In [1]:

```
import argparse
import os
import math
import numpy as np
from scipy import fftpack
from PIL import Image
from matplotlib import pyplot as plt
from skimage import img_as_ubyte
import cv2
from utility import *
from huffmantree import HuffmanTree
# from scipy.misc import imread,imsave
import imageio
```

把图像的长和高转换成8的倍数，并把RGB转换成YCbCr颜色模型

In [2]:

```
img1 = imageio.imread('../动物照片.jpg')
img2 = imageio.imread('../动物卡通图片.jpg')

print("原动物照片的大小: \n",img1.shape)
print("原动物卡通图片的大小: \n",img2.shape)
# 块的大小
B=8
# 图片的大小
height1,width1=(np.array(img1.shape[:2])/B * B).astype(np.int32)
img1=img1[:height1,:width1]
height2,width2=(np.array(img2.shape[:2])/B * B).astype(np.int32)
img2=img2[:height2,:width2]

mat = np.array(
    [[ 65.481, 128.553, 24.966 ],
     [-37.797, -74.203, 112.0  ],
     [  112.0, -93.786, -18.214]])
offset = np.array([16, 128, 128])
# mat = np.array(
#     [[ 0.299, 0.587, 0.144 ],
#      [-0.168736, -0.331264, 0.5  ],
#      [  0.5, -0.418688, -0.081312]])
# offset = np.array([0, 128, 128])

mat_inv = np.linalg.inv(mat)

# RGB转YCBCr
ycbcr1 = np.zeros(img1.shape)
for x in range(img1.shape[0]):
    for y in range(img1.shape[1]):
        ycbcr1[x, y, :] = np.round(np.dot(mat, img1[x, y, :] * 1.0 / 255) + of
fset)

ycbcr2 = np.zeros(img2.shape)
```

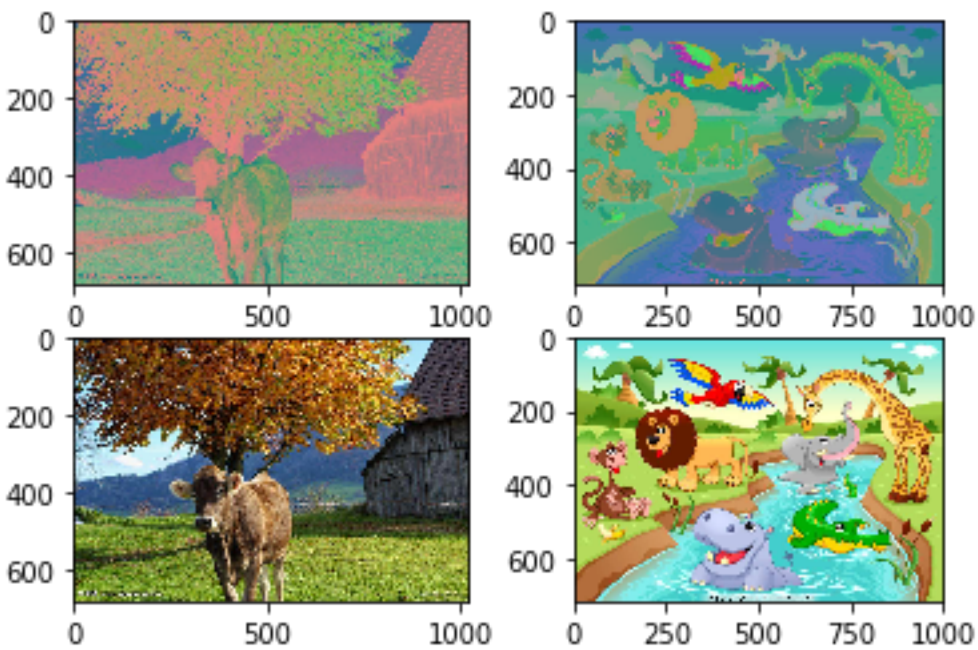
```
for x in range(img2.shape[0]):
    for y in range(img2.shape[1]):
        ycbcr2[x, y, :] = np.round(np.dot(mat, img2[x, y, :] * 1.0 / 255) + of
fset)

# YCbCr转RGB
rgb_img1 = np.zeros(ycbcr1.shape, dtype=np.uint8)
for x in range(ycbcr1.shape[0]):
    for y in range(ycbcr1.shape[1]):
        [r, g, b] = ycbcr1[x,y,:]
        rgb_img1[x, y, :] = np.maximum(0, np.minimum(255, np.round(np.dot(mat_
inv, ycbcr1[x, y, :] - offset) * 255.0)))

rgb_img2 = np.zeros(ycbcr2.shape, dtype=np.uint8)
for x in range(ycbcr2.shape[0]):
    for y in range(ycbcr2.shape[1]):
        [r, g, b] = ycbcr2[x,y,:]
        rgb_img2[x, y, :] = np.maximum(0, np.minimum(255, np.round(np.dot(mat_
inv, ycbcr2[x, y, :] - offset) * 255.0)))

# ycbcr1 = cv2.cvtColor(img1, cv2.COLOR_RGB2YCR_CB)
# ycbcr2 = cv2.cvtColor(img2, cv2.COLOR_RGB2YCR_CB)

# 显示YCBCR图片和RGB图片
plt.subplot(2,2,1)
plt.imshow(ycbcr1)
plt.subplot(2,2,2)
plt.imshow(ycbcr2)
plt.subplot(2,2,3)
plt.imshow(rgb_img1)
plt.subplot(2,2,4)
plt.imshow(rgb_img2)
plt.show()
imageio.imsave('../ycbcr1.jpg',ycbcr1)
imageio.imsave('../ycbcr2.jpg',ycbcr2)
```

原动物照片的大小：

```
 (682, 1024, 3)
```

原动物卡通图片的大小：

```
 (715, 1000, 3)
```




```
/anaconda3/lib/python3.6/site-packages/imageio/core/util.py:104: U
serWarning: Conversion from float64 to uint8, range [16.0, 235.0]
  'range [{2}, {3}]'.format(dtype_str, out_type.__name__, mi, ma))
/anaconda3/lib/python3.6/site-packages/imageio/core/util.py:104: U
serWarning: Conversion from float64 to uint8, range [16.0, 240.0]
  'range [{2}, {3}]'.format(dtype_str, out_type.__name__, mi, ma))
```

进行4:2:0的二次采样

In [3]:

```
# 每两个像素垂直采样一次
vertical_subsample=2
# 每两个像素水平采样一次
horizontal_subsample=2

# 2*2平滑滤波（取区域内的平均值）
crf1=cv2.boxFilter(ycbcr1[:,:,1],ddepth=-1,ksize=(2,2))
cbf1=cv2.boxFilter(ycbcr1[:,:,2],ddepth=-1,ksize=(2,2))
crf2=cv2.boxFilter(ycbcr2[:,:,1],ddepth=-1,ksize=(2,2))
cbf2=cv2.boxFilter(ycbcr2[:,:,2],ddepth=-1,ksize=(2,2))
# 每隔一行和一列采样，即2*2区域内采样一次
crsub1=crf1[::vertical_subsample,::horizontal_subsample]
cbsub1=cbf1[::vertical_subsample,::horizontal_subsample]
crsub2=crf2[::vertical_subsample,::horizontal_subsample]
cbsub2=cbf2[::vertical_subsample,::horizontal_subsample]
# 将三个通道下采样后的像素值存入列表
sub_img1=[ycbcr1[:,:,0],crsub1,cbsub1]
sub_img2=[ycbcr2[:,:,0],crsub2,cbsub2]

# 输出大小检验
print("图片1：\nY值采样点数量",ycbcr1[:,:,0].size)
print("Cr值采样点数量",crsub1.size)
print("Cb值采样点数量",cbsub1.size)
# print("\n")
print("图片2：\nY值采样点数量",ycbcr2[:,:,0].size)
print("Cr值采样点数量",crsub2.size)
print("Cb值采样点数量",cbsub2.size)
# print(imSub)
```

```
图片1：
Y值采样点数量 698368
Cr值采样点数量 174592
Cb值采样点数量 174592
图片2：
Y值采样点数量 715000
Cr值采样点数量 179000
Cb值采样点数量 179000
```

对8x8的图像块进行二维DCT变换和量化

In [4]:

```
# 亮度和色度量化表
QY=np.array([[16,11,10,16,24,40,51,61],
             [12,12,14,19,26,48,60,55],
             [14,13,16,24,40,57,69,56],
             [14,17,22,29,51,87,80,62],
             [18,22,37,56,68,109,103,77],
             [24,35,55,64,81,104,113,92],
             [49,64,78,87,103,121,120,101],
             [72,92,95,98,112,100,103,99]])

QC=np.array([[17,18,24,47,99,99,99,99],
             [18,21,26,66,99,99,99,99],
             [24,26,56,99,99,99,99,99],
             [47,66,99,99,99,99,99,99],
             [99,99,99,99,99,99,99,99],
             [99,99,99,99,99,99,99,99],
             [99,99,99,99,99,99,99,99],
             [99,99,99,99,99,99,99,99]])
```

In [5]:

```
# 所有dct变换后的块
dct_blocks1=[]
dct_blocks2=[]
# 所有量化后的块
quan_blocks1=[]
quan_blocks2=[]
# YCrCb颜色通道
ch=['Y','Cr','Cb']
# 量化表
Q=[QY,QC,QC]
# 所有z扫描后的向量
Zs1 = []
Zs2 = []
# 遍历每个颜色通道
for index,channel in enumerate(sub_img1):
        # 行数
        rows=channel.shape[0]
        # 列数
        cols=channel.shape[1]
        # dct变换后的块
        dct_block = np.zeros((rows,cols), np.float32)
        # 量化后的块
        quan_block = np.zeros((rows,cols), np.float32)
        # 块的行数
        block_rows=int(rows/B)
        # 块的列数
        block_cols=int(cols/B)

        # z扫描后的向量
        z = []

        block = np.zeros((rows,cols), np.float32)
        block[:rows, :cols] = channel
        # 整齐化，减128使Y分量（DC）成为均值为0
```

```
        # 整齐化，减128使Y分量（DC）成为均值为0。
        block=block-128
        # for debug
#         print(block_rows)
#         print(block_cols)
        # 处理每个块
        for row in range(block_rows):
                for col in range(block_cols):
                        # 当前块
                        currentblock = cv2.dct(block[row*B:(row+1)*B,col*B:(co
l+1)*B])
                        # 存储二维dct变换后的块
                        dct_block[row*B:(row+1)*B,col*B:(col+1)*B]=currentbloc
k
                        # 存储量化后的块
                        quan_block[row*B:(row+1)*B,col*B:(col+1)*B]=np.round(c
urrentblock/Q[index])
                        # z扫描
                        z.append(block_to_zigzag(quan_block[row*B:(row+1)*B,co
l*B:(col+1)*B]).astype(np.int32))


        dct_blocks1.append(dct_block)
        quan_blocks1.append(quan_block)
        Zs1.append(z)

# print(len(dct_blocks1[0]))
# print(len(dct_blocks1[1]))
# print(len(dct_blocks1[2]))
print("origin block 1:\n",sub_img1[0][0:8,0:8])
print("DCT block 1:\n",dct_blocks1[0][0:8,0:8])
print("QUAN block 1:\n",quan_blocks1[0][0:8,0:8])
print("Z array:\n",Zs1[0][0])

# print(len(quan_blocks1))
# print(dct_blocks)
# print(quan_blocks)

dcs1 = dcpm(Zs1)
dcs1_values = dc(Zs1)
acs1_symbol1 = rlc(Zs1)
acs1 = ac(Zs1)
acs1_bin = rlc_values(Zs1)
# print(len(dcs1[0]))
print("DC size block 1:",dcs1[0][0])
print("DC value block 1:",dcs1_values[0][0])
# print(len(acs1_symbol1[0][0]))
print("AC values block 1:",acs1[0][0])
print("AC sizes block 1:",acs1_symbol1[0][0])
print("AC bin_str block 1:",acs1_bin[0][0])
# print(len(acs1_symbol1[0][0]))
# print(len(acs1_bin[0][0]))

H_DC_Y = HuffmanTree(dcs1[0])
H_DC_C = HuffmanTree(dcs1[1]+dcs1[2])
H_AC_Y = HuffmanTree(flatten(acs1_symbol1[0]))
H_AC_C = HuffmanTree(flatten(acs1_symbol1[1])+flatten(acs1_symbol1[2]))
```

```
tables = {'dc_y': H_DC_Y.value_to_bitstring_table(),
            'ac_y': H_AC_Y.value_to_bitstring_table(),
            'dc_c': H_DC_C.value_to_bitstring_table(),
            'ac_c': H_AC_C.value_to_bitstring_table()}

write_to_file('encode1.b', dcs1, dcs1_values,acs1_symbol1, acs1_bin,tables)

for index,channel in enumerate(sub_img2):
        # 行数
        rows=channel.shape[0]
        # 列数
        cols=channel.shape[1]
        # dct变换后的块
        dct_block = np.zeros((rows,cols), np.float32)
        # 量化后的块
        quan_block = np.zeros((rows,cols), np.float32)
        # 块的行数
        block_rows=int(rows/B)
        # 块的列数
        block_cols=int(cols/B)
        # z扫描后的向量
        z = []


        block = np.zeros((rows,cols), np.float32)
        block[:rows, :cols] = channel
        # 整齐化，减128使Y分量（DC）成为均值为0。
        block=block-128

        pass
        # for debug
        # print(block_rows)
        # print(block_cols)
        # print(block[0:8,0:8])
        # print(cv2.dct(block[0:8,0:8]))

        # 处理每个块
        for row in range(block_rows):
                for col in range(block_cols):
                        # 当前块
                        currentblock = cv2.dct(block[row*B:(row+1)*B,col*B:(co
l+1)*B])
                        # 存储二维dct变换后的块
                        dct_block[row*B:(row+1)*B,col*B:(col+1)*B]=currentbloc
k
                        # 存储量化后的块
                        quan_block[row*B:(row+1)*B,col*B:(col+1)*B]=np.round(c
urrentblock/Q[index])
                        # z扫描
                        z.append(block_to_zigzag(quan_block[row*B:(row+1)*B,co
l*B:(col+1)*B]).astype(np.int32))

        dct_blocks2.append(dct_block)
        quan_blocks2.append(quan_block)
        Zs2.append(z)
```

```python
# print(len(dct_blocks1[0]))

# print(len(dct_blocks1[1]))
# print(len(dct_blocks1[2]))
print("origin block 1:\n",sub_img2[0][0:8,0:8])
print("DCT block 1:\n",dct_blocks2[0][0:8,0:8])
print("QUAN block 1:\n",quan_blocks2[0][0:8,0:8])
print("Z array:\n",Zs2[0][0])

# print(len(quan_blocks1))
# print(dct_blocks)
# print(quan_blocks)

dcs2 = dcpm(Zs2)
dcs2_values = dc(Zs2)
acs2_symbol1 = rlc(Zs2)
acs2 = ac(Zs2)
acs2_bin = rlc_values(Zs2)
# print(len(dcs1[0]))
print("DC size block 1:",dcs2[0][0])
print("DC value block 1:",dcs2_values[0][0])
# print(len(acs1_symbol1[0][0]))
print("AC values block 1:",acs2[0][0])
print("AC sizes block 1:",acs2_symbol1[0][0])
print("AC bin_str block 1:",acs2_bin[0][0])
# print(len(acs1_symbol1[0][0]))
# print(len(acs1_bin[0][0]))

H_DC_Y = HuffmanTree(dcs2[0])
H_DC_C = HuffmanTree(dcs2[1]+dcs2[2])
H_AC_Y = HuffmanTree(flatten(acs2_symbol1[0]))
H_AC_C = HuffmanTree(flatten(acs2_symbol1[1])+flatten(acs2_symbol1[2]))

tables = {'dc_y': H_DC_Y.value_to_bitstring_table(),
          'ac_y': H_AC_Y.value_to_bitstring_table(),
          'dc_c': H_DC_C.value_to_bitstring_table(),
          'ac_c': H_AC_C.value_to_bitstring_table()}

write_to_file('encode2.b', dcs2, dcs2_values,acs2_symbol1, acs2_bin,tables)
# for debug
# 根据书上的例子对DCT和量化进行测试
# block = np.array([
#                 [200, 202, 189, 188, 189, 175, 175, 175],
#                 [200, 203, 198, 188, 189, 182, 178, 175],
#                 [203, 200, 200, 195, 200, 187, 185, 175],
#                 [200, 200, 200, 200, 197, 187, 187, 187],
#                 [200, 205, 200, 200, 195, 188, 187, 175],
#                 [200, 200, 200, 200, 200, 190, 187, 175],
#                 [205, 200, 199, 200, 191, 187, 187, 175],
#                 [210, 200, 200, 200, 188, 185, 187, 186]
#             ])

# block = block - 128
# # DCT
# dct_block = fftpack.dct(fftpack.dct(block.T, norm='ortho').T, norm='ortho').
round().astype(np.int32)
# # 量化
# dct_q = (dct_block / QY).round().astype(np.int32)
```

```
# # 反量化
# i_q = dct_q * QY
# # 逆DCT
# i_block = fftpack.idct(fftpack.idct(i_q.T, norm='ortho').T, norm='ortho').ro
und().astype(np.int32)
# i_block = i_block + 128
# # 误差
# err = block-i_block+128

# print("原始块:\n",block+128)
# print("DCT变换系数:\n",dct_block)
# print("量化后:\n",dct_q)
# print("逆量化后:\n",i_q)
# print("重构后的:\n",i_block)
# print("误差:\n",err)
```

```
origin block 1:
 [[ 213.  174.  125.  132.  137.  100.  144.   99.]
 [ 206.  224.  108.   44.   47.   30.   19.   74.]
 [ 201.  195.  189.  176.   82.   18.   53.   29.]
 [ 191.  183.  165.  168.  191.   49.  112.   66.]
 [ 134.   53.   51.   68.  178.  159.  208.  142.]
 [ 109.   54.   58.   25.  110.  207.  162.  175.]
 [ 119.   18.   43.   42.   18.  131.  203.  201.]
 [ 193.  129.   40.   44.   59.   22.   91.  101.]]
DCT block 1:
 [[-112.625        90.57981873  155.20181274   70.25214386   32.12
5
    24.54866409  -36.55039215   43.3731842 ]
 [  82.54890442  247.46185303  -71.96418762  -54.25366592   -1.353
91319
   -33.33273697  -40.72128296   -1.20829308]
 [ -72.82316589   51.08989334  110.66429138  -14.01447201   -0.546
00382
    -1.03978515   -0.47989395  -38.34343719]
 [  45.78198624 -250.1946106    15.51844978   96.55448151  -33.461
20071
    -1.13736629   52.51040268    1.79191852]
 [  68.875        16.18461609  -50.46648407   38.17147064   45.625
     2.98483419  -66.63457489   50.09516525]
 [  68.57692719  -21.94193077  -41.06401825  -42.47582626    3.078
22084
    64.53166962   -3.34531879    3.39095736]
 [  30.29964066   43.35163498  -52.72989655   -0.6331141    -0.991
52911
     3.26194       5.8357091    -4.64618444]
 [   1.03994894  -62.04674911   -1.59952772    1.24717855    1.107
65278
    64.89634705   -0.79913193    0.95200229]]
QUAN block 1:
 [[ -7.   8.  16.   4.   1.   1.  -1.   1.]
 [  7.  21.  -5.  -3.  -0.  -1.  -1.  -0.]
 [ -5.   4.   7.  -1.  -0.  -0.  -0.  -1.]
 [  3. -15.   1.   3.  -1.  -0.   1.   0.]
 [  4.   1.  -1.   1.   1.   0.  -1.   1.]
 [  3.  -1.  -1.  -1.   0.   1.  -0.   0.]
 [  1.   1.  -1.  -0.  -0.   0.   0.  -0.]
```

```
 [  0.  -1.  -0.   0.   0.   1.  -0.   0.]]
Z array:
 [ -7   8   7  -5  21  16   4  -5   4   3   4 -15   7  -3   1   1
0  -1
   1   1   3   1  -1  -1   3   0  -1  -1   1  -1   0  -1   1  -1
1   0
  -1  -1  -1   1   0   0   0  -1   1   0   0   0   0   0   0   1
-1   0
   1   0   0   0   1   0   0   0   0   0]
DC size block 1: 3
DC value block 1: -7
AC values block 1: [  8   7  -5  21  16   4  -5   4   3   4 -15
7  -3   1   1   0  -1   1
   1   3   1  -1  -1   3   0  -1  -1   1  -1   0  -1   1  -1   1
0  -1
  -1  -1   1   0   0   0  -1   1   0   0   0   0   0   1  -1
0   1
   0   0   0   1   0   0   0   0   0]
AC sizes block 1: [(0, 4), (0, 3), (0, 3), (0, 5), (0, 5), (0, 3),
(0, 3), (0, 3), (0, 2), (0, 3), (0, 4), (0, 3), (0, 2), (0, 1), (0
, 1), (1, 1), (0, 1), (0, 1), (0, 2), (0, 1), (0, 1), (0, 1), (0,
2), (1, 1), (0, 1), (0, 1), (0, 1), (1, 1), (0, 1), (0, 1), (0, 1)
, (1, 1), (0, 1), (0, 1), (0, 1), (3, 1), (0, 1), (6, 1), (0, 1),
(1, 1), (3, 1), (0, 0)]
AC bin_str block 1: ['1000', '111', '010', '10101', '10000', '100'
, '010', '100', '11', '100', '0000', '111', '00', '1', '1', '0', '
1', '1', '11', '1', '0', '0', '11', '0', '0', '1', '0', '0', '1',
'0', '1', '0', '0', '0', '1', '0', '1', '1', '0', '1', '1', '']
origin block 1:
 [[ 176.  176.  176.  176.  176.  176.  176.  176.]
 [ 176.  176.  176.  176.  176.  176.  176.  176.]
 [ 176.  176.  176.  176.  176.  176.  176.  176.]
 [ 176.  176.  176.  176.  176.  176.  176.  176.]
 [ 177.  177.  177.  177.  177.  177.  177.  177.]
 [ 177.  177.  177.  177.  177.  177.  177.  177.]
 [ 178.  178.  178.  178.  178.  178.  178.  178.]
 [ 178.  178.  178.  178.  178.  178.  178.  178.]]
DCT block 1:
 [[  3.90000000e+02   0.00000000e+00   0.00000000e+00   0.00000000
e+00
    0.00000000e+00   0.00000000e+00   0.00000000e+00   0.00000000e
+00]
 [ -6.18742561e+00   0.00000000e+00   0.00000000e+00   0.00000000e
+00
    0.00000000e+00   0.00000000e+00   0.00000000e+00   0.00000000e
+00]
 [   1.84775913e+00   0.00000000e+00   0.00000000e+00   0.00000000e
+00
    0.00000000e+00   0.00000000e+00   0.00000000e+00   0.00000000e
+00]
 [   3.72782290e-01   0.00000000e+00   0.00000000e+00   0.00000000e
+00
    0.00000000e+00   0.00000000e+00   0.00000000e+00   0.00000000e
+00]
 [   0.00000000e+00   0.00000000e+00   0.00000000e+00   0.00000000e
+00
    0.00000000e+00   0.00000000e+00   0.00000000e+00   0.00000000e
```

```
+00]
 [ -2.49085248e-01   0.00000000e+00   0.00000000e+00   0.00000000e
+00
    0.00000000e+00   0.00000000e+00   0.00000000e+00   0.00000000e
+00]
 [ -7.65366912e-01   0.00000000e+00   0.00000000e+00   0.00000000e
+00
    0.00000000e+00   0.00000000e+00   0.00000000e+00   0.00000000e
+00]
 [  1.23075557e+00   0.00000000e+00   0.00000000e+00   0.00000000e
+00
    0.00000000e+00   0.00000000e+00   0.00000000e+00   0.00000000e
+00]]
QUAN block 1:
 [[ 24.   0.   0.   0.   0.   0.   0.   0.]
 [ -1.   0.   0.   0.   0.   0.   0.   0.]
 [  0.   0.   0.   0.   0.   0.   0.   0.]
 [  0.   0.   0.   0.   0.   0.   0.   0.]
 [  0.   0.   0.   0.   0.   0.   0.   0.]
 [ -0.   0.   0.   0.   0.   0.   0.   0.]
 [ -0.   0.   0.   0.   0.   0.   0.   0.]
 [  0.   0.   0.   0.   0.   0.   0.   0.]]
Z array:
 [24  0 -1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0]
DC size block 1: 5
DC value block 1: 24
AC values block 1: [ 0 -1  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0  0  0  0  0  0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
0  0  0
  0  0  0  0  0  0  0  0  0  0  0  0  0]
AC sizes block 1: [(1, 1), (0, 0)]
AC bin_str block 1: ['0', '']
```

Out[5]:

```
588892
```

重构:

1. 逆量化
2. 逆DCT
3. 插值上采样
4. 转换成RGB

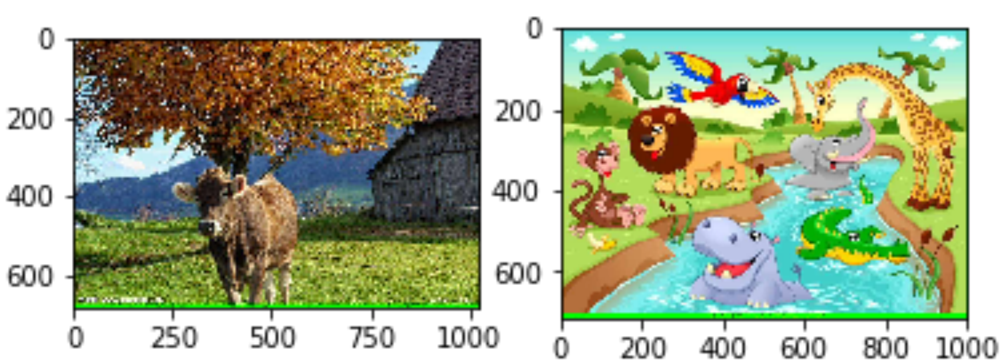
In [ ]:

```python
reCons1=np.zeros((height1,width1,3), np.uint8)
reCons2=np.zeros((height2,width2,3), np.uint8)
print(reCons1.shape)
print(reCons2.shape)

for index,channel in enumerate(quan_blocks1):
```

```
    rows=channel.shape[0]

    cols=channel.shape[1]
    block_rows=int(rows/B)
    block_cols=int(cols/B)

    block = np.zeros((rows,cols), np.uint8)
#     print(block.shape)
    for row in range(block_rows):
        for col in range(block_cols):
            # 逆量化
            dequantblock=channel[row*B:(row+1)*B,col*B:(col+1)*B]*
Q[index]
            # 逆DCT
            currentblock = np.round(cv2.idct(dequantblock))+128
            # 设定阈值
            currentblock[currentblock>255]=255
            currentblock[currentblock<0]=0

            block[row*B:(row+1)*B,col*B:(col+1)*B]=currentblock
    #
    back1=cv2.resize(block,(width1,height1))
    print(back1.shape)
    reCons1[:,:,index]=np.round(back1)

print(reCons1.shape)
# print(reCons1)

for index,channel in enumerate(quan_blocks2):
    rows=channel.shape[0]
    cols=channel.shape[1]
    block_rows=int(rows/B)
    block_cols=int(cols/B)

    block = np.zeros((rows,cols), np.uint8)
#     print(block.shape)
    for row in range(block_rows):
        for col in range(block_cols):
            # 逆量化
            dequantblock=channel[row*B:(row+1)*B,col*B:(col+1)*B]*
Q[index]
            # 逆DCT
            currentblock = np.round(cv2.idct(dequantblock))+128
            # 设定阈值
            currentblock[currentblock>255]=255
            currentblock[currentblock<0]=0

            block[row*B:(row+1)*B,col*B:(col+1)*B]=currentblock
    #
    back1=cv2.resize(block,(width2,height2))
    print(back1.shape)
    reCons2[:,:,index]=np.round(back1)

print(reCons2.shape)
# print(reCons2)

# rgb1 = cv2.cvtColor(reCons1, cv2.COLOR_YCR_CB2RGB)
# rgb2 = cv2.cvtColor(reCons2, cv2.COLOR_YCR_CB2RGB)
```

```
# YCbCr转RGB
rgb1 = np.zeros(reCons1.shape, dtype=np.uint8)
for x in range(reCons1.shape[0]):
    for y in range(reCons1.shape[1]):
        [r, g, b] = reCons1[x,y,:]
        rgb1[x, y, :] = np.maximum(0, np.minimum(255, np.round(np.dot(mat_inv, 
reCons1[x, y, :] - offset) * 255.0)))

rgb2 = np.zeros(reCons2.shape, dtype=np.uint8)
for x in range(reCons2.shape[0]):
    for y in range(reCons2.shape[1]):
        [r, g, b] = reCons2[x,y,:]
        rgb2[x, y, :] = np.maximum(0, np.minimum(255, np.round(np.dot(mat_inv, 
reCons2[x, y, :] - offset) * 255.0)))

# 显示结果
# res_img1 = Image.fromarray(reCons1,'YCbCr')
# res_img1 = res_img1.convert('RGB')
# res_img1.save('jpeg_com1.jpg')
# res_img2 = Image.fromarray(reCons2,'YCbCr')
# res_img2 = res_img2.convert('RGB')
# res_img2.save('jpeg_com2.jpg')
# Reconstructed_img1 = imageio.imread('jpeg_com1.jpg')
# Reconstructed_img2 = imageio.imread('jpeg_com2.jpg')
plt.subplot(1,2,1)
plt.imshow(rgb1)
plt.subplot(1,2,2)
plt.imshow(rgb2)
plt.show()
imageio.imwrite('Reconstructed_img1.jpg',rgb1)
imageio.imwrite('Reconstructed_img2.jpg',rgb2)
```

```
(682, 1024, 3)
(715, 1000, 3)
(682, 1024)
(682, 1024)
(682, 1024)
(682, 1024, 3)
(715, 1000)
(715, 1000)
(715, 1000)
(715, 1000, 3)
```



In [ ]:

```
# 失真度计算

# 适用于灰度图像
# 均方差
# def MSE(reCons, origin):
#     return ((reCons - origin) ** 2).mean()
# 信噪比
# def SNR(reCons,origin):
#     return 10*math.log((origin**2).mean()/MSE(reCons, origin),10)

# 适用于RGB图像，注意shape相同
def MSE(reCons,origin):
    res = 0
    for i in range(reCons.shape[0]):
        for j in range(reCons.shape[1]):
                res += sum((reCons[i,j] - origin[i,j]) ** 2)
    res = res / (reCons.shape[0]*reCons.shape[1])
    return res

def SNR(reCons,origin):
    res = 0;
    for i in range(origin.shape[0]):
        for j in range(origin.shape[1]):
                res += sum(origin[i,j]** 2)
    res = res / (origin.shape[0]*origin.shape[1])
    return 10*math.log(res/MSE(reCons, origin),10)

print("JPEG\n")
print("动物图片的均方差：",MSE(rgb1,img1))
print("动物卡通图片的均方差：",MSE(rgb2,img2))
print("动物图片的信噪比：",SNR(rgb1,img1))
print("动物卡通图片的信噪比：",SNR(rgb2,img2))

gif1 = imageio.imread('../动物gif.gif')
gif2 = imageio.imread('../卡通gif.gif')
gif1 = gif1[:,:,0:3]
gif2 = gif2[:,:,0:3]
print("GIF\n")
print("动物图片的均方差：",MSE(gif1,img1))
print("动物卡通图片的均方差：",MSE(gif2,img2))
print("动物图片的信噪比：",SNR(gif1,img1))
print("动物卡通图片的信噪比：",SNR(gif2,img2))
```

```
JPEG

动物图片的均方差： 141.428259886
动物卡通图片的均方差： 111.04381958
动物图片的信噪比： 3.4220790620509205
动物卡通图片的信噪比： 4.496659737831077
GIF

动物图片的均方差： 131.650367714
动物卡通图片的均方差： 98.9218447552
动物图片的信噪比： 3.7332202763411164
```