Writeup for CTF challenge

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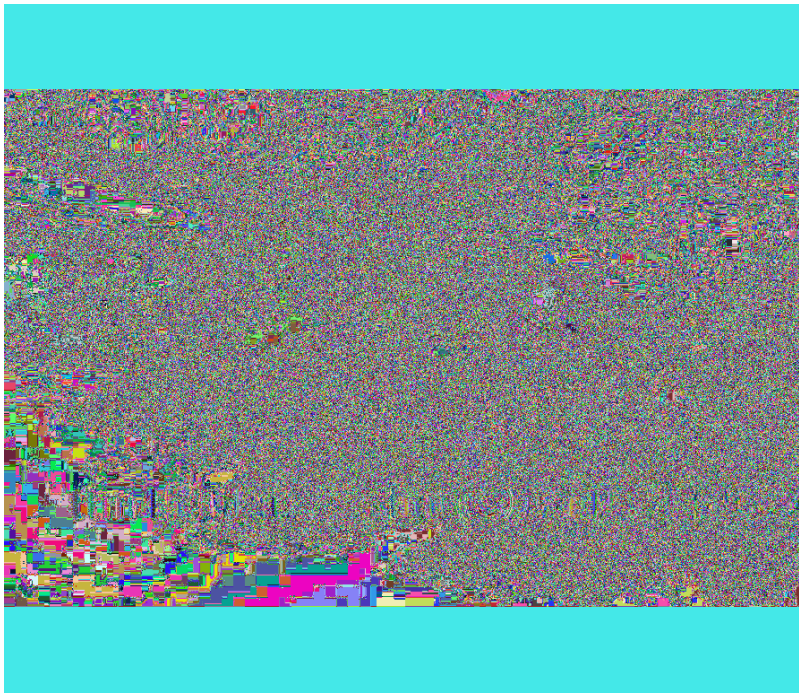
Requirement



A picture and a Python code are provided.

```
from PIL import Image
import random
import sys
def qq(x, y):
    return (2 * x + 3 * y + 29) % 256
def transform(pixelinfo):
    pixelreverse = [pixelinfo[len(pixelinfo)-1-i] for i in range(len(pixelinfo))]
    out = [pixelinfo[i] for i in range(len(pixelinfo))]
    for i in range(len(pixelinfo)):
        out[0] = qq(pixelreverse[i], out[0])
        for j in range(1,len(pixelinfo)):
            out[j] = qq(out[j-1], out[j])
    return out
image = Image.open(sys.argv[1])
outfile1 = Image.new(image.mode, image.size)
```

```
for x in range(0, image.size[0]):
    for y in range(0, image.size[1]):
        sourcepixel = list(image.getpixel((x, y)))
        tran = transform(sourcepixel)
        outfile1.putpixel((x, y), tuple(tran))
outfile1.save('out1.bmp')
```

It is easy to see that this picture is the result of an transformation using the script. So our target is to reverse this transformation to find the original picture.

Solution

We need to build an inverse function of the above transformation. . The format of this picture is *BMP*, that means each pixel includes 3 values `(R, G, B)` in which *R*, *G*, *B* go from *0* to *255*. Therefore, if we build an 3-dimension array and each member has the size of 1 byte, so it requires `256^3 * 256^3 byte = 64MB`. Each item of this array at position **[a, b, c]** is the origin pixel of pixel `(a,b,c)`. As the required memory is quite small, it is possible to use this solution.

This is the *Python* code that I used to reverse the picture

```
from PIL import Image

import random
import sys

def qq(x, y):
    return (2 * x + 3 * y + 29) % 256

def transform(pixelinfo):
    pixelreverse = [pixelinfo[len(pixelinfo)-1-i] for i in range(len(pixelinfo))]
    out = [pixelinfo[i] for i in range(len(pixelinfo))]
    for i in range(len(pixelinfo)):
        out[0] = qq(pixelreverse[i], out[0])
        for j in range(1,len(pixelinfo)):
            out[j] = qq(out[j-1], out[j])
    return out


image = Image.open(sys.argv[1])
outfile1 = Image.new(image.mode, image.size)
# My code start from here
listReverse=[[]]*256*256*256
hundred=256*256
ten=256
```

```
for x in range(0, 256):
    for y in range(0, 256):
        for z in range(0, 256):
            sourcepixel = [x,y,z]
            tran = transform(sourcepixel)
            listReverse[tran[0]*hundred+tran[1]*ten+tran[2]]=sourcepixel

for x in range(0, image.size[0]):
    for y in range(0, image.size[1]):
        sourcepixel = list(image.getpixel((x, y)))
        tran = listReverse[sourcepixel[0]*hundred + sourcepixel[1]*ten+sourcepixel[2]]
        outfile1.putpixel((x, y), tuple(tran))


outfile1.save('out1.bmp')
```

The first step is to prepare the array. I a nested `for` loop with 3 indexes `x, y, z`. With each pixel `(x, y, z)`, I found the its transformation pixel,`(tR, tG, tB)` then assigning `(x, y, z)` to an item of the array at position `(tR, tG, tB)` because `(x, y, z)` is converted to `(tR, tG, tB)`.

After finishing the array, I ran two nested `for` loops to go through all positions in the picture. At the position `(x, y)`, I got the pixel value, looked up on the array to get the original pixel, and put it back to that position in the output picture.

The output picture is the original one, containing the flag.

In my code, I avoided to use 3-dimension array. Instead, I used a 1-dimension array having `256^3` items. I converted the index ‘`(a, b, c)` to `256^2 * a + 256 * b + c = d` and used `d` as the index in my array.

The flag is in this picture