```
# To load from colab
from google.colab import drive
drive.mount('/content/drive')
```

```
     Mounted at /content/drive
```

```
import tensorflow as tf
print(tf.__version__)
```

```
     2.4.0
```

```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g. pd.read_csv)
import os
from tensorflow.keras import layers
from tensorflow.keras import Model
from tensorflow.keras.applications import Xception
from tensorflow.keras.optimizers import RMSprop
from tensorflow.keras.preprocessing.image import ImageDataGenerator
import os
import matplotlib.pyplot as plt
import pandas as pd
from keras.callbacks import ReduceLROnPlateau
```

```
datagen = ImageDataGenerator( rescale = 1.0/255,
                                          width_shift_range=0.1,
                                          height_shift_range=0.1,
                                          zoom_range=0.2,
                                          vertical_flip=True,
                                          horizontal_flip=True,
                                          fill_mode='nearest')

#Load data
train_generator = datagen.flow_from_directory(
    '/content/drive/My Drive/Assgn-2/CV_Assignment3/intel-image-classification/seg_train/s
    target_size=(150, 150),
    shuffle=True,
    batch_size=32,
    class_mode="categorical")

validation_generator = datagen.flow_from_directory(
    '/content/drive/My Drive/Assgn-2/CV_Assignment3/intel-image-classification/seg_train/s
    target_size=(150, 150),
    batch_size=128,
    shuffle=True,
    class_mode="categorical")

test_generator = datagen.flow_from_directory(
    '/content/drive/My Drive/Assgn-2/CV_Assignment3/intel-image-classification/seg_test/se
    target_size=(150, 150),
    shuffle=True,
    batch_size=128,
    class_mode="categorical",
)
```

```
Found 14034 images belonging to 6 classes.
Found 14034 images belonging to 6 classes.
Found 3000 images belonging to 6 classes.
```

```
#load the pretrained model
from keras.applications.inception_v3 import InceptionV3
inceptionV3 = InceptionV3(include_top= False, input_shape=(150,150,3))

for layer in inceptionV3.layers:
  layer.trainable = False

last_layer = inceptionV3.get_layer('mixed9')

print('last layer output shape: ', last_layer.output_shape)

last_output = last_layer.output
```

```
Downloading data from https://storage.googleapis.com/tensorflow/keras-applications/ir
87916544/87910968 [==============================] - 1s 0us/step
last layer output shape:  (None, 3, 3, 2048)
```

```
LearningRateScheduler = ReduceLROnPlateau(monitor='val_acc',
                                          patience=1,
                                          verbose=1,
                                          factor=0.20,
                                          min_lr=0.000001)

x = layers.Flatten()(last_output)
x = layers.Dense(1024, activation='relu')(x)
x = layers.Dropout(0.2)(x)
x = layers.Dense(6, activation='softmax')(x)

model = Model(inceptionV3.input, x)

model.compile(optimizer = tf.keras.optimizers.Adam(),
              loss = 'categorical_crossentropy',
              metrics = ['acc'])

model.summary()
```

```
conv2d_82 (Conv2D)              (None, 3, 3, 384)    442368      activation_81[0][
________________________________________________________________________________
conv2d_83 (Conv2D)              (None, 3, 3, 384)    442368      activation_81[0][
________________________________________________________________________________
average_pooling2d_7 (AveragePoo (None, 3, 3, 1280)   0           mixed8[0][0]
________________________________________________________________________________
conv2d_76 (Conv2D)              (None, 3, 3, 320)    409600      mixed8[0][0]
________________________________________________________________________________
```

```
batch_normalization_78 (BatchNo (None, 3, 3, 384)    1152        conv2d_78[0][0]
__________________________________________________________________________________
batch_normalization_79 (BatchNo (None, 3, 3, 384)    1152        conv2d_79[0][0]
__________________________________________________________________________________
batch_normalization_82 (BatchNo (None, 3, 3, 384)    1152        conv2d_82[0][0]
__________________________________________________________________________________
batch_normalization_83 (BatchNo (None, 3, 3, 384)    1152        conv2d_83[0][0]
__________________________________________________________________________________
conv2d_84 (Conv2D)              (None, 3, 3, 192)    245760      average_pooling2d
__________________________________________________________________________________
batch_normalization_76 (BatchNo (None, 3, 3, 320)    960         conv2d_76[0][0]
__________________________________________________________________________________
activation_78 (Activation)      (None, 3, 3, 384)    0           batch_normalizati
__________________________________________________________________________________
activation_79 (Activation)      (None, 3, 3, 384)    0           batch_normalizati
__________________________________________________________________________________
activation_82 (Activation)      (None, 3, 3, 384)    0           batch_normalizati
__________________________________________________________________________________
activation_83 (Activation)      (None, 3, 3, 384)    0           batch_normalizati
__________________________________________________________________________________
batch_normalization_84 (BatchNo (None, 3, 3, 192)    576         conv2d_84[0][0]
__________________________________________________________________________________
activation_76 (Activation)      (None, 3, 3, 320)    0           batch_normalizati
__________________________________________________________________________________
mixed9_0 (Concatenate)          (None, 3, 3, 768)    0           activation_78[0][
                                                                 activation_79[0][
__________________________________________________________________________________
concatenate (Concatenate)       (None, 3, 3, 768)    0           activation_82[0][
                                                                 activation_83[0][
__________________________________________________________________________________
activation_84 (Activation)      (None, 3, 3, 192)    0           batch_normalizati
__________________________________________________________________________________
mixed9 (Concatenate)            (None, 3, 3, 2048)   0           activation_76[0][
                                                                 mixed9_0[0][0]
                                                                 concatenate[0][0]
                                                                 activation_84[0][
__________________________________________________________________________________
flatten (Flatten)               (None, 18432)        0           mixed9[0][0]
__________________________________________________________________________________
dense (Dense)                   (None, 1024)         18875392    flatten[0][0]
__________________________________________________________________________________
dropout (Dropout)               (None, 1024)         0           dense[0][0]
__________________________________________________________________________________
dense_1 (Dense)                 (None, 6)            6150        dropout[0][0]
==================================================================================
Total params: 34,604,262
Trainable params: 18,881,542
Non-trainable params: 15,722,720
__________________________________________________________________________________
```

```
history = model.fit(train_generator,
                    epochs = 10,
                    verbose = 1,
                   validation_data = validation_generator,
                   callbacks=[LearningRateScheduler])
```

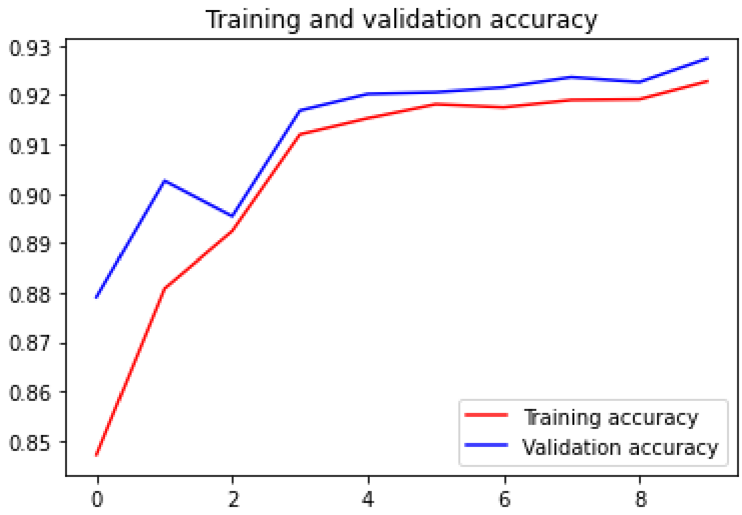
```
    Epoch 1/10
    439/439 [==============================] - 3436s 8s/step - loss: 0.6832 - acc: 0.7915
    Epoch 2/10
    439/439 [==============================] - 187s 427ms/step - loss: 0.3216 - acc: 0.88
    Epoch 3/10
    439/439 [==============================] - 187s 426ms/step - loss: 0.3278 - acc: 0.88

    Epoch 00003: ReduceLROnPlateau reducing learning rate to 0.00020000000949949026.
    Epoch 4/10
    439/439 [==============================] - 187s 427ms/step - loss: 0.2561 - acc: 0.96
    Epoch 5/10
    439/439 [==============================] - 186s 425ms/step - loss: 0.2289 - acc: 0.91
    Epoch 6/10
    439/439 [==============================] - 188s 428ms/step - loss: 0.2176 - acc: 0.92
    Epoch 7/10
    439/439 [==============================] - 187s 427ms/step - loss: 0.2150 - acc: 0.91
    Epoch 8/10
    439/439 [==============================] - 184s 421ms/step - loss: 0.2033 - acc: 0.92

    Epoch 00008: ReduceLROnPlateau reducing learning rate to 4.0000001899898055e-05.
    Epoch 9/10
    439/439 [==============================] - 185s 421ms/step - loss: 0.1944 - acc: 0.92
    Epoch 10/10
    439/439 [==============================] - 184s 420ms/step - loss: 0.1886 - acc: 0.93
```

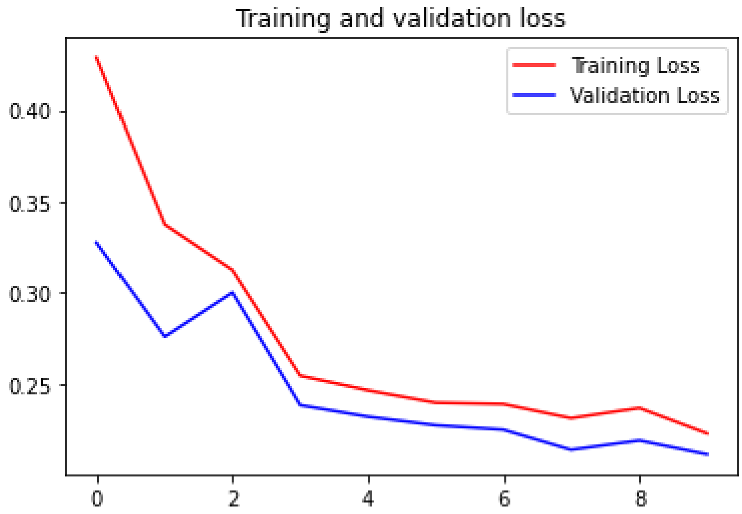
```
# Predictions on test dataset

model.save_weights('/content/drive/My Drive/Assgn-2/CV_Assignment3')
test_generator.reset()
pred=model.predict_generator(test_generator,
verbose=1)
```

```
    /usr/local/lib/python3.6/dist-packages/tensorflow/python/keras/engine/training.py:196
      warnings.warn('`Model.predict_generator` is deprecated and '
    24/24 [==============================] - 951s 41s/step
```

```
from sklearn.metrics import confusion_matrix
from sklearn.metrics import f1_score, accuracy_score
ypred=predicted_class_indices
ytest=test_generator.labels
confusion_mat=tf.math.confusion_matrix(
    ytest,ypred,num_classes=None, weights=None, dtype=tf.dtypes.int32,
    name=None
)
```

```
acc = history.history['acc']
val_acc = history.history['val_acc']
loss = history.history['loss']
val_loss = history.history['val_loss']

epochs = range(len(acc))

plt.plot(epochs, acc, 'r', label='Training accuracy')
plt.plot(epochs, acc, 'r', label='Training accuracy')
plt.plot(epochs, val_acc, 'b', label='Validation accuracy')
plt.title('Training and validation accuracy')
plt.legend()
plt.figure()

plt.plot(epochs, loss, 'r', label='Training Loss')
plt.plot(epochs, val_loss, 'b', label='Validation Loss')
plt.title('Training and validation loss')
plt.legend()

plt.show()
```

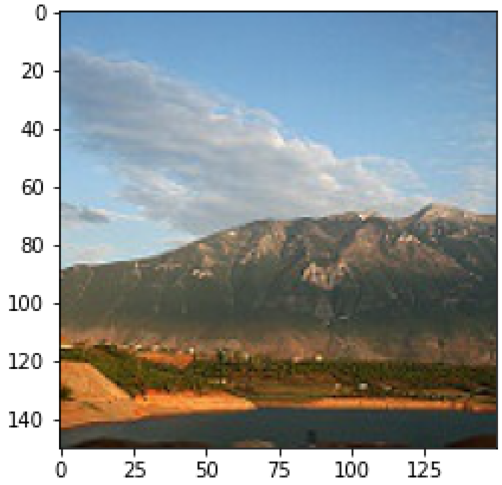




```
import numpy as np
from keras.preprocessing import image

file_path =  '/content/drive/My Drive/Assgn-2/CV_Assignment3/intel-image-classification/se

test_image = image.load_img(file_path, target_size = (150, 150))
plt.imshow(test_image)
test_image = image.img_to_array(test_image)
test_image = np.expand_dims(test_image, axis = 0)
result = model.predict(test_image)

classes=train_generator.class_indices
```

```
classes=['buildings','forest','glacier','mountain','sea','street']

print("Prediction for this image is :",classes[np.argmax(result)])
```

```
Prediction for this image is : sea
```



```
from sklearn.metrics import confusion_matrix
from sklearn.metrics import f1_score, accuracy_score
ypred=predicted_class_indices
ytest=test_generator.labels
confusion_mat=tf.math.confusion_matrix(
    ytest,ypred,num_classes=None, weights=None, dtype=tf.dtypes.int32,
    name=None
)
print('F1 Score =', f1_score(ytest, ypred,average='micro'))
print('Accuracy =', accuracy_score(ytest, ypred))
FP = confusion_mat[0][1]
TP = confusion_mat[1][1]
print('True Positive =', TP)
print('False Positive =', FP)
```

```
F1 Score = 0.17333333333333334
Accuracy = 0.17333333333333334
True Positive = tf.Tensor(71, shape=(), dtype=int32)
False Positive = tf.Tensor(75, shape=(), dtype=int32)
```