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CS 4670 Project 2 Written

1. A)

$$\frac{\partial I}{\partial x} =$$

0	-1	0	1	0	0
0	-1	0	1	0	0
0	0	0	1	0	0
0	0	0	1	0	0

$$\frac{\partial I}{\partial y} =$$

0	0	0	0	0	0
-1	-1	0	0	0	0
0	0	0	0	0	0
0	0	0	0	0	0

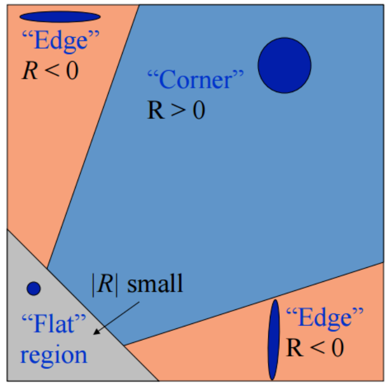
B) By first computing the Ix^2, Iy^2 and IxIy matrices then using the following code, we arrive at our answer:

```
import math
import cv2
import numpy as np
import scipy
from scipy import ndimage, spatial

def computeHarrisValues():
	Ix2 = np.array([[0,1,0,1,0,0],
	                [0,1,0,1,0,0],
	                [0,0,0,1,0,0],
	                [0,0,0,1,0,0]])

	Iy2 = np.array([[0,0,0,0,0,0],
	                [1,1,0,0,0,0],
	                [0,0,0,0,0,0],
	                [0,0,0,0,0,0]])

	IxIy = np.array([[0,0,0,0,0,0],
	                 [0,1,0,0,0,0],
	                 [0,0,0,0,0,0],
	                 [0,0,0,0,0,0]])

	Harris = np.array([[0,0,0,0,0,0],
	                   [0,0,0,0,0,0],
	                   [0,0,0,0,0,0],
	                   [0,0,0,0,0,0]])

	w_p = np.array([[0,1,0],
	                [1,2,1],
	                [0,1,0]])

	A = ndimage.correlate(Ix2, w_p)
	B = ndimage.correlate(IxIy, w_p)
	C = ndimage.correlate(Iy2, w_p)

	print "A",A
	print "B",B
	print "C",C

	det_H = A*C-B**2
	trace_H = A + C

	R = det_H-.04*(trace_H**2)

	print "R"
	print R

computeHarrisValues()
```

Answer:

```
R
[[ 0.84  2.    -0.16 -0.64 -0.04  0.  ]
 [ 2.    3.56  0.64 -0.64 -0.04  0.  ]
 [-0.04 -0.16 -0.04 -0.64 -0.04  0.  ]
 [ 0.    0.   -0.04 -0.64 -0.04  0.  ]]
```

C) A corner is defined as R>0, and |R| is a "large" value (see picture below). Therefore, if we set the cutoff as 2.5, we have only one corner, pixel coordinate **(1,1).**



If our cut-off was .5, then we would have 5 pixels: **$\{(x_i,y_i)\}$ = {(0,0), (1,0), (0,1), (1,1), (2,1)}**

D) If we were to first convolve a 3x3 gaussian kernel over the image, this would blur the R values, bringing them closer to the value of zero. After the second gaussian, it would be more blurred/closer to zero values. Eventually, there would be such a blurred image that the image would have no change in intensity and result in all zeros for the Harris image.

E) No we are not. For one thing, the number of pixels will increase, so this will increase the number of R values. Also, the corner is becoming blurred as the image size increases, so the R values will decrease.