

Computer Vision I

Homework 6 - Yokoi Connectivity Number

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Usage of the full code:

python3 main.py [Image_path]

After the code exit, output file will be in the directory where you execute the code.

Environment: Python3.7 on Windows Linux Subsystem (Ubuntu 18.04.1)

Contents: Yokoi Connectivity Number:

1. Downsampling Lena from 512x512 to 64x64:

Binarize lena, then using 8x8 blocks to take the topmost-left pixel.

我把 Binarize 跟 Downsampling 一起做，Downsampling 取最上的左邊，也就是八個取第一個像素作為取樣點。

```
# Downsample to 64x64 and binarize
def downsample_binary(img_o):
    img_t = np.zeros((66, 66), dtype=np.int32)
    for i in range(64):
        for j in range(64):
            img_t[i+1, j+1] = (0 if img_o[8 * i, 8 * j] < 128 else 1)
    return img_t
```

2. Count the Yokoi connectivity number

```
# h operation
def _h(b, c, d, e):
    if b == c and (d != b or e != b): return 'q'
    elif b == c and (d == b and e == b): return 'r'
    else: return 's'

# f operation
def _f(neighbors):
    if(neighbors.count('r') == 4): return 5
    else: return neighbors.count('q')
```

$$h(b, c, d, e) = \begin{cases} q & \text{if } b = c \text{ and } (d \neq b \vee e \neq b) \\ r & \text{if } b = c \text{ and } (d = b \wedge e = b) \\ s & \text{if } b \neq c \text{ and } (d = b \wedge e = b) \end{cases}$$
$$f(a_1, a_2, a_3, a_4) = \begin{cases} 5 & \text{if } a_1 = a_2 = a_3 = a_4 = r \\ n & \text{where } n = \text{number of } \{a_k | a_k = q\}, \text{ otherwise} \end{cases}$$

上圖，對照右側兩個 function；

下圖則是將對應的值餵入公式即得所求

注意要將 result 的 i, j 互調；各減一是因為邊界問題，超出邊界的點設為 0

```
# Yokoi f(a1, a2, a3, a4)
result = [[' ' for x in range(64)] for y in range(64)]
for i in range(1, 65):
    for j in range(1, 65):
        if img_down[i][j] != 0:
            result[j-1][i-1] = str(_f([_h(d[i, j], d[i, j+1], d[i-1, j+1], d[i-1, j]),
            _h(d[i, j], d[i-1, j], d[i-1, j-1], d[i, j-1]),
            _h(d[i, j], d[i, j-1], d[i+1, j-1], d[i+1, j]),
            _h(d[i, j], d[i+1, j], d[i+1, j+1], d[i, j+1]))]))
```

Result 如下頁:

| | | | |
|----------|------------------------------------|-----------------|-------------------|
| 11111111 | 121111111111122322221 | 1111111111111 | 0 0 |
| 15555551 | 115555555511 2 11 11 | 1155555555511 | 0 |
| 15555551 | 1 2115555112 21112221 | 155555555551 | 21 |
| 15555551 | 1 2 155112 22221511 | 1555555555511 | 1 |
| 15555551 | 22 2112 22 121 0 0 | 15555555555511 | 0 |
| 15555551 | 1 2 21 2 1 1 | 1555555555551 0 | |
| 15555551 | 12 1 121111 1321 | 15555555555511 | |
| 15111551 | 1322 1155551111 | 15555555555551 | |
| 111 1551 | 1 121555555511 | 155555555555511 | |
| 11 1551 | 21155555511 | 15511155555511 | |
| 21 1551 | 2 15555555111 | 1551 11555511 | |
| 1 1551 | 2 155555555511 | 1551 115551 | 1 |
| 1551 | 112115555555551 | 1551 15511 | 12 |
| 1551 | 1555555555555511 | 1551 1111 | 111 |
| 1551 | 1 222115555555555511 | 1151 11 | 1151 |
| 1551 | 2 22 1 1555555555555511 | 151 1111 | 1551 |
| 1551 | 2 1 1155555555555551 | 151 11551 | 11551 |
| 1551 | 2 11555555555555511151115551 | | 115551 |
| 1551 | 12 115555555555555555555551 | | 155551 |
| 1551 | 11 0 22155555555555555555555112 | | 1155551 |
| 1551 | 111 22 155555555555555555555551 1 | | 1555551 |
| 1551 | 1511 1 12511211111211155555555111 | | 11555551 |
| 1551 | 15521 1 121 1 11 1 15555555111 0 | | 15555551 |
| 1551 | 1151 132 2 1155555111 0 | | 115555551 |
| 1551 | 151 0 322 115555111 121 | | 155555551 |
| 1551 | 1221 2 1555551 131 | | 1155555551 |
| 1551 | 2 0 1 11555511 1 | | 1155555551 |
| 1551 | 2 0 0 115555551 0 | | 1 155555551 |
| 1551 | 2 1155555551 | | 2115555551 |
| 1551 | 1 0 11555555551 | | 1555555551 |
| 1551 | 1 11511115555521 1 | | 115555555551 |
| 1551 | 1 1 11111 1155511 2 | | 155555555551 |
| 1551 | 131 111 15111 2 | | 155555555551 |
| 1551 | 121 0 1121 1 111 1 2 | | 1155555555551 |
| 1551 | 11 111 1 221 11 1 2 | | 1555555555551 |
| 1551 | 12 0 1 21 121 11 1111 2 | | 15555555555551 |
| 1551 | 1 12 22 151111111551 2 | | 11555555555551 |
| 1551 | 1 2 1555551115511 1 | | 15555555555551 |
| 1551 | 2 0 0 22 1255551 15551 1 | | 15555555555551 |
| 1551 | 1 1 1555511 11511 2 | | 115555555555551 |
| 1551 | 0 0 21 155551 1 151 2 | | 155555555555551 |
| 1551 | 2 15555112 151 2 | | 155555555555551 |
| 1551 | 1 1 1 1155555511111 2 | | 1555555555555551 |
| 1551 | 2 22 111511111212 2115555555555551 | | 1555555555555551 |
| 1551 0 | 1 12 151 2 1 1555555511155551 | | 15555555511555551 |
| 1551 | 0 0 0 1111 121 155555551 1555551 | | 155555551 1555551 |
| 1551 | 0 11111111 155555551 15555511 | | 155555551 1555511 |
| 1551 | 0 15551 211111111 155511 | | |
| 11521 | 1 12 122155511 2 | | 11 115511 |
| 1 151 0 | 1 1 155555111 2111 | | 15511 |
| 22 1511 | 1 15555555111 155111 | | 1511 |
| 22 1511 | 1 1555555551 155551 | | 1151 |
| 2 151 | 0 1 11155555555511 155511 | | 1511 |
| 2 1521 0 | 1 155555555555511 15551 12151 | | |
| 2 151 | 121 155555555555551 155511 | | 1551 |
| 2 1511 | 0 1555555555555551 115551 | | 1511 |
| 21 1511 | 11 1555555555555551 111111151 | | |
| 11 151 | 0 115555555555555511 111511 | | |
| 11 151 | 155555555555555551 151 | | |
| 11 151 | 0 115555555555555551 211 | | |
| 11 151 | 1155555555555555511 1 | | |
| 11 151 | 0 155555555555555551 | | |
| 11 111 | 0 12111111111111111111 | | |