Display an image and extract feature using pre-trained convolutional neural network

In [14]:
```
%reset
```

```
Once deleted, variables cannot be recovered. Proceed (y/[n])? y
```

In [15]:
```
from PIL import Image
#import torch
import matplotlib.pyplot as plt
import numpy as np
# import torch.nn.functional as F
# from torch import nn
from torchvision import datasets, transforms
import torchvision.models as models
import os
from time import time

os.chdir(r'D:\1_Code\FOE\ECE3086\lab1_cbir_student_sol')
imgpath = r'.\images'

from ai_pytorch_module import *
device= torch.device("cpu")
```

In [16]:
```
#%% Load model used to extract feature
model = models.vgg16(pretrained=True)
model.classifier = model.classifier[:4] # until linear (3)before relu (4)
model.to(device)
print(model)
```

```
VGG(
  (features): Sequential(
    (0): Conv2d(3, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (1): ReLU(inplace=True)
    (2): Conv2d(64, 64, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (3): ReLU(inplace=True)
    (4): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (5): Conv2d(64, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (6): ReLU(inplace=True)
    (7): Conv2d(128, 128, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (8): ReLU(inplace=True)
    (9): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (10): Conv2d(128, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (11): ReLU(inplace=True)
    (12): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (13): ReLU(inplace=True)
    (14): Conv2d(256, 256, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (15): ReLU(inplace=True)
    (16): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (17): Conv2d(256, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (18): ReLU(inplace=True)
    (19): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (20): ReLU(inplace=True)
    (21): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (22): ReLU(inplace=True)
    (23): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
    (24): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (25): ReLU(inplace=True)
    (26): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
    (27): ReLU(inplace=True)
    (28): Conv2d(512, 512, kernel_size=(3, 3), stride=(1, 1), padding=(1, 1))
```

```
    (29): ReLU(inplace=True)
    (30): MaxPool2d(kernel_size=2, stride=2, padding=0, dilation=1, ceil_mode=False)
  )
  (avgpool): AdaptiveAvgPool2d(output_size=(7, 7))
  (classifier): Sequential(
    (0): Linear(in_features=25088, out_features=4096, bias=True)
    (1): ReLU(inplace=True)
    (2): Dropout(p=0.5, inplace=False)
    (3): Linear(in_features=4096, out_features=4096, bias=True)
  )
)
```

In [17]:

```
#%% Extract the feature from pre-trained convolutional neural network CNN

filename = '002.jpg'
start = time()
filename_ = os.path.join(imgpath, filename)
imgFeature = getCNNFeature(model, filename_,  device, showImage = False,)
end = time()
print("The feature dimension = ", imgFeature.shape)
print(" Time taken to extract feature from one image (sec) = ", end - start) # 1.3 s

im = Image.open(filename_)
plt.figure(figsize=(8,6))
plt.imshow(im) , plt.axis('off')
titleStr = " Image {}".format(filename)
plt.title(titleStr,  fontsize=20)

# Extract the feature from colour histogram
# Your code for getColorHist(filename)

def getColorHist(filename):
#Extract the feature from pre-trained convolutional neural network CNN <br>

    im = np.array( Image.open(filename) )

    # create the histogram plot, with three lines, one for
    # each color
    colors = ("r", "g", "b")
    channel_ids = (0, 1, 2)
    plt.figure()
    plt.xlim([0, 256])

    histL = []
    for channel_id, c in zip(channel_ids, colors):
        histogram, bin_edges = np.histogram(
            im[:, :, channel_id], bins=256, range=(0, 256)
        )

        plt.plot(bin_edges[0:-1], histogram, color=c)
        histogram_n = histogram / np.sum(histogram)
        histL.extend(histogram_n)

    hist_feat = np.array(histL)  # hist is the histogram vector that represent the i

    plt.xlabel("Color value")
    plt.ylabel("Pixels")
    plt.title(filename)
    plt.show()

    return hist_feat
```

```
The feature dimension =  (1, 4096)
 Time taken to extract feature from one image (sec) =  0.28756165504455566
```

Question 3:

(a) Compute dissimilarity distance (euclidian) with feature from colour histogram
Extract the feature from image '001.jpg' , '022.jpg' and '400.jpg'. Compute the euclidian distance between the two feature vector. Compute the euclidian distance between the two feature vector from '001.jpg' , '022.jpg'. Then Compute the euclidian distance between the two feature vector from '001.jpg' , '400.jpg'.

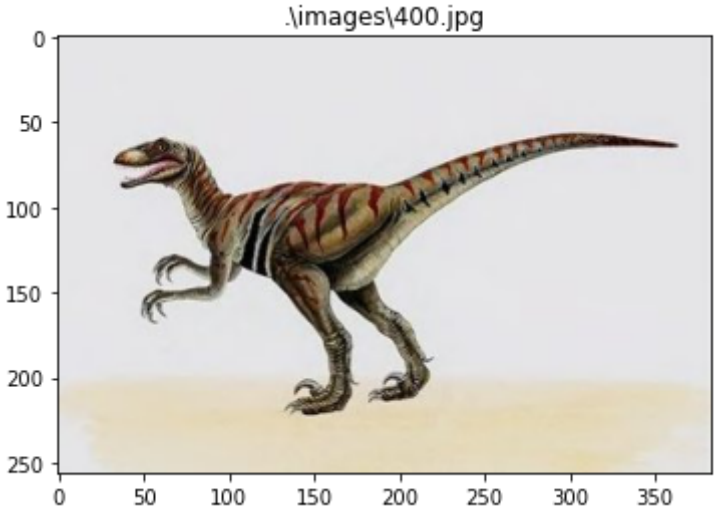
(b) Compute dissimilarity distance (euclidian) with feature from pre-trained convolutional neural network CNN
Extract the feature from image '001.jpg' , '022.jpg' and '400.jpg'. Compute the euclidian distance between the two feature vector. Compute the euclidian distance between the two feature vector from '001.jpg' , '022.jpg'. Then Compute the euclidian distance between the two feature vector from '001.jpg' , '400.jpg'.

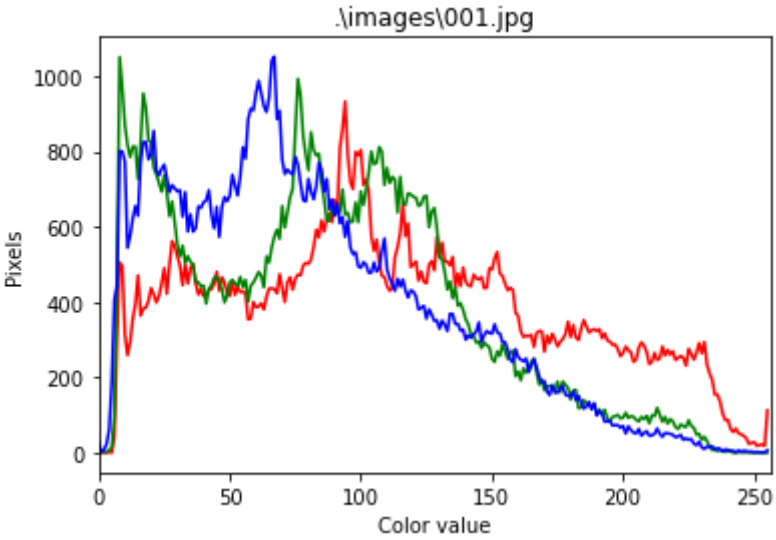
In [18]:
```
# Answer: Insert your code in this cell

#%% Get color histogram feature
for f in ['001.jpg', '022.jpg', '400.jpg' ] :
    filename = os.path.join(imgpath, f)
    img = Image.open(filename)
    plt.figure()
    plt.imshow(img)
    plt.title(filename)
    print(filename)


imgpath = r'.\images'
feat_hists = []
i=0
for f in  ['001.jpg', '022.jpg', '400.jpg' ]  :
    filename = os.path.join(imgpath, f)
    feat = getColorHist(filename)
    feat_hists.append(feat)
```

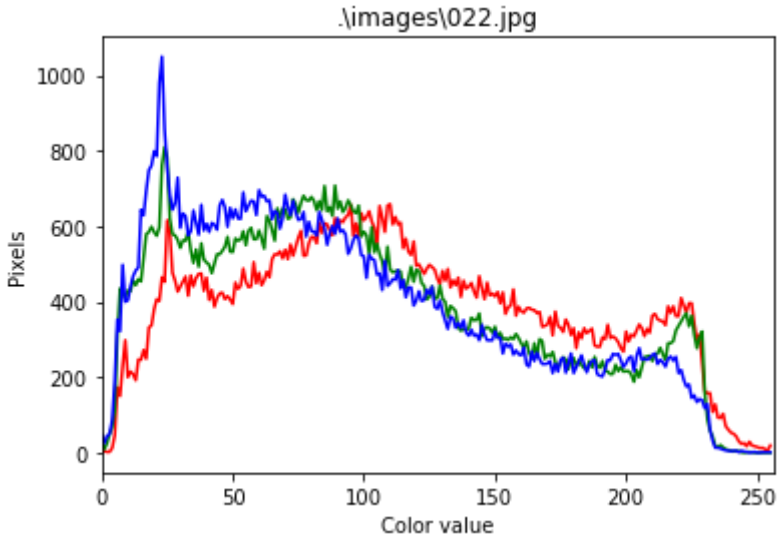
```
#%% Get CNN feature
feat_cnns = []
i=0
for f in  ['001.jpg', '022.jpg', '400.jpg' ]  :
    filename = os.path.join(imgpath, f)
    print(filename)
    feat = getCNNFeature(model, filename,  device, showImage = False)
    feat_cnns.append(feat)


#%% Comparing with color histogram
# '001.jpg' vs '022.jpg'
# your code
# printing Euclidean distance
print("With color hist, image 1 vs image 22 , distance = ", dist1_vs_22)

# '001.jpg' , '400.jpg'.
# your code
# printing Euclidean distance
print("With color hist, image 1 vs image 400 , distance = ", dist1_vs_400)


#%% Comparing with CNN feature
# '001.jpg' vs '022.jpg'
# your code
# printing Euclidean distance
print("With cnn feature, image 1 vs image 22 , distance = ",dist1_vs_22) #

# '001.jpg' , '400.jpg'.
# your code
# printing Euclidean distance
print("With cnn feature, image 1 vs image 400 , distance = ", dist1_vs_400) #
```

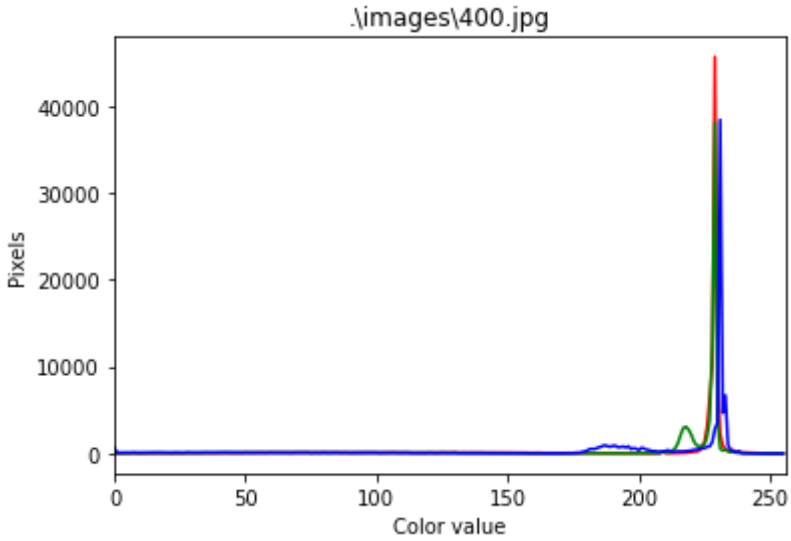
```
.\images\001.jpg
.\images\022.jpg
.\images\400.jpg
```


.\images\022.jpg
0
50
100
150
200
250
0
50
100
150
200
250
300
350


.\images\400.jpg
0
50
100
150
200
250
0
50
100
150
200
250
300
350


.\images\001.jpg
Pixels
0
200
400
600
800
1000
0
50
100
150
200
250
Color value






```
.\images\001.jpg
.\images\022.jpg
.\images\400.jpg
With color hist, image 1 vs image 22 , distance =  0.0345468839243469
With color hist, image 1 vs image 400 , distance =  0.7658398822987645
With cnn feature, image 1 vs image 22 , distance =  99.12702
With cnn feature, image 1 vs image 400 , distance =  133.52898
```

Question 4:

Explain your conclusion on the pairwise similarity between the three images '001.jpg' , '022.jpg' and '400.jpg' . Comment on the semantic similarity between the three images and the euclidian distance among their feature vectors. Compare colour histogram and CNN feature.

Your answer

In [ ]:

In [ ]: