

File Edit View Insert Cell Kernel Widgets Help

Not Trusted | Python 3

File Insert Run Cell Code

```
In [1]: import os
from glob import glob

import pandas as pd
import numpy as np
from sklearn.model_selection import train_test_split
from keras.utils.np_utils import to_categorical # convert to one-hot-encoding

from keras.preprocessing.image import ImageDataGenerator
from keras import layers
from keras import Model
from keras.applications.inception_v3 import InceptionV3, preprocess_input
from keras.optimizers import Adam
from keras.callbacks import ReduceLROnPlateau, EarlyStopping
from keras import backend as K

%matplotlib inline
import matplotlib.pyplot as plt

Using TensorFlow backend.
```

```
In [2]: X_train = np.load("/floyd/input/skin_cancer_192_256/256_192_train.npy")
```

```
In [3]: y_train = np.load("/floyd/input/skin_cancer_192_256/train_labels.npy")
```

```
In [4]: X_val = np.load("/floyd/input/skin_cancer_192_256/256_192_val.npy")
```

```
In [5]: y_val = np.load("/floyd/input/skin_cancer_192_256/val_labels.npy")
```

```
In [6]: X_train.shape, X_val.shape
```

```
Out[6]: ((8111, 192, 256, 3), (902, 192, 256, 3))
```

```
In [7]: y_train.shape, y_val.shape
```

```
Out[7]: ((8111,), (902,))
```

```
In [8]: y_train = to_categorical(y_train)
y_val = to_categorical(y_val)
```

```
In [9]: pre_trained_model = InceptionV3(input_shape=(192, 256, 3), include_top=False, weights="imagenet")
```

```
In [10]: for layer in pre_trained_model.layers:
    print(layer.name)
    if hasattr(layer, 'moving_mean') and hasattr(layer, 'moving_variance'):
        layer.trainable = True
        K.eval(K.update(layer.moving_mean, K.zeros_like(layer.moving_mean)))
        K.eval(K.update(layer.moving_variance, K.zeros_like(layer.moving_variance)))
    else:
        layer.trainable = False

print(len(pre_trained_model.layers))
```

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conv2d_1
batch_normalization_1
activation_1
conv2d_2
batch_normalization_2
activation_2
conv2d_3
batch_normalization_3
activation_3
max_pooling2d_1
conv2d_4
batch_normalization_4
activation_4
conv2d_5
batch_normalization_5
activation_5
max_pooling2d_2
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```

```
model.compile(loss='categorical_crossentropy',
              optimizer=optimizer,
              metrics=['accuracy'])
```

```
In [13]: model.summary()
```

Layer (type)	Output Shape	Param #	Connected to
input_1 (InputLayer)	(None, 192, 256, 3)	0	
conv2d_1 (Conv2D)	(None, 95, 127, 32)	864	input_1[0][0]
batch_normalization_1 (BatchNor	(None, 95, 127, 32)	96	conv2d_1[0][0]
activation_1 (Activation)	(None, 95, 127, 32)	0	batch_normalization_1[0][0]
conv2d_2 (Conv2D)	(None, 93, 125, 32)	9216	activation_1[0][0]
batch_normalization_2 (BatchNor	(None, 93, 125, 32)	96	conv2d_2[0][0]
activation_2 (Activation)	(None, 93, 125, 32)	0	batch_normalization_2[0][0]
conv2d_3 (Conv2D)	(None, 93, 125, 64)	18432	activation_2[0][0]

```
In [14]: train_datagen = ImageDataGenerator(rotation_range=0, width_shift_range=0.2, height_shift_range=0.2,
                                         shear_range=0.2, zoom_range=0.2, fill_mode='nearest')

train_datagen.fit(X_train)

val_datagen = ImageDataGenerator()
val_datagen.fit(X_val)
```

```
In [15]: batch_size = 64
epochs = 3
history = model.fit_generator(train_datagen.flow(X_train,y_train, batch_size=batch_size),
                               epochs = epochs, validation_data = val_datagen.flow(X_val, y_val),
                               verbose = 1, steps_per_epoch=(X_train.shape[0] // batch_size),
                               validation_steps=(X_val.shape[0] // batch_size))
```

```
Epoch 1/3
126/126 [=====] - 125s 994ms/step - loss: 1.5077 - acc: 0.6045 - val_loss: 1.1479 - val_acc: 0.6496
Epoch 2/3
126/126 [=====] - 109s 865ms/step - loss: 1.0800 - acc: 0.6632 - val_loss: 0.9732 - val_acc: 0.6897
Epoch 3/3
126/126 [=====] - 107s 849ms/step - loss: 1.0364 - acc: 0.6674 - val_loss: 0.9118 - val_acc: 0.7014
```

```
In [16]: for layer in pre_trained_model.layers[249:]:
    layer.trainable = True
```

```
In [17]: optimizer = Adam(lr=0.0001, beta_1=0.9, beta_2=0.999, epsilon=None, decay=0.0, amsgrad=False)
model.compile(loss='categorical_crossentropy',
              optimizer=optimizer,
              metrics=['acc'])
```

```
In [18]: learning_rate_reduction = ReduceLROnPlateau(monitor='val_acc', patience=3, verbose=1, factor=0.5,
                                                    min_lr=0.000001, cooldown=2)
```

```
In [19]: model.summary()
```

Layer (type)	Output Shape	Param #	Connected to
input_1 (InputLayer)	(None, 192, 256, 3)	0	
conv2d_1 (Conv2D)	(None, 95, 127, 32)	864	input_1[0][0]
batch_normalization_1 (BatchNor	(None, 95, 127, 32)	96	conv2d_1[0][0]
activation_1 (Activation)	(None, 95, 127, 32)	0	batch_normalization_1[0][0]
conv2d_2 (Conv2D)	(None, 93, 125, 32)	9216	activation_1[0][0]
batch_normalization_2 (BatchNor	(None, 93, 125, 32)	96	conv2d_2[0][0]
activation_2 (Activation)	(None, 93, 125, 32)	0	batch_normalization_2[0][0]
conv2d_3 (Conv2D)	(None, 93, 125, 64)	18432	activation_2[0][0]

```
In [20]: batch_size = 64
epochs = 35
history = model.fit_generator(train_datagen.flow(X_train,y_train, batch_size=batch_size),
                               epochs = epochs, validation_data = val_datagen.flow(X_val, y_val),
                               verbose = 1, steps_per_epoch=(X_train.shape[0] // batch_size),
                               validation_steps=(X_val.shape[0] // batch_size),
                               callbacks=[learning_rate_reduction])
```

```
Epoch 1/35
126/126 [=====] - 126s 998ms/step - loss: 0.9149 - acc: 0.6921 - val_loss: 0.8397 - val_acc: 0.7009
Epoch 2/35
126/126 [=====] - 112s 886ms/step - loss: 0.7910 - acc: 0.7198 - val_loss: 0.7592 - val_acc: 0.7366
Epoch 3/35
126/126 [=====] - 111s 882ms/step - loss: 0.7137 - acc: 0.7440 - val_loss: 0.8139 - val_acc: 0.7156
Epoch 4/35
126/126 [=====] - 111s 883ms/step - loss: 0.6664 - acc: 0.7614 - val_loss: 0.6727 - val_acc: 0.7522
Epoch 5/35
126/126 [=====] - 111s 882ms/step - loss: 0.6168 - acc: 0.7779 - val_loss: 0.7178 - val_acc: 0.7370
Epoch 6/35
126/126 [=====] - 111s 879ms/step - loss: 0.5867 - acc: 0.7870 - val_loss: 0.7066 - val_acc: 0.7522
Epoch 7/35
126/126 [=====] - 110s 877ms/step - loss: 0.5364 - acc: 0.8025 - val loss: 0.7239 - val acc: 0.7488
```

```

Epoch 00007: ReduceLROnPlateau reducing learning rate to 4.999999873689376e-05.
Epoch 8/35
126/126 [=====] - 111s 878ms/step - loss: 0.5206 - acc: 0.8136 - val_loss: 0.6172 - val_acc: 0.7812
Epoch 9/35
126/126 [=====] - 110s 876ms/step - loss: 0.4848 - acc: 0.8226 - val_loss: 0.6283 - val_acc: 0.7678
Epoch 10/35
126/126 [=====] - 111s 877ms/step - loss: 0.4660 - acc: 0.8291 - val_loss: 0.6477 - val_acc: 0.7634
Epoch 11/35
126/126 [=====] - 110s 876ms/step - loss: 0.4631 - acc: 0.8288 - val_loss: 0.5939 - val_acc: 0.7820
Epoch 12/35
126/126 [=====] - 111s 877ms/step - loss: 0.4377 - acc: 0.8429 - val_loss: 0.6533 - val_acc: 0.7768
Epoch 13/35
126/126 [=====] - 110s 876ms/step - loss: 0.4127 - acc: 0.8503 - val_loss: 0.6776 - val_acc: 0.7630
Epoch 14/35
126/126 [=====] - 111s 877ms/step - loss: 0.4097 - acc: 0.8502 - val_loss: 0.7174 - val_acc: 0.7433

Epoch 00014: ReduceLROnPlateau reducing learning rate to 2.499999936844688e-05.
Epoch 15/35
126/126 [=====] - 110s 876ms/step - loss: 0.4023 - acc: 0.8564 - val_loss: 0.6920 - val_acc: 0.7915
Epoch 16/35
126/126 [=====] - 111s 877ms/step - loss: 0.3759 - acc: 0.8638 - val_loss: 0.5571 - val_acc: 0.7969
Epoch 17/35
126/126 [=====] - 110s 876ms/step - loss: 0.3592 - acc: 0.8693 - val_loss: 0.6749 - val_acc: 0.7630
Epoch 18/35
126/126 [=====] - 110s 877ms/step - loss: 0.3538 - acc: 0.8683 - val_loss: 0.6179 - val_acc: 0.7924
Epoch 19/35
126/126 [=====] - 110s 876ms/step - loss: 0.3580 - acc: 0.8732 - val_loss: 0.5775 - val_acc: 0.8057
Epoch 20/35
126/126 [=====] - 110s 877ms/step - loss: 0.3466 - acc: 0.8741 - val_loss: 0.6076 - val_acc: 0.7991
Epoch 21/35
126/126 [=====] - 110s 876ms/step - loss: 0.3395 - acc: 0.8759 - val_loss: 0.6784 - val_acc: 0.7630
Epoch 22/35
126/126 [=====] - 111s 877ms/step - loss: 0.3318 - acc: 0.8770 - val_loss: 0.5841 - val_acc: 0.8058
Epoch 23/35
126/126 [=====] - 110s 876ms/step - loss: 0.3154 - acc: 0.8835 - val_loss: 0.7083 - val_acc: 0.7725
Epoch 24/35
126/126 [=====] - 111s 877ms/step - loss: 0.3240 - acc: 0.8847 - val_loss: 0.6087 - val_acc: 0.8080
Epoch 25/35
126/126 [=====] - 110s 876ms/step - loss: 0.3049 - acc: 0.8886 - val_loss: 0.7642 - val_acc: 0.7725
Epoch 26/35
126/126 [=====] - 111s 877ms/step - loss: 0.3123 - acc: 0.8882 - val_loss: 0.6861 - val_acc: 0.8013
Epoch 27/35
126/126 [=====] - 110s 876ms/step - loss: 0.2995 - acc: 0.8935 - val_loss: 0.6753 - val_acc: 0.7725

Epoch 00027: ReduceLROnPlateau reducing learning rate to 1.249999968422344e-05.
Epoch 28/35
126/126 [=====] - 110s 877ms/step - loss: 0.2937 - acc: 0.8964 - val_loss: 0.6672 - val_acc: 0.7879
Epoch 29/35
126/126 [=====] - 110s 876ms/step - loss: 0.2922 - acc: 0.8899 - val_loss: 0.6256 - val_acc: 0.8057
Epoch 30/35
126/126 [=====] - 111s 877ms/step - loss: 0.2844 - acc: 0.8978 - val_loss: 0.6403 - val_acc: 0.7857
Epoch 31/35
126/126 [=====] - 111s 878ms/step - loss: 0.2776 - acc: 0.8971 - val_loss: 0.6824 - val_acc: 0.7924

Epoch 00031: ReduceLROnPlateau reducing learning rate to 6.24999984211172e-06.
Epoch 32/35
126/126 [=====] - 110s 876ms/step - loss: 0.2740 - acc: 0.9008 - val_loss: 0.6319 - val_acc: 0.7962
Epoch 33/35
126/126 [=====] - 111s 877ms/step - loss: 0.2777 - acc: 0.8998 - val_loss: 0.7288 - val_acc: 0.7857
Epoch 34/35
126/126 [=====] - 110s 876ms/step - loss: 0.2666 - acc: 0.9007 - val_loss: 0.6356 - val_acc: 0.8009
Epoch 35/35
126/126 [=====] - 110s 877ms/step - loss: 0.2627 - acc: 0.9023 - val_loss: 0.6626 - val_acc: 0.7946

Epoch 00035: ReduceLROnPlateau reducing learning rate to 3.12499992105586e-06.

```

```

In [21]: loss_val, acc_val = model.evaluate(X_val, y_val, verbose=1)
print("Validation: accuracy = %f ; loss_v = %f" % (acc_val, loss_val))

902/902 [=====] - 5s 6ms/step
Validation: accuracy = 0.799335 ; loss_v = 0.676574

In [22]: X_test = np.load("/floyd/input/skin_cancer_192_256/256_192_test.npy")

In [23]: y_test = np.load("/floyd/input/skin_cancer_192_256/test_labels.npy")
y_test = to_categorical(y_test)

In [24]: loss_test, acc_test = model.evaluate(X_test, y_test, verbose=1)
print("Test: accuracy = %f ; loss = %f" % (acc_test, loss_test))

1002/1002 [=====] - 6s 6ms/step
Test: accuracy = 0.799401 ; loss = 0.748205

In [25]: model.save("InceptionV3FT.h5")

In [26]: # Retrieve a list of accuracy results on training and test data
# sets for each training epoch
acc = history.history['acc']
val_acc = history.history['val_acc']

# Retrieve a list of list results on training and test data
# sets for each training epoch
loss = history.history['loss']
val_loss = history.history['val_loss']

# Get number of epochs
epochs = range(len(acc))

# Plot training and validation accuracy per epoch
plt.plot(epochs, acc, label = "training")
plt.plot(epochs, val_acc, label = "validation")
plt.legend(loc="upper left")

```

```
plt.title('Training and validation accuracy')

plt.figure()

# Plot training and validation loss per epoch
plt.plot(epochs, loss, label = "training")
plt.plot(epochs, val_loss, label = "validation")
plt.legend(loc="upper right")
plt.title('Training and validation loss')

Out[26]: Text(0.5,1,'Training and validation loss')
```

