MIDTERM

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Ans. to Q No- 1

a

We know,

$$\Delta^2 f(x,y) = f(x+1,y) + f(x-1,y) + f(x,y+1) + f(x,y-1) - 4f(x,y)$$

$$\left[\because \nabla^2 f = \frac{\delta^2 f}{\delta x^2} + \frac{\partial^2 f}{\delta y^2} \right]$$

If we construct the kernel with the coeffecients, we get,

0	1	0
1	-4	1
0	1	0

The shape of the kernel is 3 x 3.

b

Steps to linearly filter an image :

1) Firstly, to avoid shrinking, we need to pad the image

2) Now, we'll use 2D signal correlation for linear spatial filtering.

c

```
w = [ [ 0, 1, 0 ],
      [ 1, -4, 1 ],
      [ 0, 1, 0 ]
    ]
```

```
img_filtered = signal.correlate(img_padded,
                                w, mode = 'valid',
                                method = 'auto')
```

d

A 2D kernel is seperable if it can be written as the product of two 1D kernels.

$$G(x,y) = G_1(x)\, G_2(y)$$

Our image g was of 5×5 and kernel w was 3×3 shaped.

If w is not seperable

$\Rightarrow$ Complexity: $O(mn)$

$$= O(3 \times 3)$$

$$= O(3^2)$$

If w is seperable:

$\Rightarrow$ Complexity: $O(m+m)$

$$= O(3+3)$$

$$= O(3).$$

So, seperable kernel has greater advantage.

Ans. to Q No-3

a

If we are given the coordinates of all the patches, we can do the following steps to "fix" this image.

(1) Firstly, we will group the patches according to their overall brightness and contrast.

(2) ~~Use~~ Then we will use Contrast Limited Adaptive Histogram Equalization on ~~to~~ all the patches individualy.

(3) ~~T~~ Lastly, we will concatenate all the patches back together to form the final image.

b

For i, img_patch in enumerate(all_img_patches):

~~img_patch[~~

for j in range(number_of_patches_in_a_group):

img_patch[j, :, :, :] = exposure.equalize_adapthist(img_patch[j, :, :, :], kernel size, clip limit);

Ans. to Q. No - 4

a

r_k	$h(r_k)$	$f_r(r_k)$
0	6	0.375
1	7	0.4375
2	2	0.125
3	1	0.0625

b

$H(r_k)$	$F(r_k)$
6	0.375
13	0.8125
15	0.9375
16	1

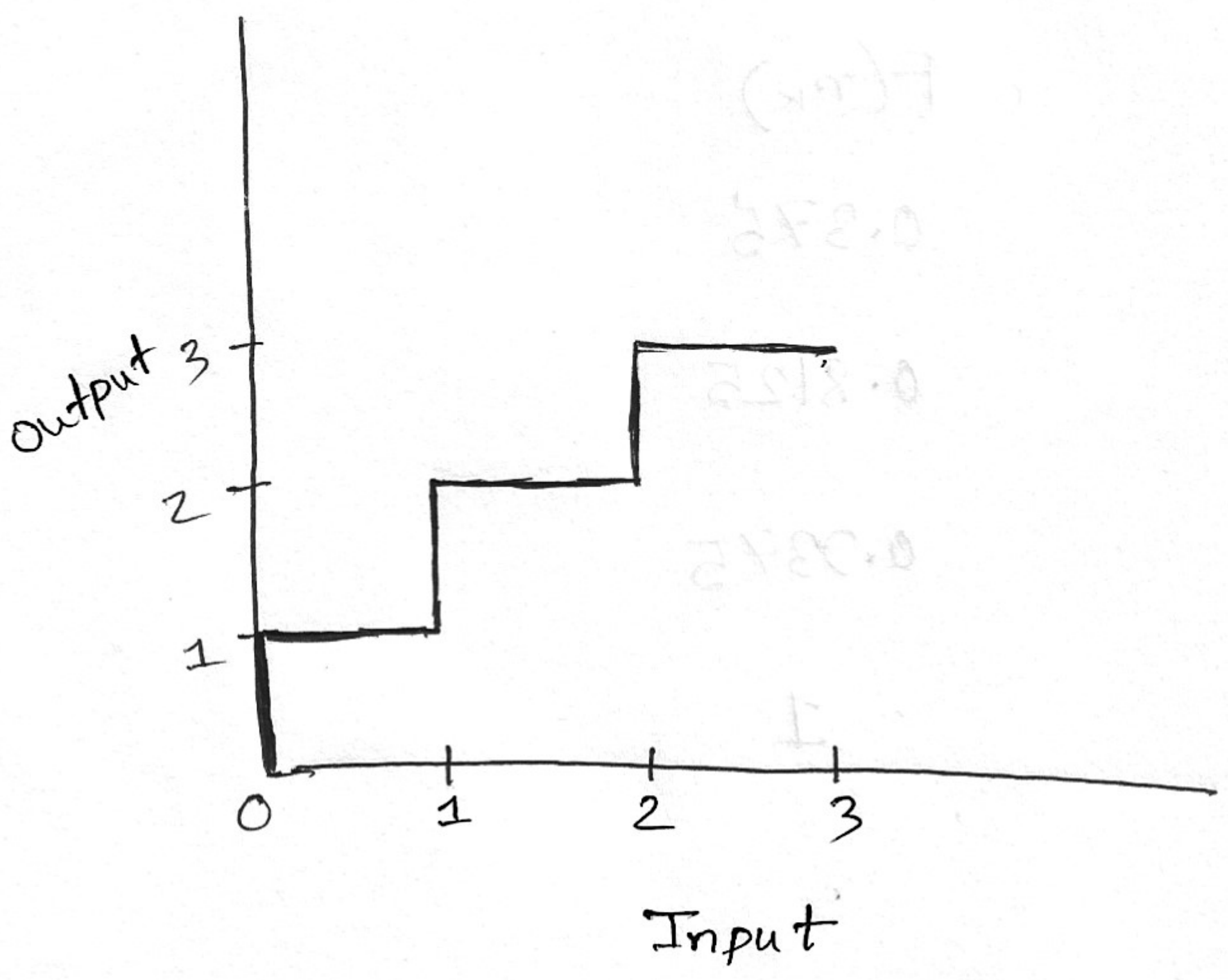
c

$$S_k = \text{round}\left(3 * F(r_k)\right)$$

d

2	3	1	1
2	1	2	3
1	2	1	2
3	1	2	2

e



Ans. to Q No-2

a

magnitude response:

$$|F(u,v)| = \sqrt{R^2(u,v) + I^2(u,v)}$$

$$\varphi(u,v) = \tan^{-1}\left(\frac{I(u,v)}{R(u,v)}\right)$$

Magnitude response is the ratio of amplitude of output signal's frequency and input signal's frequency.

Phase response ~~carries~~ is the relationship between the phase of a sinusoidal input and output signal.

Magnitude response contains information about pixel intensity and phase response contains information about shape of the image.

c

The sharp peak at the spectrum of the given magnitude response is possibly the noise of the image.

d

Our filter falls into the Low Pass Filtering (LPF) category. And the cut-off frequency D_0 is 150 Hz.

e