390 [==============================] - 38s 97ms/step - loss: 0.2695 - acc:
0.9051 - val_loss: 0.5357 - val_acc: 0.8543
Epoch 143/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2615 - acc: 0.9063
Epoch 00143: val_acc did not improve from 0.89130
391/390 [==============================] - 39s 100ms/step - loss: 0.2615 - acc:
0.9062 - val_loss: 0.3795 - val_acc: 0.8882
Epoch 144/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2618 - acc: 0.9080
Epoch 00144: val_acc did not improve from 0.89130
391/390 [==============================] - 38s 97ms/step - loss: 0.2619 - acc:
0.9079 - val_loss: 0.5395 - val_acc: 0.8429
Epoch 145/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2598 - acc: 0.9094
Epoch 00145: val_acc did not improve from 0.89130
391/390 [==============================] - 38s 96ms/step - loss: 0.2598 - acc:
0.9094 - val_loss: 0.4996 - val_acc: 0.8616
Epoch 146/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2603 - acc: 0.9096
Epoch 00146: val_acc did not improve from 0.89130
391/390 [==============================] - 38s 97ms/step - loss: 0.2604 - acc:
0.9094 - val_loss: 0.4093 - val_acc: 0.8859
Epoch 147/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2608 - acc: 0.9071
Epoch 00147: val_acc did not improve from 0.89130
391/390 [==============================] - 38s 97ms/step - loss: 0.2608 - acc:
0.9071 - val_loss: 0.5897 - val_acc: 0.8461
Epoch 148/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2639 - acc: 0.9058
Epoch 00148: val_acc did not improve from 0.89130
391/390 [==============================] - 38s 97ms/step - loss: 0.2642 - acc:
0.9057 - val_loss: 0.4006 - val_acc: 0.8822
Epoch 149/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2588 - acc: 0.9090
Epoch 00149: val_acc did not improve from 0.89130
391/390 [==============================] - 38s 97ms/step - loss: 0.2589 - acc:
0.9091 - val_loss: 0.3849 - val_acc: 0.8897
Epoch 150/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2578 - acc: 0.9093-
ETA: 1s - loss: 0.
Epoch 00150: val_acc did not improve from 0.89130
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391/390 [==============================] - 38s 97ms/step - loss: 0.2579 - acc: 0.9093 - val_loss: 0.4113 - val_acc: 0.8867
Epoch 151/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2595 - acc: 0.9084
Epoch 00151: val_acc did not improve from 0.89130
391/390 [==============================] - 38s 97ms/step - loss: 0.2597 - acc: 0.9084 - val_loss: 0.5415 - val_acc: 0.8529
Epoch 152/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2590 - acc: 0.9080
Epoch 00152: val_acc did not improve from 0.89130
391/390 [==============================] - 38s 97ms/step - loss: 0.2590 - acc: 0.9081 - val_loss: 0.4159 - val_acc: 0.8788
Epoch 153/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2580 - acc: 0.9088
Epoch 00153: val_acc did not improve from 0.89130
391/390 [==============================] - 38s 97ms/step - loss: 0.2580 - acc: 0.9088 - val_loss: 0.3920 - val_acc: 0.8870
Epoch 154/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2586 - acc: 0.9086-
ETA: 2s - los - ETA: 0s - loss: 0.2581 - acc
Epoch 00154: val_acc improved from 0.89130 to 0.89160, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 38s 97ms/step - loss: 0.2588 - acc: 0.9085 - val_loss: 0.3765 - val_acc: 0.8916
Epoch 155/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2576 - acc: 0.9091
Epoch 00155: val_acc did not improve from 0.89160
391/390 [==============================] - 38s 98ms/step - loss: 0.2573 - acc: 0.9091 - val_loss: 0.3909 - val_acc: 0.8870
Epoch 156/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2576 - acc: 0.9102
Epoch 00156: val_acc improved from 0.89160 to 0.89990, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 38s 98ms/step - loss: 0.2574 - acc: 0.9103 - val_loss: 0.3416 - val_acc: 0.8999
Epoch 157/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2531 - acc: 0.9120
Epoch 00157: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2531 - acc: 0.9120 - val_loss: 0.4498 - val_acc: 0.8765
Epoch 158/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2586 - acc: 0.9083
Epoch 00158: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2587 - acc: 0.9083 - val_loss: 0.3478 - val_acc: 0.8996
Epoch 159/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2511 - acc: 0.9110
Epoch 00159: val_acc did not improve from 0.89990

391/390 [==============================] - 38s 97ms/step - loss: 0.2512 - acc: 0.9109 - val_loss: 0.5047 - val_acc: 0.8606
Epoch 160/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2541 - acc: 0.9106
Epoch 00160: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 96ms/step - loss: 0.2541 - acc: 0.9106 - val_loss: 0.4171 - val_acc: 0.8824
Epoch 161/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2516 - acc: 0.9127
Epoch 00161: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2517 - acc: 0.9126 - val_loss: 0.7756 - val_acc: 0.8023
Epoch 162/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2518 - acc: 0.9118
Epoch 00162: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 98ms/step - loss: 0.2518 - acc: 0.9118 - val_loss: 0.4007 - val_acc: 0.8887
Epoch 163/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2562 - acc: 0.9106
Epoch 00163: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2561 - acc: 0.9107 - val_loss: 0.4053 - val_acc: 0.8859
Epoch 164/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2535 - acc: 0.9102
Epoch 00164: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 98ms/step - loss: 0.2533 - acc: 0.9103 - val_loss: 0.4923 - val_acc: 0.8663
Epoch 165/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2476 - acc: 0.9130
Epoch 00165: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2474 - acc: 0.9130 - val_loss: 0.3745 - val_acc: 0.8893
Epoch 166/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2492 - acc: 0.9119
Epoch 00166: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2493 - acc: 0.9119 - val_loss: 0.4049 - val_acc: 0.8833
Epoch 167/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2503 - acc: 0.9108
Epoch 00167: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 96ms/step - loss: 0.2505 - acc: 0.9108 - val_loss: 0.4207 - val_acc: 0.8826
Epoch 168/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2505 - acc: 0.9128
Epoch 00168: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 96ms/step - loss: 0.2506 - acc: 0.9127 - val_loss: 0.3767 - val_acc: 0.8906
Epoch 169/300

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390/390 [==============================>.] - ETA: 0s - loss: 0.2519 - acc: 0.9111
Epoch 00169: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2521 - acc:
0.9111 - val_loss: 0.4144 - val_acc: 0.8801
Epoch 170/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2526 - acc: 0.9114
Epoch 00170: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2526 - acc:
0.9114 - val_loss: 0.3516 - val_acc: 0.8947
Epoch 171/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2454 - acc: 0.9140
Epoch 00171: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2454 - acc:
0.9140 - val_loss: 0.5599 - val_acc: 0.8460
Epoch 172/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2470 - acc: 0.9130
Epoch 00172: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2470 - acc:
0.9130 - val_loss: 0.4110 - val_acc: 0.8836
Epoch 173/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2494 - acc: 0.9121
Epoch 00173: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2495 - acc:
0.9120 - val_loss: 0.3983 - val_acc: 0.8839
Epoch 174/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2416 - acc: 0.9144
Epoch 00174: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2421 - acc:
0.9142 - val_loss: 0.6538 - val_acc: 0.8368
Epoch 175/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2493 - acc: 0.9119
Epoch 00175: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2491 - acc:
0.9120 - val_loss: 0.3894 - val_acc: 0.8883
Epoch 176/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2450 - acc: 0.9138
Epoch 00176: val_acc did not improve from 0.89990
391/390 [==============================] - 39s 99ms/step - loss: 0.2449 - acc:
0.9138 - val_loss: 0.4652 - val_acc: 0.8698
Epoch 177/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2432 - acc: 0.9150
Epoch 00177: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2431 - acc:
0.9151 - val_loss: 0.4605 - val_acc: 0.8768
Epoch 178/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2472 - acc: 0.9121
Epoch 00178: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2474 - acc:
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0.9121 - val_loss: 0.4396 - val_acc: 0.8752
Epoch 179/300
390/390 [============================>.] - ETA: 0s - loss: 0.2465 - acc: 0.9128
Epoch 00179: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2465 - acc:
0.9128 - val_loss: 0.4470 - val_acc: 0.8744
Epoch 180/300
390/390 [============================>.] - ETA: 0s - loss: 0.2444 - acc: 0.9138
Epoch 00180: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 98ms/step - loss: 0.2445 - acc:
0.9138 - val_loss: 0.4882 - val_acc: 0.8706
Epoch 181/300
390/390 [============================>.] - ETA: 0s - loss: 0.2445 - acc: 0.9139-
ETA: 1s - loss: 0.2
Epoch 00181: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2445 - acc:
0.9139 - val_loss: 0.3979 - val_acc: 0.8843
Epoch 182/300
390/390 [============================>.] - ETA: 0s - loss: 0.2439 - acc: 0.9145
Epoch 00182: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2438 - acc:
0.9145 - val_loss: 0.4263 - val_acc: 0.8835
Epoch 183/300
390/390 [============================>.] - ETA: 0s - loss: 0.2458 - acc: 0.9125
Epoch 00183: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 98ms/step - loss: 0.2461 - acc:
0.9124 - val_loss: 0.5067 - val_acc: 0.8616
Epoch 184/300
390/390 [============================>.] - ETA: 0s - loss: 0.2424 - acc: 0.9157
Epoch 00184: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2423 - acc:
0.9158 - val_loss: 0.4438 - val_acc: 0.8773
Epoch 185/300
390/390 [============================>.] - ETA: 0s - loss: 0.2424 - acc: 0.9156
Epoch 00185: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2424 - acc:
0.9156 - val_loss: 0.3946 - val_acc: 0.8898
Epoch 186/300
390/390 [============================>.] - ETA: 0s - loss: 0.2401 - acc: 0.9148
Epoch 00186: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2402 - acc:
0.9148 - val_loss: 0.4895 - val_acc: 0.8731
Epoch 187/300
390/390 [============================>.] - ETA: 0s - loss: 0.2424 - acc: 0.9141
Epoch 00187: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2423 - acc:
0.9142 - val_loss: 0.3874 - val_acc: 0.8869
Epoch 188/300

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390/390 [=============================>.] - ETA: 0s - loss: 0.2383 - acc: 0.9164
Epoch 00188: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2383 - acc:
0.9165 - val_loss: 0.5063 - val_acc: 0.8618
Epoch 189/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2423 - acc: 0.9149
Epoch 00189: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 98ms/step - loss: 0.2421 - acc:
0.9150 - val_loss: 0.4289 - val_acc: 0.8775
Epoch 190/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2405 - acc: 0.9154
Epoch 00190: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2405 - acc:
0.9155 - val_loss: 0.5525 - val_acc: 0.8469
Epoch 191/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2359 - acc: 0.9162
Epoch 00191: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 98ms/step - loss: 0.2358 - acc:
0.9163 - val_loss: 0.4534 - val_acc: 0.8824
Epoch 192/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2391 - acc: 0.9154-
ETA: 4s - loss: 0.2388
Epoch 00192: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2393 - acc:
0.9154 - val_loss: 0.4709 - val_acc: 0.8748
Epoch 193/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2359 - acc: 0.9164
Epoch 00193: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2358 - acc:
0.9164 - val_loss: 0.4753 - val_acc: 0.8700
Epoch 194/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2392 - acc: 0.9152
Epoch 00194: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2392 - acc:
0.9151 - val_loss: 0.4101 - val_acc: 0.8807
Epoch 195/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2364 - acc: 0.9160
Epoch 00195: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2362 - acc:
0.9161 - val_loss: 0.3740 - val_acc: 0.8909
Epoch 196/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2367 - acc: 0.9170
Epoch 00196: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2365 - acc:
0.9170 - val_loss: 0.4817 - val_acc: 0.8699
Epoch 197/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2379 - acc: 0.9169
Epoch 00197: val_acc did not improve from 0.89990
```

391/390 [==============================] - 38s 98ms/step - loss: 0.2379 - acc: 0.9168 - val_loss: 0.5141 - val_acc: 0.8626
Epoch 198/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2313 - acc: 0.9178
Epoch 00198: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 98ms/step - loss: 0.2315 - acc: 0.9177 - val_loss: 0.4293 - val_acc: 0.8818
Epoch 199/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2325 - acc: 0.9176
Epoch 00199: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 98ms/step - loss: 0.2324 - acc: 0.9177 - val_loss: 0.4413 - val_acc: 0.8822
Epoch 200/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2338 - acc: 0.9166
Epoch 00200: val_acc did not improve from 0.89990
391/390 [==============================] - 38s 97ms/step - loss: 0.2338 - acc: 0.9166 - val_loss: 0.4441 - val_acc: 0.8768
Epoch 201/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2322 - acc: 0.9184
Epoch 00201: val_acc improved from 0.89990 to 0.90240, saving model to
DNST_model_with_augmentation.hdf5
391/390 [==============================] - 38s 98ms/step - loss: 0.2323 - acc: 0.9184 - val_loss: 0.3344 - val_acc: 0.9024
Epoch 202/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2329 - acc: 0.9187
Epoch 00202: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 97ms/step - loss: 0.2327 - acc: 0.9187 - val_loss: 0.4380 - val_acc: 0.8834
Epoch 203/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2314 - acc: 0.9189
Epoch 00203: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2314 - acc: 0.9189 - val_loss: 0.3648 - val_acc: 0.8958
Epoch 204/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2366 - acc: 0.9160
Epoch 00204: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2366 - acc: 0.9160 - val_loss: 0.4576 - val_acc: 0.8743
Epoch 205/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2345 - acc: 0.9168
Epoch 00205: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 97ms/step - loss: 0.2347 - acc: 0.9167 - val_loss: 0.3815 - val_acc: 0.8922
Epoch 206/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2337 - acc: 0.9188-
ETA: 2s - los
Epoch 00206: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 97ms/step - loss: 0.2336 - acc:

0.9187 - val_loss: 0.4275 - val_acc: 0.8775
Epoch 207/300
390/390 [============================>.] - ETA: 0s - loss: 0.2303 - acc: 0.9191-
ETA: 0s - loss: 0.2305 - acc: 0
Epoch 00207: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 100ms/step - loss: 0.2302 - acc:
0.9190 - val_loss: 0.4250 - val_acc: 0.8828
Epoch 208/300
390/390 [============================>.] - ETA: 0s - loss: 0.2323 - acc: 0.9181
Epoch 00208: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2323 - acc:
0.9181 - val_loss: 0.4312 - val_acc: 0.8795
Epoch 209/300
390/390 [============================>.] - ETA: 0s - loss: 0.2319 - acc: 0.9187
Epoch 00209: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2318 - acc:
0.9187 - val_loss: 0.3660 - val_acc: 0.8982
Epoch 210/300
390/390 [============================>.] - ETA: 0s - loss: 0.2314 - acc: 0.9175
Epoch 00210: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2316 - acc:
0.9174 - val_loss: 0.4273 - val_acc: 0.8825
Epoch 211/300
390/390 [============================>.] - ETA: 0s - loss: 0.2298 - acc: 0.9178
Epoch 00211: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2299 - acc:
0.9178 - val_loss: 0.4319 - val_acc: 0.8786
Epoch 212/300
390/390 [============================>.] - ETA: 0s - loss: 0.2270 - acc: 0.9183
Epoch 00212: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2268 - acc:
0.9183 - val_loss: 0.4200 - val_acc: 0.8836
Epoch 213/300
390/390 [============================>.] - ETA: 0s - loss: 0.2288 - acc: 0.9191
Epoch 00213: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2289 - acc:
0.9190 - val_loss: 0.3964 - val_acc: 0.8857
Epoch 214/300
390/390 [============================>.] - ETA: 0s - loss: 0.2297 - acc: 0.9189
Epoch 00214: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2298 - acc:
0.9189 - val_loss: 0.3639 - val_acc: 0.8948
Epoch 215/300
390/390 [============================>.] - ETA: 0s - loss: 0.2297 - acc: 0.9191-
ETA: 2s - loss
Epoch 00215: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2296 - acc:
0.9191 - val_loss: 0.3814 - val_acc: 0.8947

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Epoch 216/300
390/390 [============================>.] - ETA: 0s - loss: 0.2279 - acc: 0.9187
Epoch 00216: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2280 - acc:
0.9188 - val_loss: 0.3481 - val_acc: 0.9002
Epoch 217/300
390/390 [============================>.] - ETA: 0s - loss: 0.2231 - acc: 0.9216
Epoch 00217: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2231 - acc:
0.9215 - val_loss: 0.4287 - val_acc: 0.8815
Epoch 218/300
390/390 [============================>.] - ETA: 0s - loss: 0.2303 - acc: 0.9198
Epoch 00218: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2302 - acc:
0.9199 - val_loss: 0.3792 - val_acc: 0.8973
Epoch 219/300
390/390 [============================>.] - ETA: 0s - loss: 0.2259 - acc: 0.9212
Epoch 00219: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2258 - acc:
0.9212 - val_loss: 0.4492 - val_acc: 0.8756
Epoch 220/300
390/390 [============================>.] - ETA: 0s - loss: 0.2278 - acc: 0.9187
Epoch 00220: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2278 - acc:
0.9187 - val_loss: 0.3677 - val_acc: 0.8983
Epoch 221/300
390/390 [============================>.] - ETA: 0s - loss: 0.2269 - acc: 0.9203
Epoch 00221: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 100ms/step - loss: 0.2268 - acc:
0.9203 - val_loss: 0.4079 - val_acc: 0.8835
Epoch 222/300
390/390 [============================>.] - ETA: 0s - loss: 0.2263 - acc: 0.9207
Epoch 00222: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2262 - acc:
0.9208 - val_loss: 0.3796 - val_acc: 0.8937
Epoch 223/300
390/390 [============================>.] - ETA: 0s - loss: 0.2275 - acc: 0.9196
Epoch 00223: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 100ms/step - loss: 0.2276 - acc:
0.9196 - val_loss: 0.4039 - val_acc: 0.8916
Epoch 224/300
390/390 [============================>.] - ETA: 0s - loss: 0.2261 - acc: 0.9193
Epoch 00224: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2258 - acc:
0.9194 - val_loss: 0.4462 - val_acc: 0.8819
Epoch 225/300
390/390 [============================>.] - ETA: 0s - loss: 0.2277 - acc: 0.9184
Epoch 00225: val_acc did not improve from 0.90240
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391/390 [==============================] - 39s 100ms/step - loss: 0.2275 - acc: 0.9185 - val_loss: 0.4177 - val_acc: 0.8850
Epoch 226/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2235 - acc: 0.9203
Epoch 00226: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2238 - acc: 0.9201 - val_loss: 0.4311 - val_acc: 0.8828
Epoch 227/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2220 - acc: 0.9212- ETA: 1s - loss: 0.2
Epoch 00227: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2220 - acc: 0.9212 - val_loss: 0.3986 - val_acc: 0.8908
Epoch 228/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2216 - acc: 0.9200
Epoch 00228: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 100ms/step - loss: 0.2215 - acc: 0.9200 - val_loss: 0.4110 - val_acc: 0.8819
Epoch 229/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2221 - acc: 0.9208
Epoch 00229: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 100ms/step - loss: 0.2220 - acc: 0.9208 - val_loss: 0.3757 - val_acc: 0.8918
Epoch 230/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2252 - acc: 0.9206
Epoch 00230: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2252 - acc: 0.9206 - val_loss: 0.4769 - val_acc: 0.8718
Epoch 231/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2204 - acc: 0.9225
Epoch 00231: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2201 - acc: 0.9226 - val_loss: 0.3525 - val_acc: 0.8980
Epoch 232/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2159 - acc: 0.9236
Epoch 00232: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2159 - acc: 0.9236 - val_loss: 0.4565 - val_acc: 0.8787
Epoch 233/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2217 - acc: 0.9213
Epoch 00233: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 97ms/step - loss: 0.2218 - acc: 0.9213 - val_loss: 0.4153 - val_acc: 0.8857
Epoch 234/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2207 - acc: 0.9219- ETA: 2s - lo
Epoch 00234: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 97ms/step - loss: 0.2206 - acc:

0.9219 - val_loss: 0.3585 - val_acc: 0.8987
Epoch 235/300
390/390 [============================>.] - ETA: 0s - loss: 0.2206 - acc: 0.9207
Epoch 00235: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2207 - acc:
0.9206 - val_loss: 0.3869 - val_acc: 0.8912
Epoch 236/300
390/390 [============================>.] - ETA: 0s - loss: 0.2188 - acc: 0.9220
Epoch 00236: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2187 - acc:
0.9220 - val_loss: 0.4815 - val_acc: 0.8723
Epoch 237/300
390/390 [============================>.] - ETA: 0s - loss: 0.2175 - acc: 0.9229
Epoch 00237: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2174 - acc:
0.9229 - val_loss: 0.3632 - val_acc: 0.8988
Epoch 238/300
390/390 [============================>.] - ETA: 0s - loss: 0.2203 - acc: 0.9223
Epoch 00238: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 99ms/step - loss: 0.2203 - acc:
0.9223 - val_loss: 0.4030 - val_acc: 0.8903
Epoch 239/300
390/390 [============================>.] - ETA: 0s - loss: 0.2139 - acc: 0.9234
Epoch 00239: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 101ms/step - loss: 0.2140 - acc:
0.9233 - val_loss: 0.4148 - val_acc: 0.8870
Epoch 240/300
390/390 [============================>.] - ETA: 0s - loss: 0.2235 - acc: 0.9220
Epoch 00240: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 97ms/step - loss: 0.2237 - acc:
0.9219 - val_loss: 0.5174 - val_acc: 0.8624
Epoch 241/300
390/390 [============================>.] - ETA: 0s - loss: 0.2206 - acc: 0.9215
Epoch 00241: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2208 - acc:
0.9215 - val_loss: 0.4166 - val_acc: 0.8874
Epoch 242/300
390/390 [============================>.] - ETA: 0s - loss: 0.2144 - acc: 0.9249
Epoch 00242: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2146 - acc:
0.9248 - val_loss: 0.3950 - val_acc: 0.8875
Epoch 243/300
390/390 [============================>.] - ETA: 0s - loss: 0.2166 - acc: 0.9229
Epoch 00243: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 97ms/step - loss: 0.2166 - acc:
0.9229 - val_loss: 0.4983 - val_acc: 0.8665
Epoch 244/300
390/390 [============================>.] - ETA: 0s - loss: 0.2172 - acc: 0.9235

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Epoch 00244: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 97ms/step - loss: 0.2171 - acc:
0.9236 - val_loss: 0.4743 - val_acc: 0.8763
Epoch 245/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2161 - acc: 0.9228
Epoch 00245: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2160 - acc:
0.9229 - val_loss: 0.3576 - val_acc: 0.8996
Epoch 246/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2147 - acc: 0.9240
Epoch 00246: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2146 - acc:
0.9240 - val_loss: 0.3925 - val_acc: 0.8912
Epoch 247/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2134 - acc: 0.9244
Epoch 00247: val_acc did not improve from 0.90240
391/390 [==============================] - 39s 98ms/step - loss: 0.2134 - acc:
0.9243 - val_loss: 0.3922 - val_acc: 0.8918
Epoch 248/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2132 - acc: 0.9245
Epoch 00248: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 97ms/step - loss: 0.2133 - acc:
0.9245 - val_loss: 0.4253 - val_acc: 0.8844
Epoch 249/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2113 - acc: 0.9247
Epoch 00249: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2113 - acc:
0.9247 - val_loss: 0.3889 - val_acc: 0.8941
Epoch 250/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2112 - acc: 0.9259
Epoch 00250: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2111 - acc:
0.9259 - val_loss: 0.3759 - val_acc: 0.8974
Epoch 251/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2169 - acc: 0.9237
Epoch 00251: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2170 - acc:
0.9236 - val_loss: 0.4283 - val_acc: 0.8837
Epoch 252/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2141 - acc: 0.9255
Epoch 00252: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2141 - acc:
0.9256 - val_loss: 0.4018 - val_acc: 0.8924
Epoch 253/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2150 - acc: 0.9238
Epoch 00253: val_acc did not improve from 0.90240
391/390 [==============================] - 38s 98ms/step - loss: 0.2151 - acc:
0.9238 - val_loss: 0.4357 - val_acc: 0.8860
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Epoch 254/300
390/390 [============================>.] - ETA: 0s - loss: 0.2123 - acc: 0.9248
Epoch 00254: val_acc did not improve from 0.90240
391/390 [=============================] - 38s 97ms/step - loss: 0.2123 - acc:
0.9248 - val_loss: 0.3893 - val_acc: 0.8878
Epoch 255/300
390/390 [============================>.] - ETA: 0s - loss: 0.2179 - acc: 0.9237
Epoch 00255: val_acc did not improve from 0.90240
391/390 [=============================] - 39s 99ms/step - loss: 0.2178 - acc:
0.9237 - val_loss: 0.4824 - val_acc: 0.8732
Epoch 256/300
390/390 [============================>.] - ETA: 0s - loss: 0.2151 - acc: 0.9251
Epoch 00256: val_acc did not improve from 0.90240
391/390 [=============================] - 38s 97ms/step - loss: 0.2149 - acc:
0.9252 - val_loss: 0.4245 - val_acc: 0.8822
Epoch 257/300
390/390 [============================>.] - ETA: 0s - loss: 0.2148 - acc: 0.9243
Epoch 00257: val_acc did not improve from 0.90240
391/390 [=============================] - 38s 97ms/step - loss: 0.2146 - acc:
0.9244 - val_loss: 0.3907 - val_acc: 0.8932
Epoch 258/300
390/390 [============================>.] - ETA: 0s - loss: 0.2130 - acc: 0.9249-
ETA: 1s - loss: 0.2132 -
Epoch 00258: val_acc did not improve from 0.90240
391/390 [=============================] - 38s 98ms/step - loss: 0.2130 - acc:
0.9249 - val_loss: 0.4708 - val_acc: 0.8738
Epoch 259/300
390/390 [============================>.] - ETA: 0s - loss: 0.2175 - acc: 0.9234
Epoch 00259: val_acc did not improve from 0.90240
391/390 [=============================] - 38s 98ms/step - loss: 0.2176 - acc:
0.9233 - val_loss: 0.4535 - val_acc: 0.8791
Epoch 260/300
390/390 [============================>.] - ETA: 0s - loss: 0.2140 - acc: 0.9246
Epoch 00260: val_acc improved from 0.90240 to 0.90800, saving model to
DNST_model_with_augmentation.hdf5
391/390 [=============================] - 39s 100ms/step - loss: 0.2140 - acc:
0.9246 - val_loss: 0.3285 - val_acc: 0.9080
Epoch 261/300
390/390 [============================>.] - ETA: 0s - loss: 0.2149 - acc: 0.9251
Epoch 00261: val_acc did not improve from 0.90800
391/390 [=============================] - 38s 98ms/step - loss: 0.2149 - acc:
0.9251 - val_loss: 0.4503 - val_acc: 0.8816
Epoch 262/300
390/390 [============================>.] - ETA: 0s - loss: 0.2134 - acc: 0.9248
Epoch 00262: val_acc did not improve from 0.90800
391/390 [=============================] - 38s 98ms/step - loss: 0.2136 - acc:
0.9247 - val_loss: 0.3756 - val_acc: 0.8977
Epoch 263/300
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390/390 [==============================>.] - ETA: 0s - loss: 0.2131 - acc: 0.9246
Epoch 00263: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 98ms/step - loss: 0.2130 - acc:
0.9247 - val_loss: 0.4343 - val_acc: 0.8821
Epoch 264/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2142 - acc: 0.9246
Epoch 00264: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 96ms/step - loss: 0.2141 - acc:
0.9247 - val_loss: 0.4362 - val_acc: 0.8793
Epoch 265/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2119 - acc: 0.9265
Epoch 00265: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 98ms/step - loss: 0.2118 - acc:
0.9265 - val_loss: 0.3787 - val_acc: 0.8939
Epoch 266/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2107 - acc: 0.9257-
ETA: 6s
Epoch 00266: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 97ms/step - loss: 0.2108 - acc:
0.9257 - val_loss: 0.4103 - val_acc: 0.8910
Epoch 267/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2083 - acc: 0.9256
Epoch 00267: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 98ms/step - loss: 0.2084 - acc:
0.9255 - val_loss: 0.3984 - val_acc: 0.8910
Epoch 268/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2105 - acc: 0.9256-
Epoch 00268: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 98ms/step - loss: 0.2107 - acc:
0.9255 - val_loss: 0.3941 - val_acc: 0.8933
Epoch 269/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2068 - acc: 0.9260
Epoch 00269: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 100ms/step - loss: 0.2071 - acc:
0.9260 - val_loss: 0.3542 - val_acc: 0.9032
Epoch 270/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2080 - acc: 0.9263
Epoch 00270: val_acc did not improve from 0.90800
391/390 [==============================] - 37s 96ms/step - loss: 0.2080 - acc:
0.9263 - val_loss: 0.3834 - val_acc: 0.8934
Epoch 271/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2048 - acc: 0.9277
Epoch 00271: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 97ms/step - loss: 0.2049 - acc:
0.9277 - val_loss: 0.4722 - val_acc: 0.8784
Epoch 272/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2100 - acc: 0.9259
Epoch 00272: val_acc did not improve from 0.90800
```

```
391/390 [==============================] - 39s 99ms/step - loss: 0.2099 - acc:
0.9258 - val_loss: 0.4187 - val_acc: 0.8879
Epoch 273/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2070 - acc: 0.9271
Epoch 00273: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 97ms/step - loss: 0.2068 - acc:
0.9271 - val_loss: 0.4135 - val_acc: 0.8882
Epoch 274/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2061 - acc: 0.9266
Epoch 00274: val_acc did not improve from 0.90800
391/390 [==============================] - 37s 96ms/step - loss: 0.2063 - acc:
0.9266 - val_loss: 0.3961 - val_acc: 0.8934
Epoch 275/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2105 - acc: 0.9261
Epoch 00275: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 100ms/step - loss: 0.2104 - acc:
0.9261 - val_loss: 0.4087 - val_acc: 0.8911
Epoch 276/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2095 - acc: 0.9254
Epoch 00276: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 97ms/step - loss: 0.2096 - acc:
0.9254 - val_loss: 0.3625 - val_acc: 0.8949
Epoch 277/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2073 - acc: 0.9263
Epoch 00277: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 99ms/step - loss: 0.2073 - acc:
0.9263 - val_loss: 0.3852 - val_acc: 0.8972
Epoch 278/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2124 - acc: 0.9244
Epoch 00278: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 99ms/step - loss: 0.2124 - acc:
0.9244 - val_loss: 0.4904 - val_acc: 0.8720
Epoch 279/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2080 - acc: 0.9271
Epoch 00279: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 99ms/step - loss: 0.2079 - acc:
0.9271 - val_loss: 0.4147 - val_acc: 0.8874
Epoch 280/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2082 - acc: 0.9257
Epoch 00280: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 98ms/step - loss: 0.2082 - acc:
0.9257 - val_loss: 0.3974 - val_acc: 0.8931
Epoch 281/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2071 - acc: 0.9262
Epoch 00281: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 98ms/step - loss: 0.2076 - acc:
0.9261 - val_loss: 0.3598 - val_acc: 0.8999
Epoch 282/300
```

```
390/390 [=============================>.] - ETA: 0s - loss: 0.2057 - acc: 0.9281
Epoch 00282: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 99ms/step - loss: 0.2057 - acc:
0.9280 - val_loss: 0.4034 - val_acc: 0.8921
Epoch 283/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2075 - acc: 0.9266
Epoch 00283: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 98ms/step - loss: 0.2076 - acc:
0.9266 - val_loss: 0.4033 - val_acc: 0.8926
Epoch 284/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2076 - acc: 0.9264
Epoch 00284: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 97ms/step - loss: 0.2076 - acc:
0.9264 - val_loss: 0.4590 - val_acc: 0.8797
Epoch 285/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2073 - acc: 0.9274
Epoch 00285: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 99ms/step - loss: 0.2072 - acc:
0.9274 - val_loss: 0.3904 - val_acc: 0.8933
Epoch 286/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2082 - acc: 0.9270
Epoch 00286: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 98ms/step - loss: 0.2083 - acc:
0.9269 - val_loss: 0.3932 - val_acc: 0.8950
Epoch 287/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2059 - acc: 0.9272
Epoch 00287: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 99ms/step - loss: 0.2061 - acc:
0.9271 - val_loss: 0.5821 - val_acc: 0.8488
Epoch 288/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2018 - acc: 0.9283
Epoch 00288: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 98ms/step - loss: 0.2016 - acc:
0.9283 - val_loss: 0.3989 - val_acc: 0.8867
Epoch 289/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2069 - acc: 0.9274-
ETA: 2s -
Epoch 00289: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 99ms/step - loss: 0.2068 - acc:
0.9274 - val_loss: 0.4030 - val_acc: 0.8943
Epoch 290/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2041 - acc: 0.9276
Epoch 00290: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 100ms/step - loss: 0.2041 - acc:
0.9276 - val_loss: 0.3854 - val_acc: 0.8996
Epoch 291/300
390/390 [=============================>.] - ETA: 0s - loss: 0.2028 - acc: 0.9282
Epoch 00291: val_acc did not improve from 0.90800
```

```
391/390 [==============================] - 38s 97ms/step - loss: 0.2027 - acc:
0.9282 - val_loss: 0.5111 - val_acc: 0.8694
Epoch 292/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2035 - acc: 0.9276
Epoch 00292: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 98ms/step - loss: 0.2034 - acc:
0.9276 - val_loss: 0.3579 - val_acc: 0.9023
Epoch 293/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2019 - acc: 0.9273-
ETA: 1s - loss: 0.201
Epoch 00293: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 98ms/step - loss: 0.2021 - acc:
0.9272 - val_loss: 0.3475 - val_acc: 0.9040
Epoch 294/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2048 - acc: 0.9283
Epoch 00294: val_acc did not improve from 0.90800
391/390 [==============================] - 38s 98ms/step - loss: 0.2047 - acc:
0.9283 - val_loss: 0.4033 - val_acc: 0.8932
Epoch 295/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2060 - acc: 0.9275
Epoch 00295: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 100ms/step - loss: 0.2060 - acc:
0.9275 - val_loss: 0.3833 - val_acc: 0.8958
Epoch 296/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2021 - acc: 0.9278
Epoch 00296: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 99ms/step - loss: 0.2021 - acc:
0.9277 - val_loss: 0.4062 - val_acc: 0.8908
Epoch 297/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2030 - acc: 0.9287
Epoch 00297: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 100ms/step - loss: 0.2031 - acc:
0.9286 - val_loss: 0.5378 - val_acc: 0.8627
Epoch 298/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2003 - acc: 0.9282
Epoch 00298: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 99ms/step - loss: 0.2001 - acc:
0.9284 - val_loss: 0.3998 - val_acc: 0.8904
Epoch 299/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2080 - acc: 0.9263
Epoch 00299: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 100ms/step - loss: 0.2081 - acc:
0.9263 - val_loss: 0.3827 - val_acc: 0.8952
Epoch 300/300
390/390 [==============================>.] - ETA: 0s - loss: 0.2034 - acc: 0.9272
Epoch 00300: val_acc did not improve from 0.90800
391/390 [==============================] - 39s 99ms/step - loss: 0.2033 - acc:
0.9272 - val_loss: 0.3999 - val_acc: 0.8922
```

```
[22]: <tensorflow.python.keras.callbacks.History at 0x1888d7f4518>
```

```
[23]: # Test the model
      score = model1.evaluate(X_test, y_test, verbose=1)
      print('Test loss:', score[0])
      print('Test accuracy:', score[1])
```

```
10000/10000 [==============================] - 3s 262us/sample - loss: 0.3993 -
acc: 0.8922
Test loss: 0.3993266311496496
Test accuracy: 0.8922
```

```
[24]: # Save the trained weights in to .h5 format
      model1.save_weights("DNST_model_with_augmentation.h5")
      print("Saved model to disk")
```

```
Saved model to disk
```