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SUBJECT CODE : EE5353
SUBJECT : Neural Networks and Deep Learning

PROGRAM ASSIGNMENT 9:

Transfer Learning using Google Colab

```
import tensorflow as tf
import random as rn
import os,cv2
import numpy as np

os.environ['PYTHONHASHSEED'] = '0'
# Setting the seed for numpy-generated random numbers
np.random.seed(37)
# Setting the seed for python random numbers
rn.seed(1254)
# Setting the graph-level random seed.
tf.set_random_seed(89)
from keras import backend as K
session_conf = tf.ConfigProto(intra_op_parallelism_threads=1,inter_op_parallelism_threads=

#Force Tensorflow to use a single thread
sess = tf.Session(graph=tf.get_default_graph(), config=session_conf)
K.set_session(sess)
import glob

from sklearn.utils import shuffle

from sklearn.model_selection import train_test_split

import re
from keras.models import Sequential
from keras import models
from keras import layers
from keras import optimizers
from keras.applications import VGG16
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from keras.layers import Dense, Conv2D, Flatten, MaxPooling2D, Dropout
from sklearn.utils import shuffle
from PIL import Image
from google.colab.patches import cv2_imshow
import matplotlib.pyplot as plt
import  glob

def gen_image(img):
    plt.imshow(img)
    return plt



#from sklearn.cross_validation import train_test_split

from google.colab import drive
drive.mount('/content/drive')

PATH = os.getcwd()
from google.colab import drive
drive.mount('/content/drive')
```

```
train_dir = '/content/drive/My Drive/Colab Notebooks/cats_dogs_horse_humans/train'
validation_dir = '/content/drive/My Drive/Colab Notebooks/cats_dogs_horse_humans/validatio



#create model
model = Sequential()
#add model layers

model.add(Conv2D(128, kernel_size=3,strides=1, activation='relu',input_shape=(256,256,3)))
        # 64 are the number of filters, kernel size is the size of the filters example 3*3
model.add(Conv2D(128, kernel_size=3,strides=1, activation='relu'))
model.add(MaxPooling2D(pool_size=(3,3)))
model.add(Conv2D(256, kernel_size=3,strides=1, activation='relu'))
model.add(Conv2D(256, kernel_size=3,strides=1, activation='relu'))
model.add(Flatten())
model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(4, activation='softmax'))

image_size=256
train_datagen = ImageDataGenerator(
      rescale=1./255,
      rotation_range=20,
      width_shift_range=0.2,
      height_shift_range=0.2,
      horizontal_flip=True,
      fill_mode='nearest')

validation_datagen = ImageDataGenerator(rescale=1./255)

# Change the batchsize according to your system RAM
train_batchsize = 50
val_batchsize = 10

train_generator = train_datagen.flow_from_directory(
        train_dir,
        target_size=(image_size, image_size),
        batch_size=train_batchsize,
        class_mode='categorical')

validation_generator = validation_datagen.flow_from_directory(
        validation_dir,
        target_size=(image_size, image_size),
        batch_size=val_batchsize,
        class_mode='categorical',
        shuffle=False)


# Compile the model
model.compile(loss='categorical_crossentropy',
              optimizer=optimizers.RMSprop(lr=1e-4),
              metrics=['acc'])
```

```
# Train the model
history = model.fit_generator(
      train_generator,
      steps_per_epoch=train_generator.samples/train_generator.batch_size ,
      epochs=5,
      validation_data=validation_generator,
      validation_steps=validation_generator.samples/validation_generator.batch_size,
      verbose=1)


'''#TESTING
test_dir='/content/drive/My Drive/images'
test_datagen = ImageDataGenerator(rescale=1./255)
test_generator = test_datagen.flow_from_directory( test_dir, target_size=(256, 256),batch_
test_generator=test_generator.reshape(10,256,256,3)

ytested = model.predict_classes(test_generator)
labels=['human','horse','dogs','cats']
for i in range(len(ytested)):
  #print("The Predicted Testing image is =%s verify below" ,labels[ytested[i]])
  print(np.argmax(ytested[i]))
  gen_image(test_generator[i]).show() '''

#TESTING
data_path = '/content/drive/My Drive/Colab Notebooks/cats_dogs_horse_humans/test/all_data'
img_data_list=[]
img_list = glob.glob(data_path+'/*.jpg')
for img in img_list:
        input_img=cv2.imread(img,1 )
        input_img_resize=cv2.resize(input_img,(256,256))
        img_data_list.append(input_img_resize)

img_data = np.array(img_data_list)
img_data = img_data.astype('float32')
x_test = shuffle(img_data, random_state=2)
x_test=x_test/255
#Nv_test=x_test.shape[0]
x_test = x_test.reshape(40,256,256,3)
label=['humans','horse','dogs','cats']
ytested = model.predict_classes(x_test)
for i in range(40):
  print("The Predicted Testing image is =%s verify below" %label[ytested[i]])
  gen_image(x_test[i]).show() # printing image vs the predicted image below
```

```
The default version of TensorFlow in Colab will soon switch to TensorFlow 2.x.
We recommend you upgrade now or ensure your notebook will continue to use TensorFlow 1.x via the %ten
Using TensorFlow backend.
Go to this URL in a browser: https://accounts.google.com/o/oauth2/auth?client_id=94731

Enter your authorization code:
..........
Mounted at /content/drive
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.mo
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflo

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflo

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflo

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflo

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflo
Instructions for updating:
Please use `rate` instead of `keep_prob`. Rate should be set to `rate = 1 - keep_prob`
Found 608 images belonging to 4 classes.
Found 160 images belonging to 4 classes.
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/optimizers.py:793

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflo

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/tensorflow_core/python/
Instructions for updating:
Use tf.where in 2.0, which has the same broadcast rule as np.where
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflo

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflo

Epoch 1/5
WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflo

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WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflo

WARNING:tensorflow:From /usr/local/lib/python3.6/dist-packages/keras/backend/tensorflo

13/12 [==============================] - 221s 17s/step - loss: 1.7662 - acc: 0.2818
Epoch 2/5
13/12 [==============================] - 7s 546ms/step - loss: 1.3769 - acc: 0.2716
Epoch 3/5
13/12 [==============================] - 13s 1s/step - loss: 1.3905 - acc: 0.2853 -
Epoch 4/5
13/12 [==============================] - 13s 1s/step - loss: 1.3920 - acc: 0.2856 -
Epoch 5/5
13/12 [==============================] - 13s 1s/step - loss: 1.3838 - acc: 0.2796 -
The Predicted Testing image is =humans verify below
```
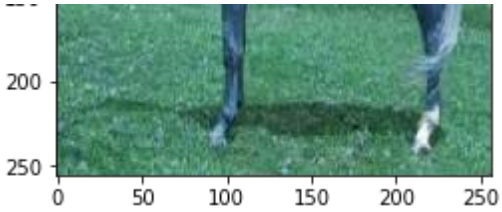
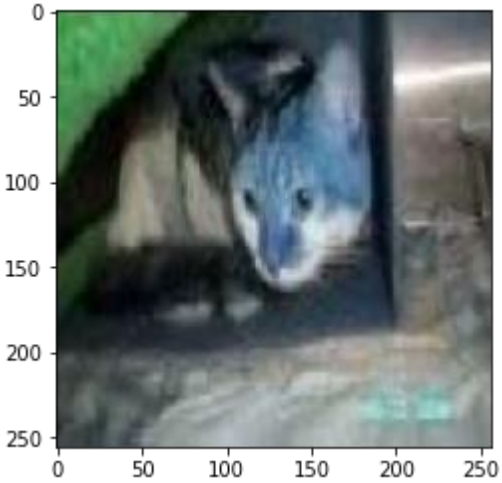
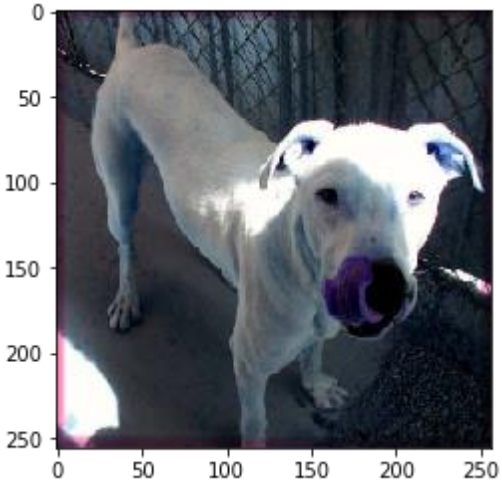



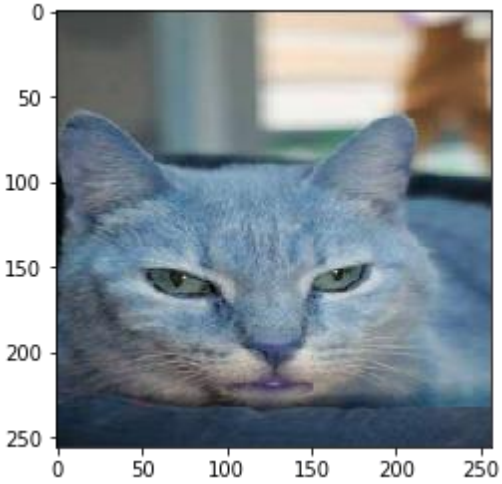
The Predicted Testing image is =humans verify below



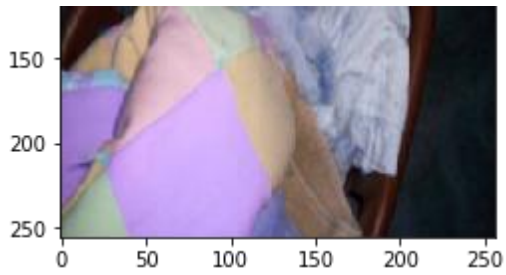
The Predicted Testing image is =humans verify below



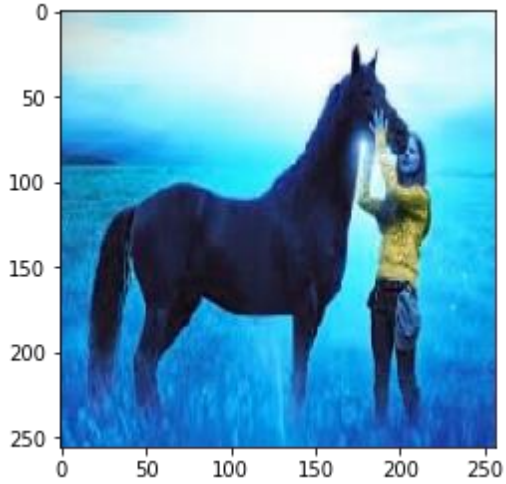
The Predicted Testing image is =horse verify below



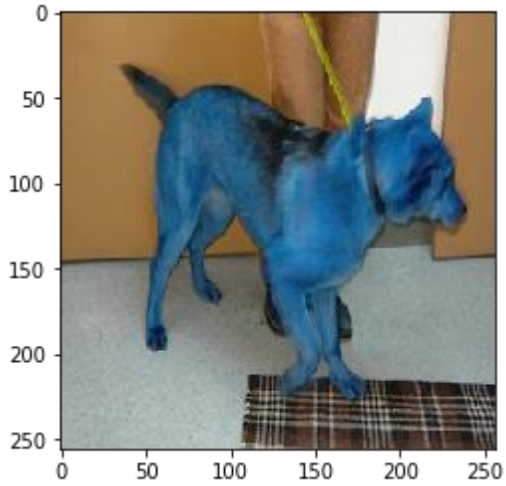
The Predicted Testing image is =humans verify below



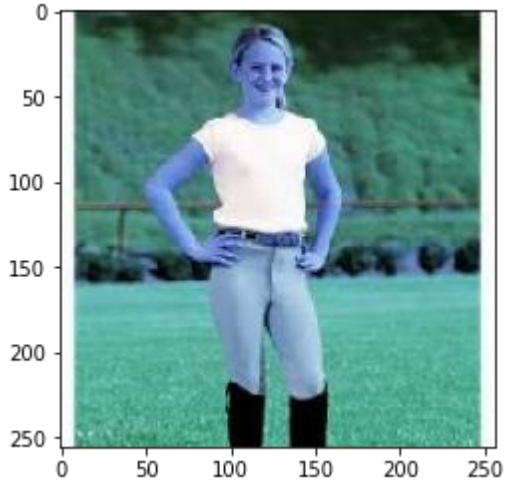
The Predicted Testing image is =humans verify below



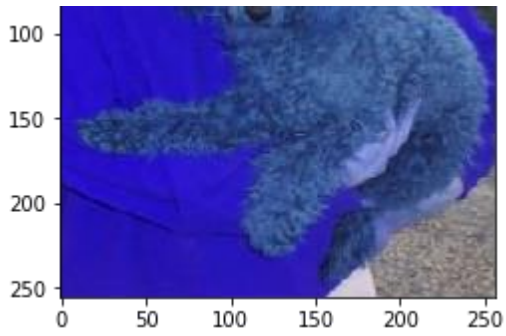
The Predicted Testing image is =cats verify below



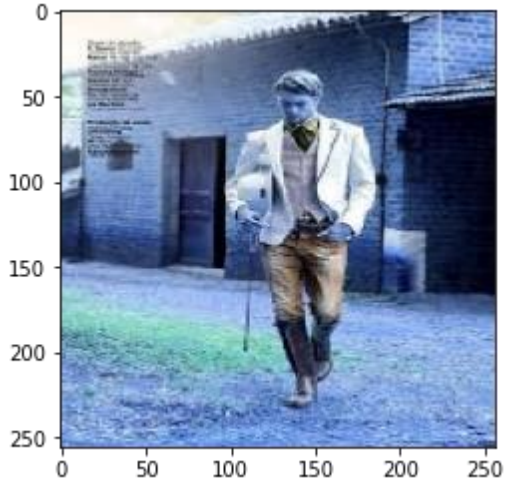
The Predicted Testing image is =humans verify below



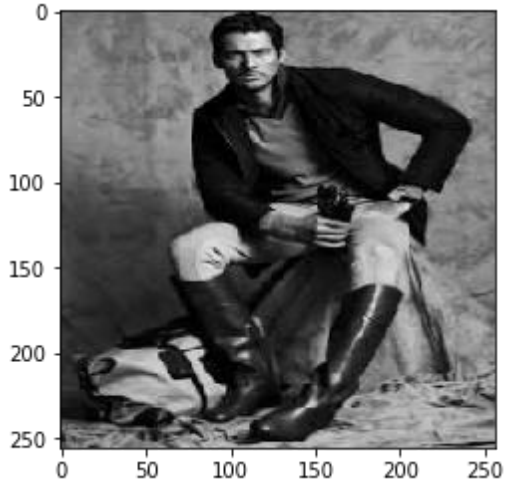
The Predicted Testing image is =humans verify below



The Predicted Testing image is =humans verify below



The Predicted Testing image is =humans verify below



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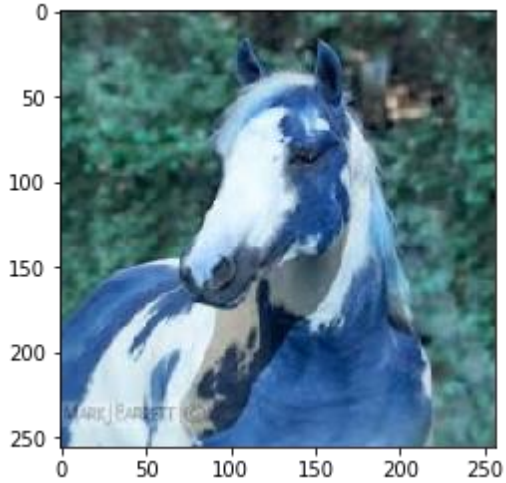
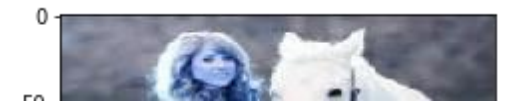
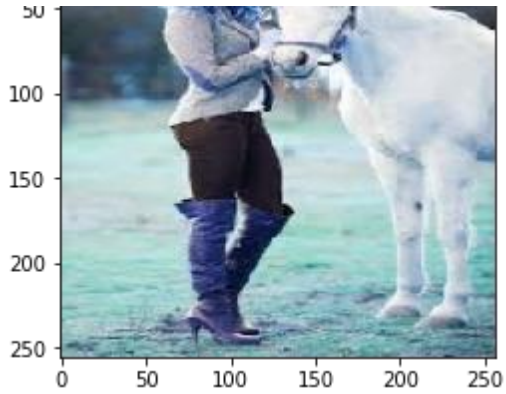
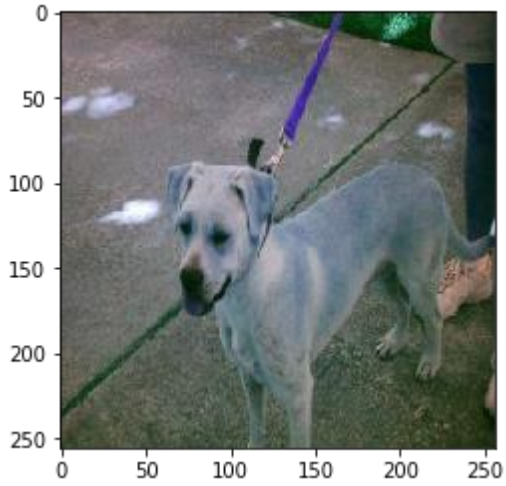


The Predicted Testing image is =humans verify below

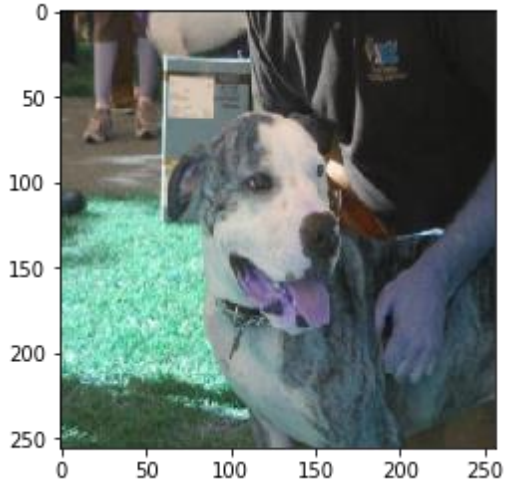




The Predicted Testing image is =cats verify below



The Predicted Testing image is =humans verify below



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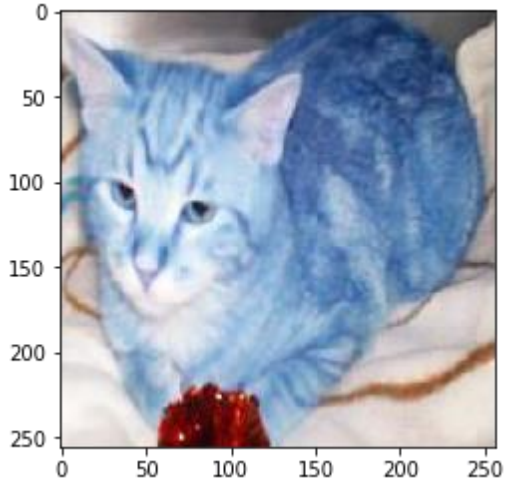

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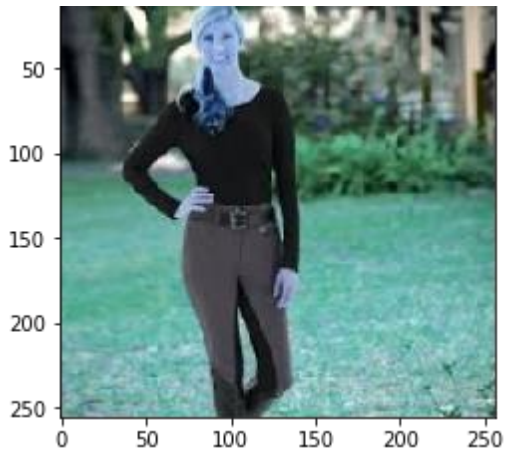

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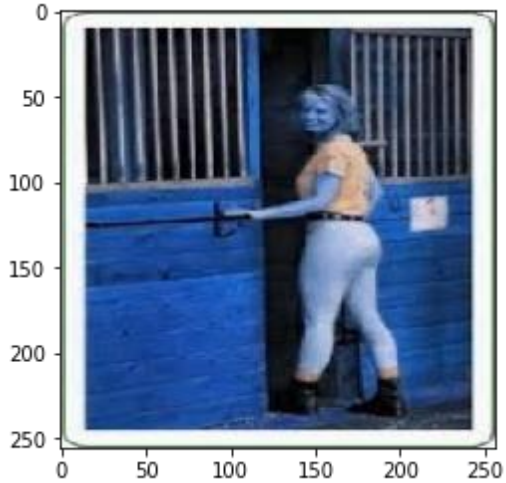

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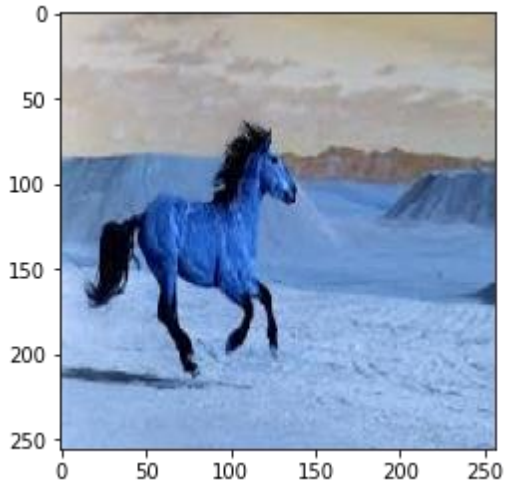

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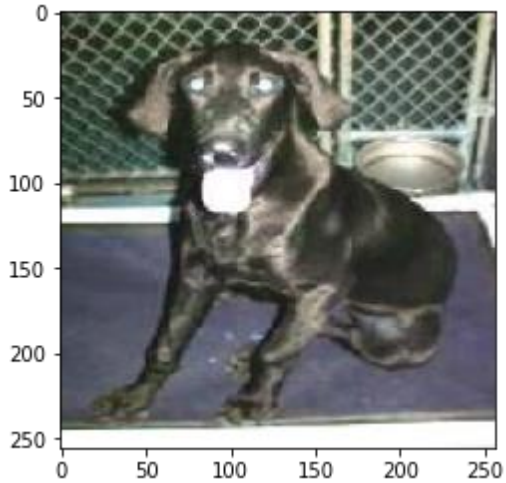

he Predicted Testing image is =humans verify below

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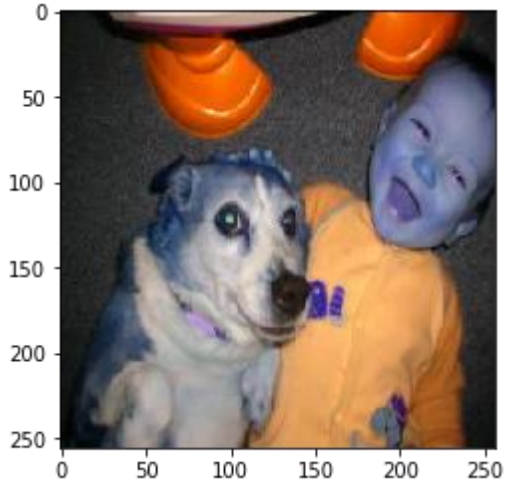
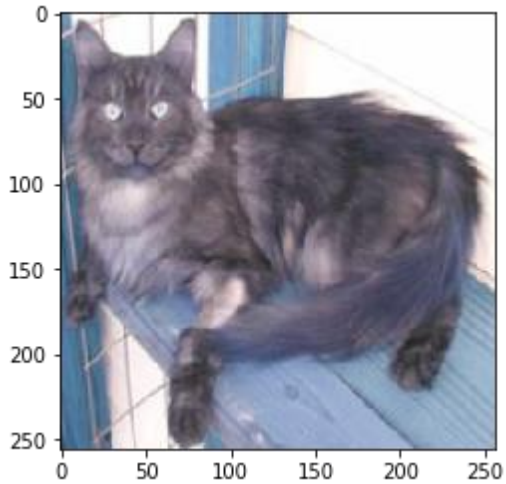
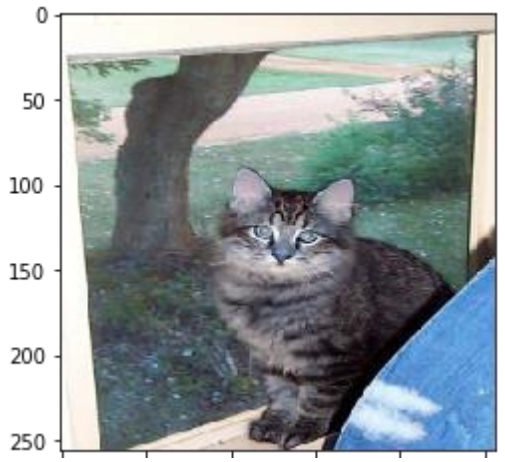
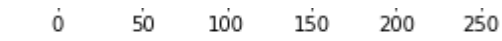


The Predicted Testing image is =cats verify below

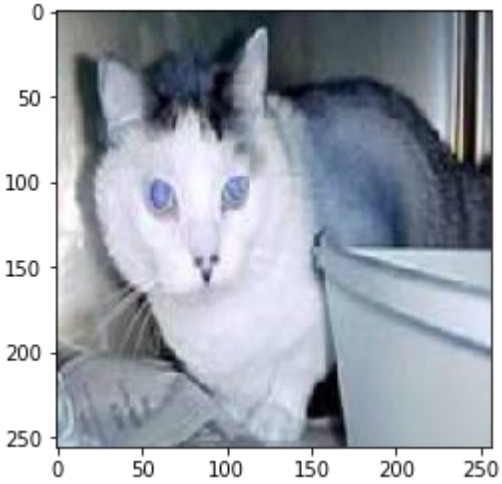


The Predicted Testing image is =humans verify below

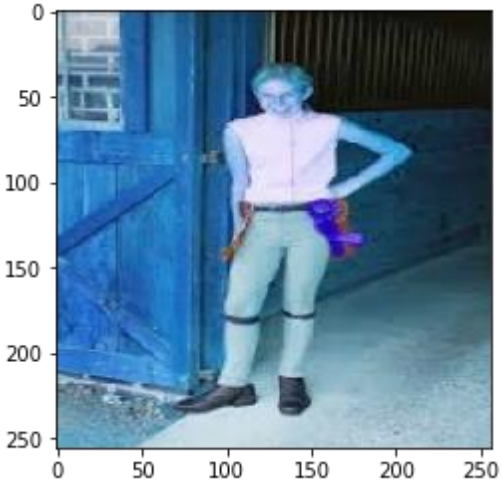




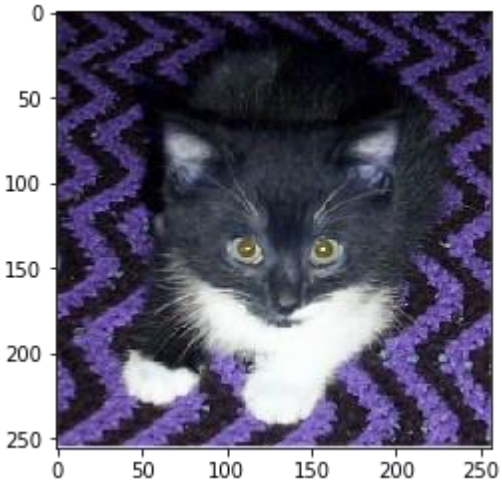
The Predicted Testing image is =humans verify below



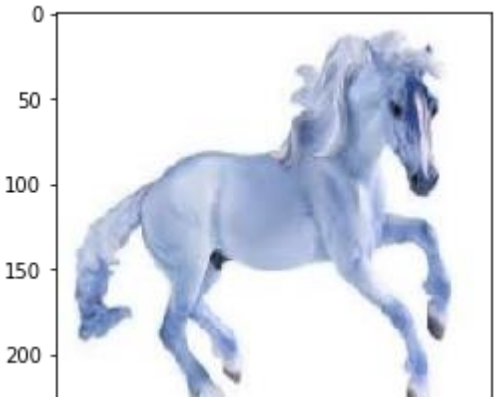
The Predicted Testing image is =humans verify below

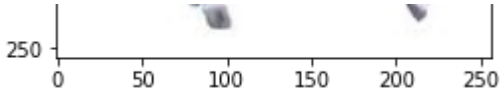


The Predicted Testing image is =humans verify below

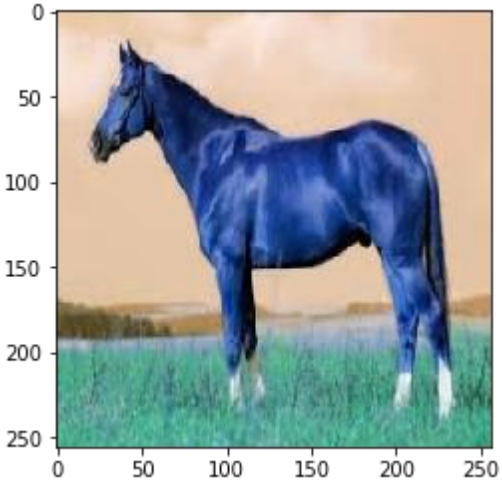


The Predicted Testing image is =cats verify below

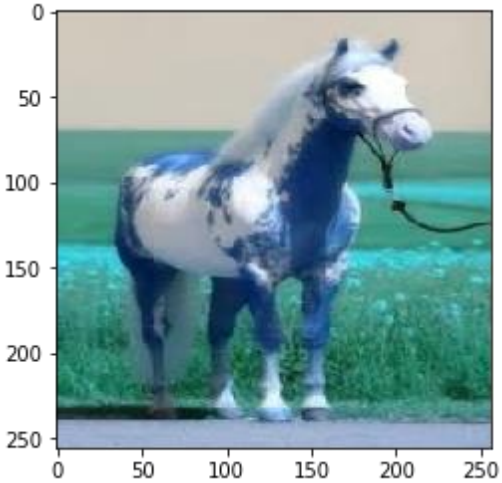




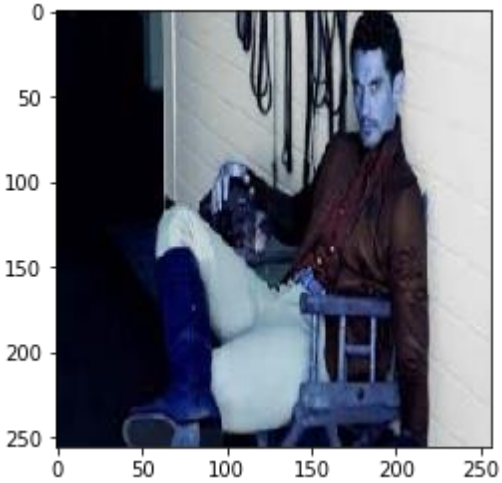
The Predicted Testing image is =humans verify below



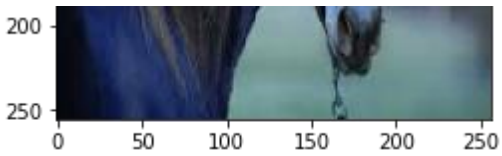
The Predicted Testing image is =humans verify below



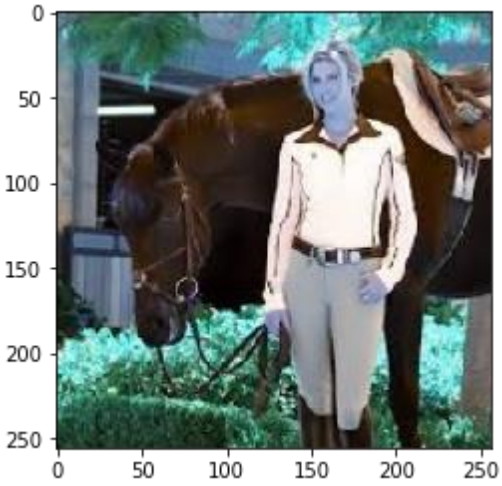
The Predicted Testing image is =humans verify below



The Predicted Testing image is =humans verify below

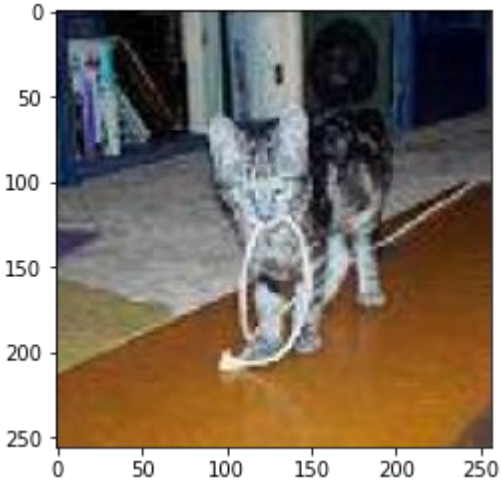


The Predicted Testing image is =humans verify below



The Predicted Testing image is =humans verify below

The Predicted Testing image is =cats verify below



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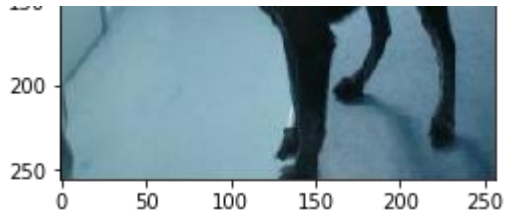

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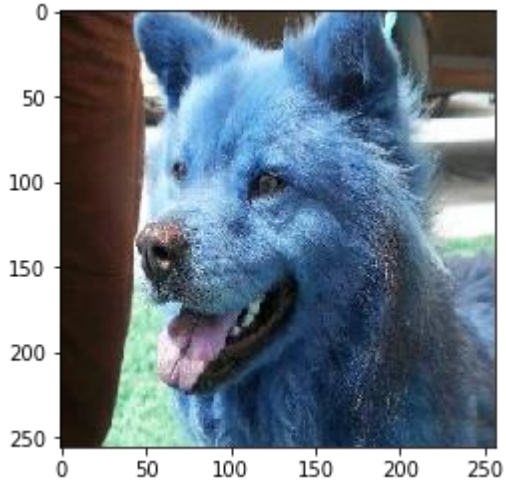
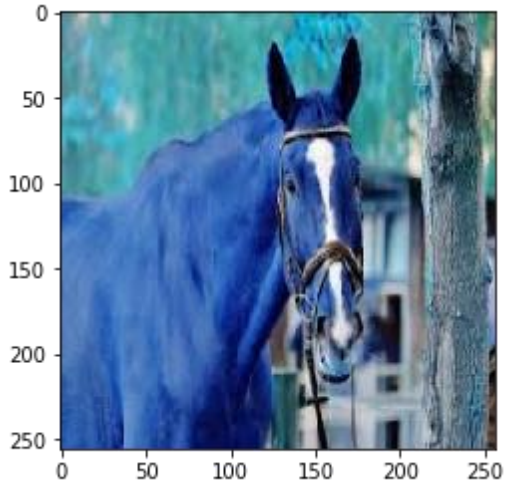
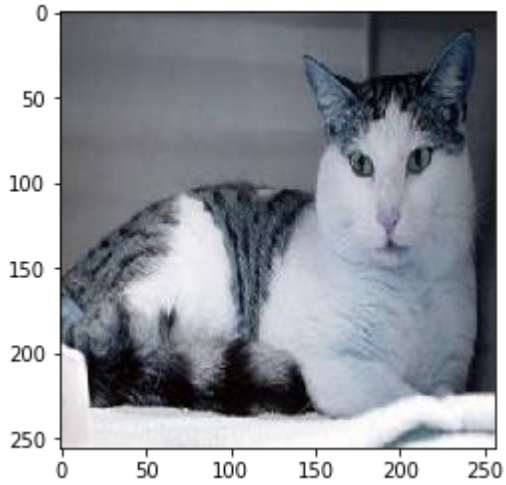


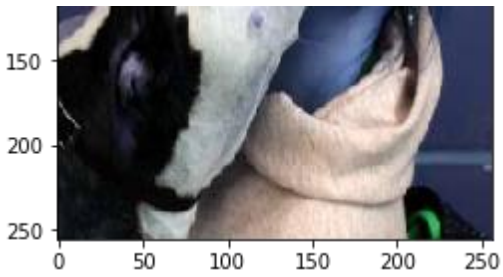
The Predicted Testing image is =humans verify below



The Predicted Testing image is =humans verify below



The Predicted Testing image is =humans verify below


150
200
250
0
50
100
150
200
250

```
from keras import models
from keras import layers
from keras import optimizers
from keras.applications import VGG16
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from keras.layers import Dense, Conv2D, Flatten, MaxPooling2D, Dropout
from sklearn.utils import shuffle
from PIL import Image
from google.colab.patches import cv2_imshow
import matplotlib.pyplot as plt
import  glob
import numpy as np
import os,cv2
#Load the VGG model

def gen_image(img):
    plt.imshow(img)
    return plt


from google.colab import drive
drive.mount('/content/drive')
train_dir = '/content/drive/My Drive/Colab Notebooks/cats_dogs_horse_humans/train'
validation_dir = '/content/drive/My Drive/Colab Notebooks/cats_dogs_horse_humans/validatio

img_width, img_height = 256, 256
image_size = img_height

vgg_conv = VGG16(weights='imagenet', include_top=False, input_shape=(img_width, img_height



# Freeze the layers except the last 4 layers
for layer in vgg_conv.layers[:-2]:
    layer.trainable = False

# Check the trainable status of the individual layers
for layer in vgg_conv.layers:
    print(layer, layer.trainable)


# Create the model
model = models.Sequential()

# Add the vgg convolutional base model
model.add(vgg_conv)

# Add new layers
model.add(Flatten())
model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(64, activation='relu'))
model.add(Dropout(0.5))
model.add(Dense(4, activation='softmax'))
```

```
# Show a summary of the model. Check the number of trainable parameters
model.summary()


train_datagen = ImageDataGenerator(
      rescale=1./255,
      rotation_range=20,
      width_shift_range=0.2,
      height_shift_range=0.2,
      horizontal_flip=True,
      fill_mode='nearest')

validation_datagen = ImageDataGenerator(rescale=1./255)

# Change the batchsize according to your system RAM
train_batchsize = 50
val_batchsize = 10

train_generator = train_datagen.flow_from_directory(
        train_dir,
        target_size=(image_size, image_size),
        batch_size=train_batchsize,
        class_mode='categorical')

validation_generator = validation_datagen.flow_from_directory(
        validation_dir,
        target_size=(image_size, image_size),
        batch_size=val_batchsize,
        class_mode='categorical',
        shuffle=False)


# Compile the model
model.compile(loss='categorical_crossentropy',
              optimizer=optimizers.RMSprop(lr=1e-4),
              metrics=['acc'])
# Train the model
history = model.fit_generator(
      train_generator,
      steps_per_epoch=train_generator.samples/train_generator.batch_size ,
      epochs=5,
      validation_data=validation_generator,
      validation_steps=validation_generator.samples/validation_generator.batch_size,
      verbose=1)

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, 'b', label='Training acc')
```

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

plt.figure()

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

plt.show()
```

```
##########################################333
# insert the testing code
#TESTING
data_path = '/content/drive/My Drive/Colab Notebooks/cats_dogs_horse_humans/test/all_data'
img_data_list=[]
img_list = glob.glob(data_path+'/*.jpg')
for img in img_list:
        input_img=cv2.imread(img,1 )
        input_img_resize=cv2.resize(input_img,(256,256))
        img_data_list.append(input_img_resize)

img_data = np.array(img_data_list)
img_data = img_data.astype('float32')
x_test = shuffle(img_data, random_state=2)
x_test=x_test/255
#Nv_test=x_test.shape[0]
x_test = x_test.reshape(40,256,256,3)
label=['humans','horse','dogs','cats']
ytested = model.predict_classes(x_test)
for i in range(40):
  print("The Predicted Testing image is =%s verify below" %label[ytested[i]])
  gen_image(x_test[i]).show() # printing image vs the predicted image below
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive.m
<keras.engine.input_layer.InputLayer object at 0x7ff970bb54e0> False
<keras.layers.convolutional.Conv2D object at 0x7ff970bb54a8> False
<keras.layers.convolutional.Conv2D object at 0x7ff970bb5780> False
<keras.layers.pooling.MaxPooling2D object at 0x7ff970bbc5f8> False
<keras.layers.convolutional.Conv2D object at 0x7ff970bafd68> False
<keras.layers.convolutional.Conv2D object at 0x7ff970b40e10> False
<keras.layers.pooling.MaxPooling2D object at 0x7ff970b44cf8> False
<keras.layers.convolutional.Conv2D object at 0x7ff970b4fbe0> False
<keras.layers.convolutional.Conv2D object at 0x7ff970b54438> False
<keras.layers.convolutional.Conv2D object at 0x7ff970b5b198> False
<keras.layers.pooling.MaxPooling2D object at 0x7ff970b60c50> False
<keras.layers.convolutional.Conv2D object at 0x7ff970b6db00> False
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<keras.layers.convolutional.Conv2D object at 0x7ff970b7b278> False
<keras.layers.pooling.MaxPooling2D object at 0x7ff970b7ab70> False
<keras.layers.convolutional.Conv2D object at 0x7ff970b0ea20> False
<keras.layers.convolutional.Conv2D object at 0x7ff970b172b0> False
<keras.layers.convolutional.Conv2D object at 0x7ff970b1e5c0> True
<keras.layers.pooling.MaxPooling2D object at 0x7ff970b22a20> True
Model: "sequential_3"
_________________________________________________________________
Layer (type)                 Output Shape              Param #
=================================================================
vgg16 (Model)                (None, 8, 8, 512)         14714688
_________________________________________________________________
flatten_3 (Flatten)          (None, 32768)             0
_________________________________________________________________
dense_7 (Dense)              (None, 64)                2097216
_________________________________________________________________
dropout_5 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_8 (Dense)              (None, 64)                4160
_________________________________________________________________
dropout_6 (Dropout)          (None, 64)                0
_________________________________________________________________
dense_9 (Dense)              (None, 4)                 260
=================================================================
Total params: 16,816,324
Trainable params: 4,461,444
Non-trainable params: 12,354,880
_________________________________________________________________
Found 608 images belonging to 4 classes.
Found 160 images belonging to 4 classes.
Epoch 1/5
13/12 [==============================] - 12s 923ms/step - loss: 1.5013 - acc: 0.287
Epoch 2/5
13/12 [==============================] - 10s 794ms/step - loss: 1.3094 - acc: 0.356
Epoch 3/5
13/12 [==============================] - 11s 815ms/step - loss: 1.2177 - acc: 0.432
Epoch 4/5
13/12 [==============================] - 10s 804ms/step - loss: 1.1500 - acc: 0.470
Epoch 5/5
13/12 [==============================] - 11s 811ms/step - loss: 1.0769 - acc: 0.534
```
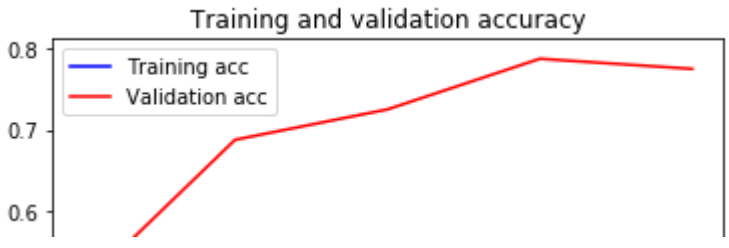
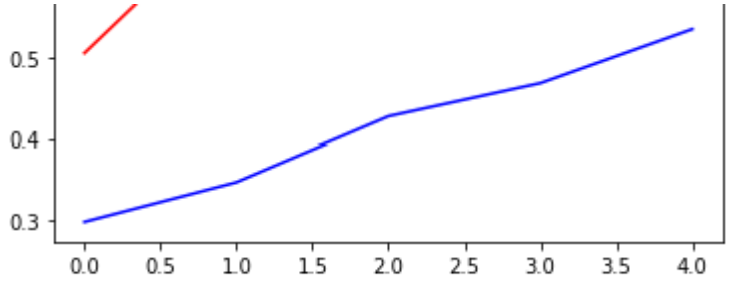
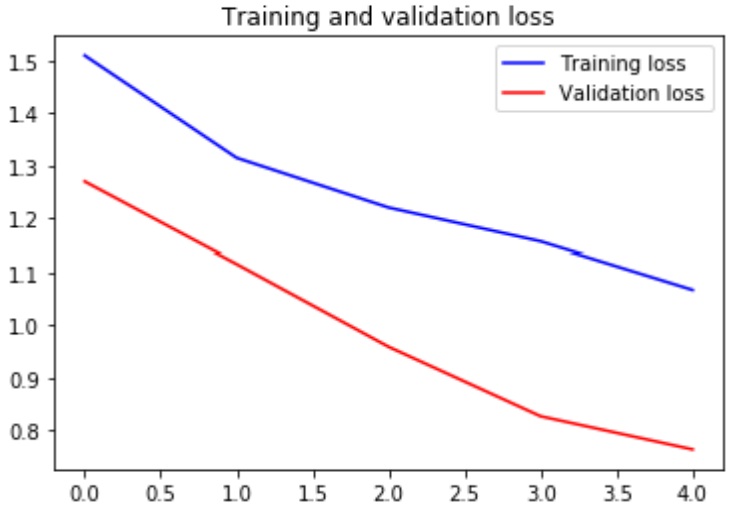
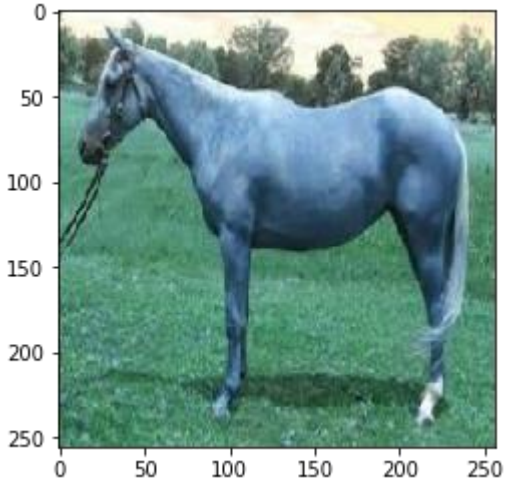



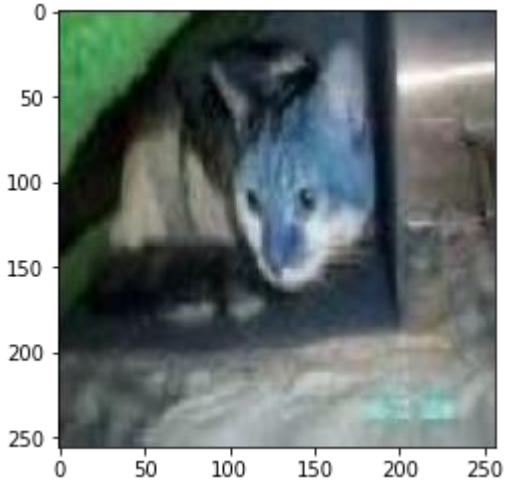




The Predicted Testing image is =cats verify below

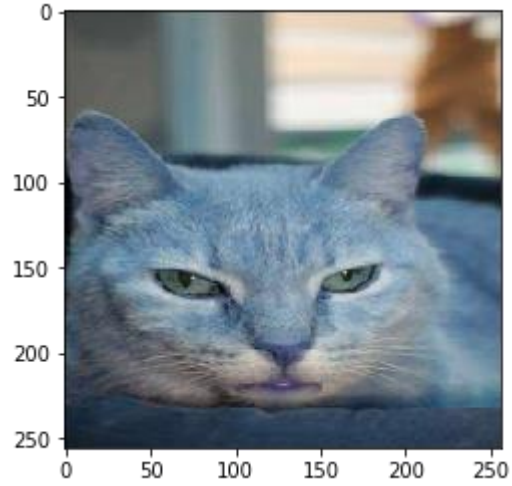


The Predicted Testing image is =horse verify below

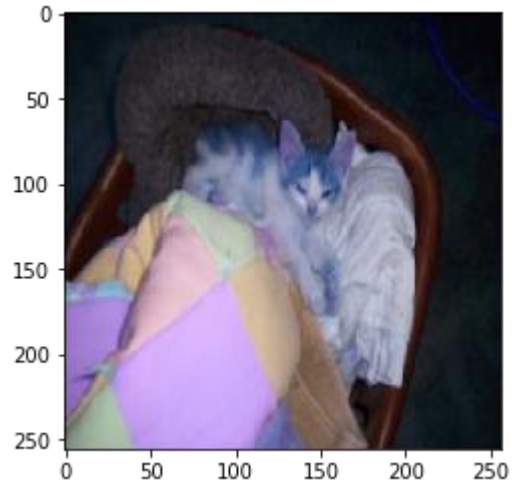


The Predicted Testing image is =dogs verify below

The Predicted Testing image is =horse verify below



The Predicted Testing image is =horse verify below



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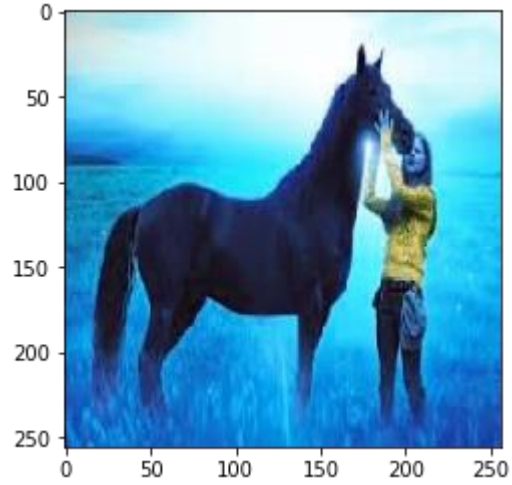
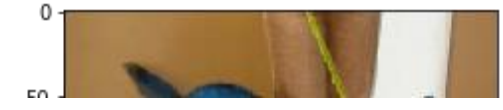
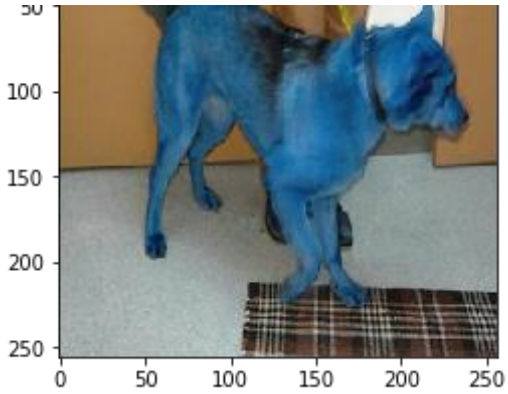
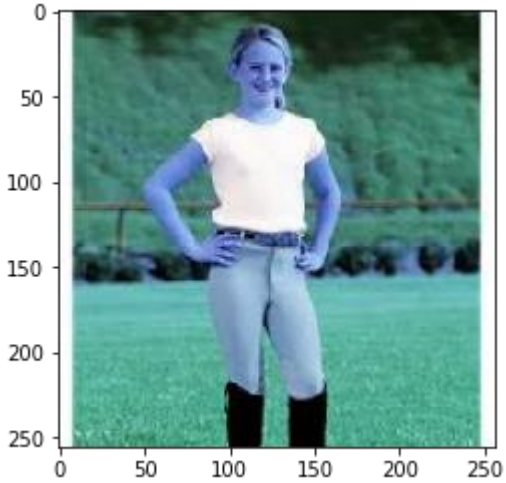


The Predicted Testing image is =dogs verify below





The Predicted Testing image is =humans verify below



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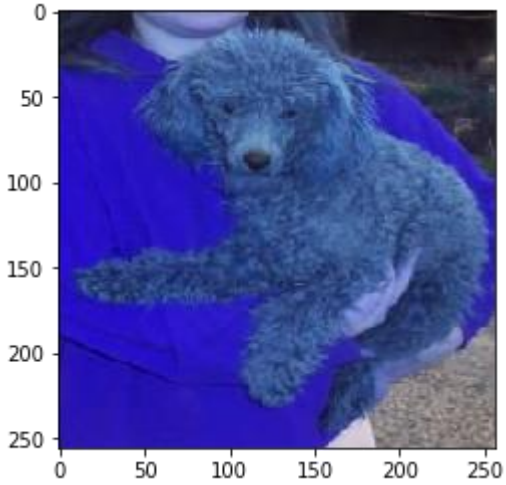

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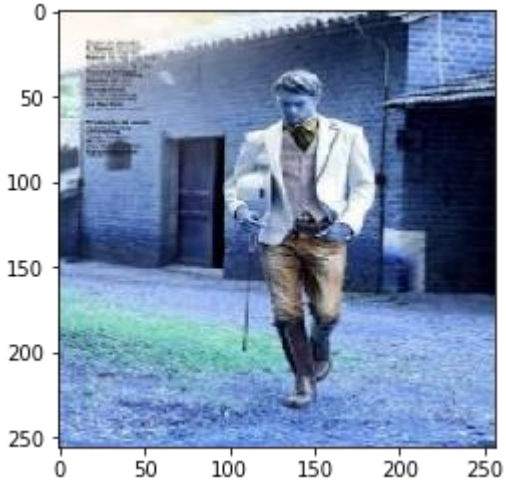

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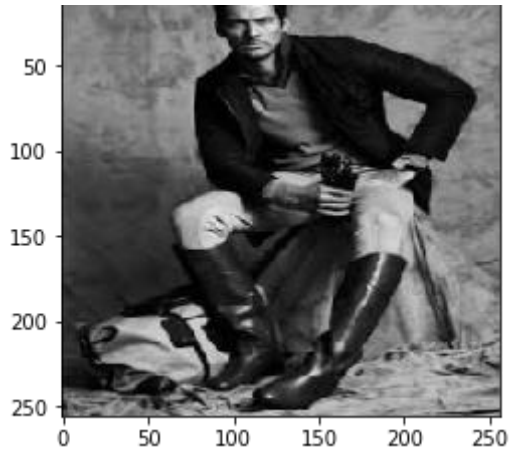
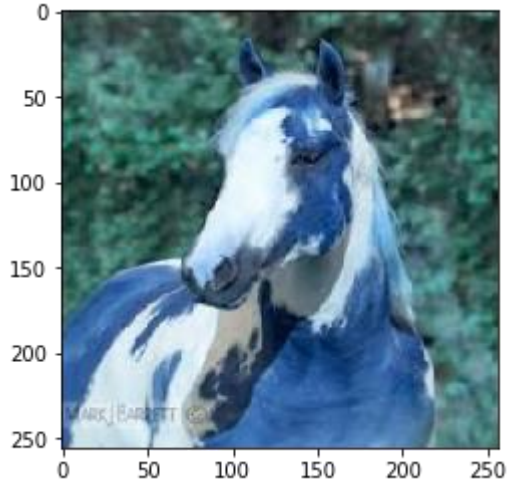
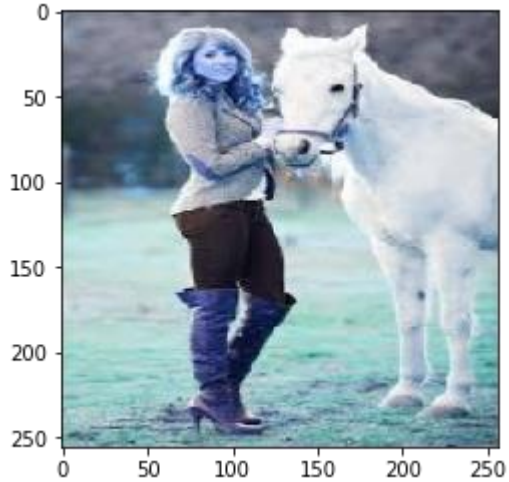


The Predicted Testing image is =dogs verify below



The Predicted Testing image is =humans verify below



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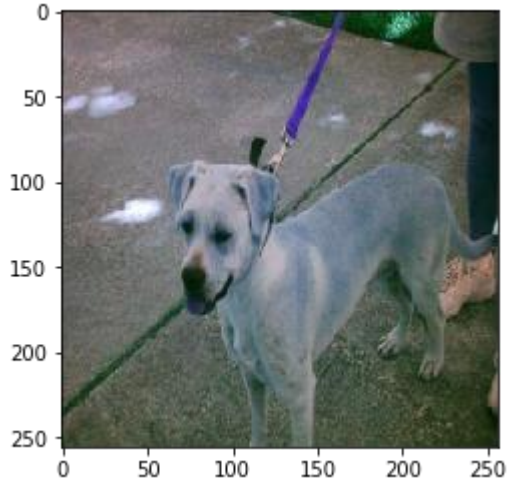
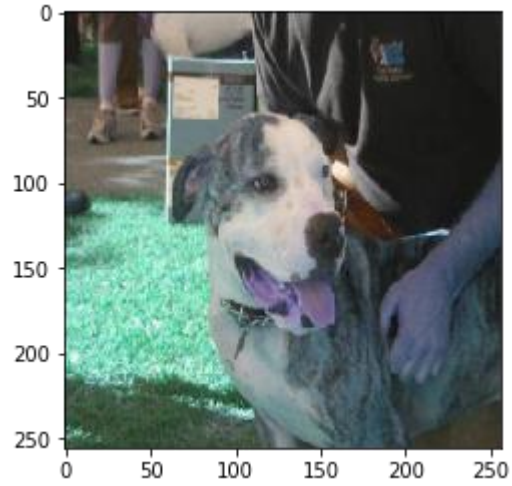
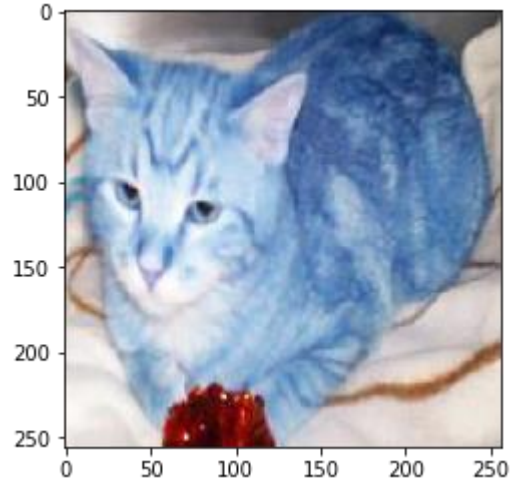


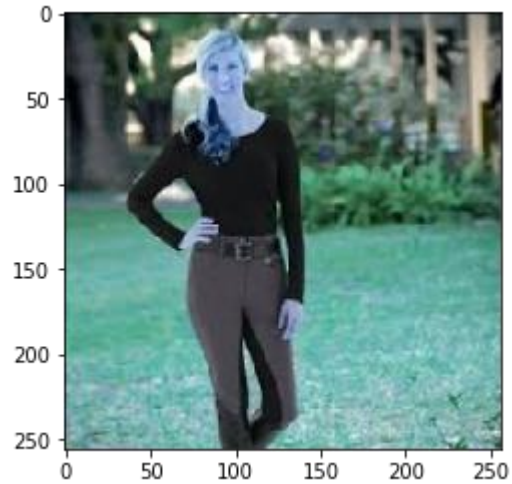
The Predicted Testing image is =dogs verify below



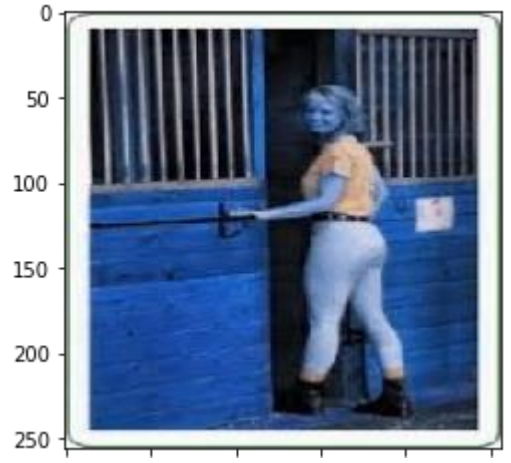
The Predicted Testing image is =horse verify below



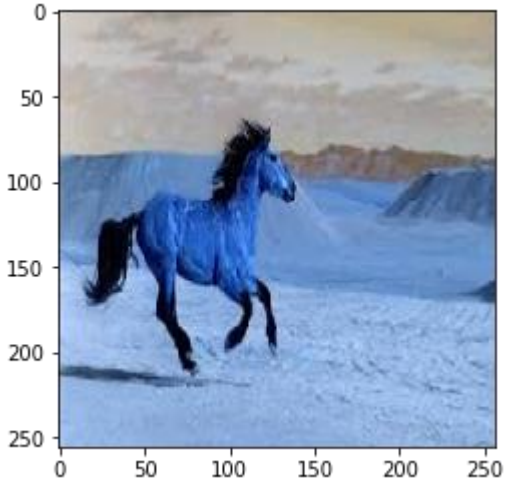
The Predicted Testing image is =humans verify below



The Predicted Testing image is =humans verify below



The Predicted Testing image is =cats verify below



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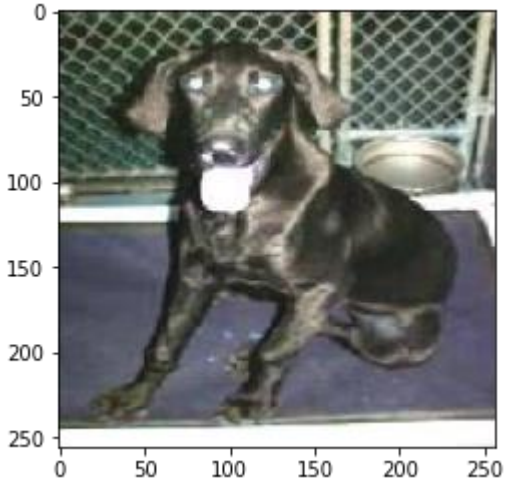

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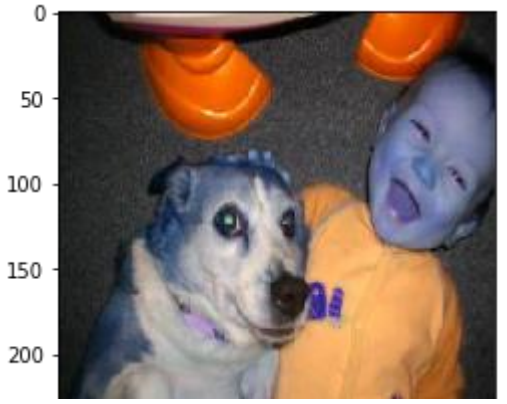

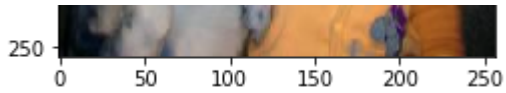

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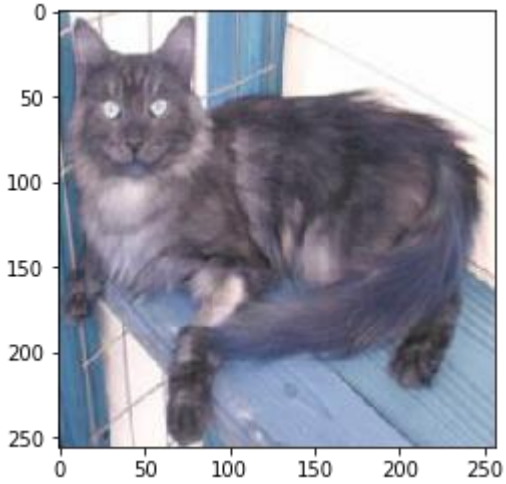

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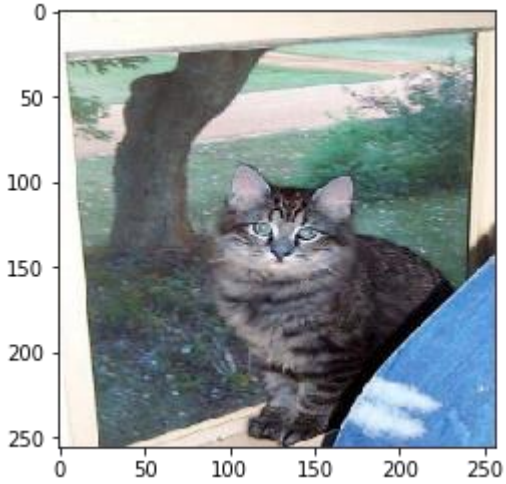

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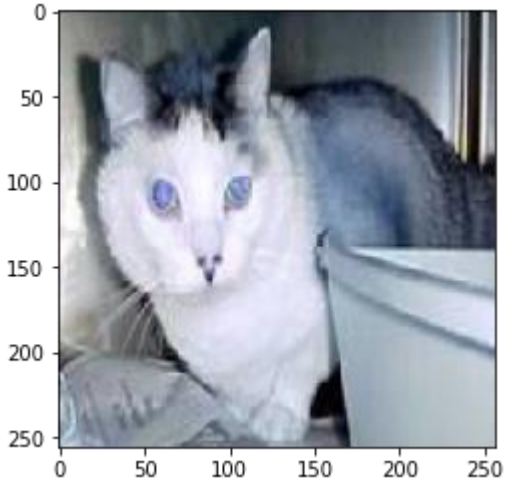

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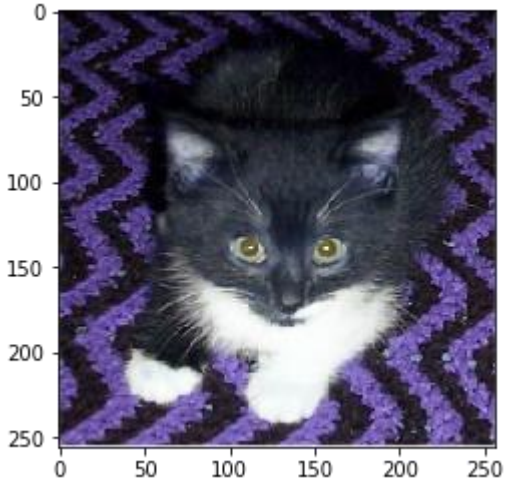

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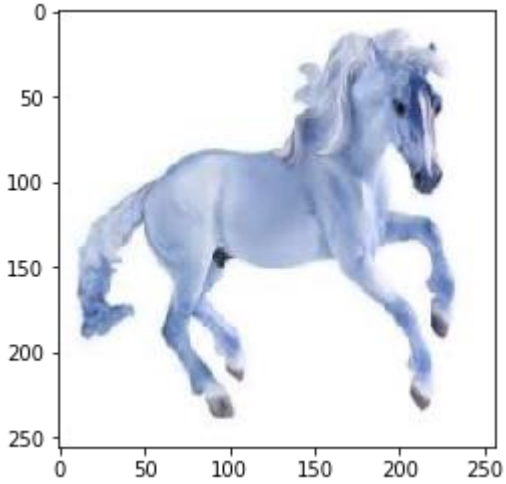

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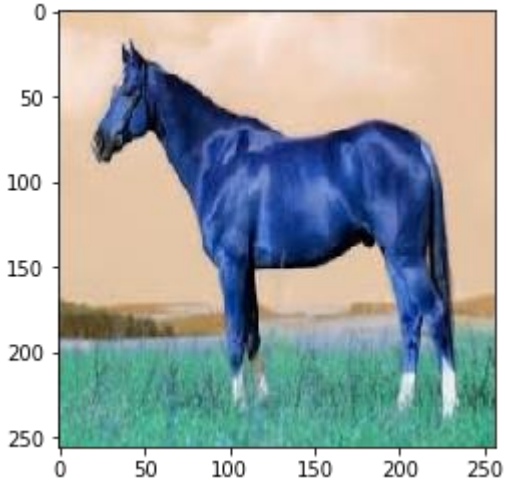

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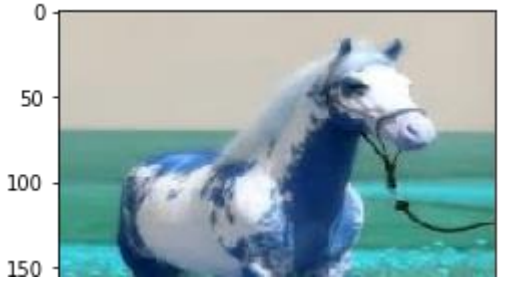

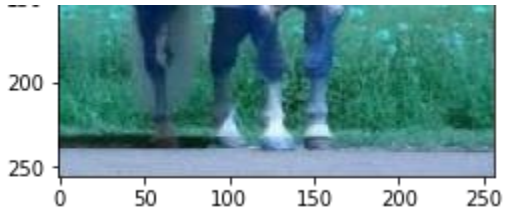

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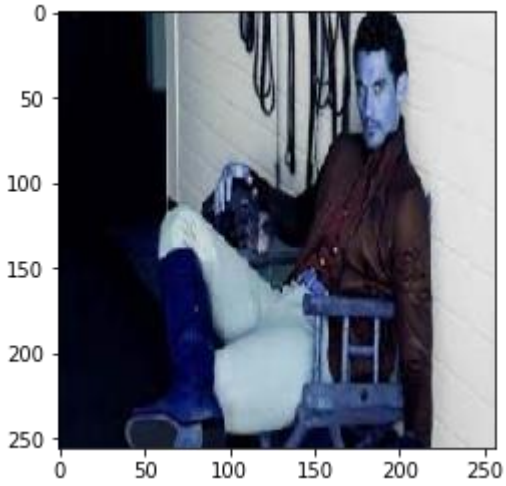

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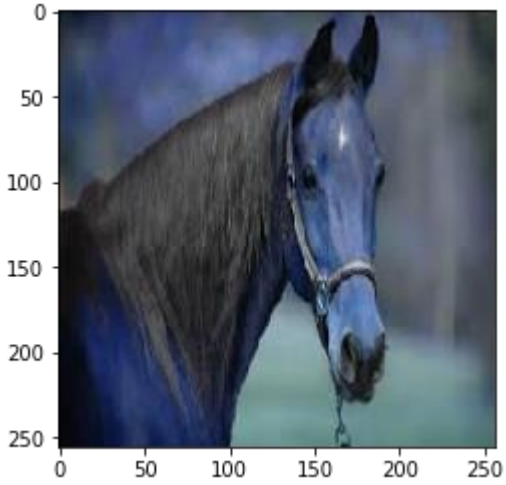

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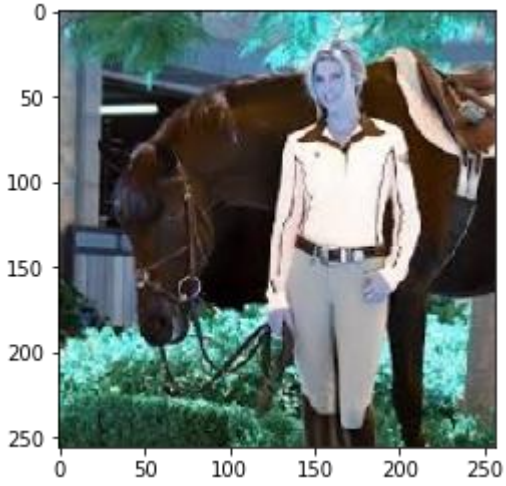

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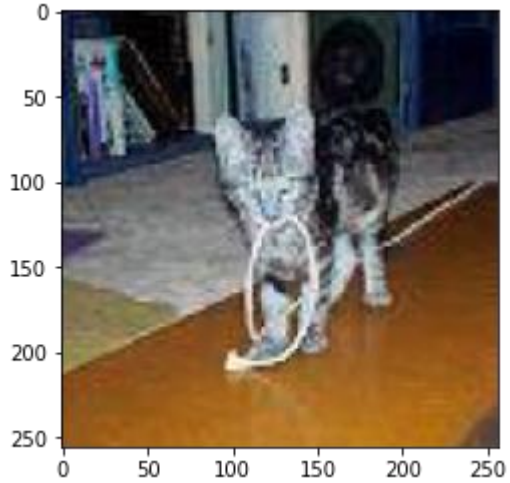

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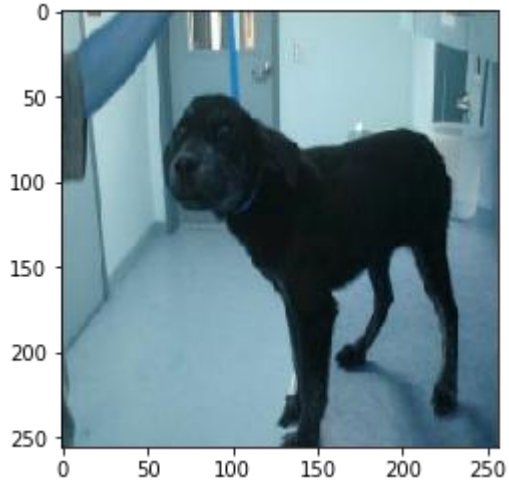

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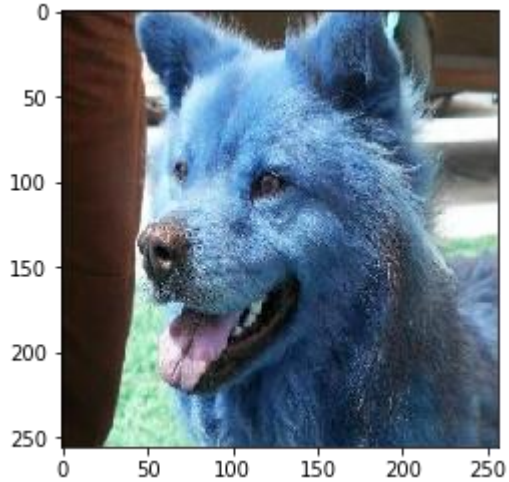

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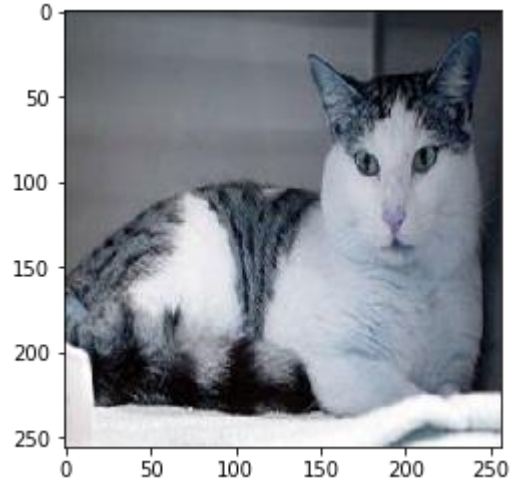

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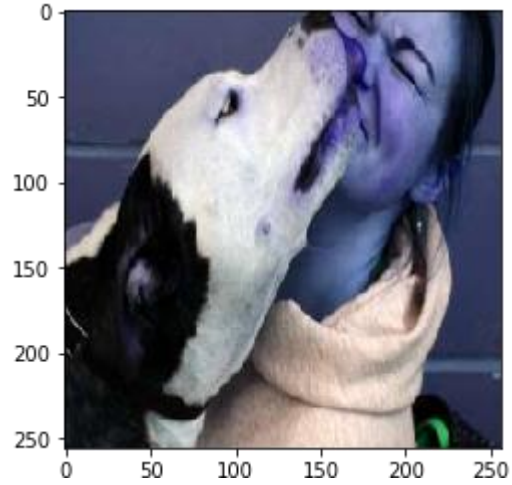

EXPLANATION:

TASK 1:

- At the beginning we are including few libraries and lines of code to generate reproduceable result, (i,e) to get same accuracy no matter how many times we run the code.
- The environ['PYTHONHASHSEED'] is used to maintain the precision which helps us to get same results.
- This seed is set by means of numpy a library which generates random numbers at python level.
- We use the tensor flow for all the functions in this program.
- We import all the files necessary for the code to run.
- We give separate data paths for training, testing and validation.
- Now add the model layers to create the CNN, this time we are using 4 convolution layers, 1 pooling layer, 1 flatten, 2 Dropout and 3 dense layers.
- With train and validation batch size we generate the train and validation data.
- In previous assignments we split the training data into training and validation, but in this assignment, we use separate data.
- Then we compile and train the model with the necessary arguments.
- Then we test the data by creating a data list, reshaping it, normalizing it and predicting the results with the image.

TASK 2:

- For task 2 we include all the libraries and the tensor flow functions along with some files which is imported necessary for the code.
- In this task for transfer learning we use VGG 16 model layer, so we need to include all the libraries for the VGG 16 model.
- We then add the model layers and we also include some code for freezing the layer as long it will be false once it's true the flow of code will be normal.
- Then we add the code to analyses the data and represent it in the form of graph.
- We give separate data paths for training, testing and validation.
- Again, with train and validation batch size we generate the train and validation data.
- Then we test the data by creating a data list, reshaping it, normalizing it and predicting the results with the image.

CONCLUSION:

In the first task we are training and validating the data by generating the weights and trying to predict the data. In previous assignments we are training and validating by splitting the data, but in this assignment, we are giving separate directory for these data. When we are testing and printing the result for task 1 we notice that the accuracy is very poor. This is because we are generating the weights. To overcome this in task 2 we are using VGG 16 model layer, which has in built layers that can generate pre trained weights. In task 2 when we test the data, we get a better accuracy than task 1 but not very good accuracy. In this assignment the images are not sectioned into different folders, they are in a single folder. There is a possibility for mismatch. So, we use VGG 16 for better performance.