

Answer according to question no 1

(a) (b)

40	20	52	35
28	30	65	45
25	20	30	60
15	10	00	15
30	12	20	20

$\frac{1}{9}$

1	1	1
1	1	1
1	1	1

lower left corner

25	20	30
15	10	00
30	12	20

25

(ii) 00 10 12 15 20 20 30 30

The median is 20 so the centre value

(b) will be replaced by 120

25	20	30
15	120	00
30	12	20

iii) 00 10 12 15 20 20 25 30 30

The Maximum value is 30 so it will be centred by

30

25	20	30
15	30	00
30	12	20

iv) 00 10 12 15 20 20 25 30 30

The minimum value is 00 so it will be replaced by centred value.

25	20	30
15	00 30	00
30	12	20

1) Given a 3×3 filter

$$g = \frac{1}{9} \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$$

$$\begin{aligned} \text{Mean} &= \frac{1}{9} [25 + 20 + 30 + 15 + 10 + 0 + 30 + 12 + \\ &\quad 20] \\ &= \frac{162}{9} = 18 \end{aligned}$$

The output pixel is 18 so 10 is replaced by 18

25	20	30
15	18	00
30	12	20

(a) In image processing, a kernel, convolution matrix or son mask is a small matrix used for blurring, sharpening, embossing edges detection.

The importance of size of kernel is 3×3 matrix in simple neighbourhood, so we will use 3×3 filter

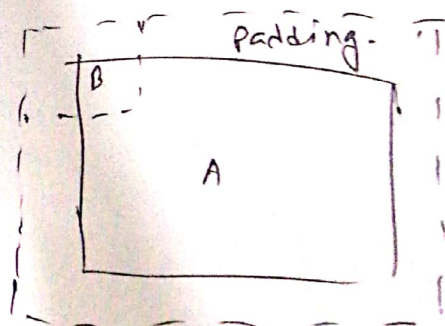
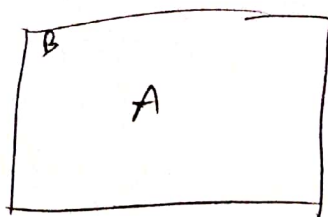
Linear spatial filtering of an image of size $m \times n$ with a filter of size $m \times n$ is given by expression

$$g(x, y) = \sum_{s=-a}^a \sum_{t=-b}^b w(s, t) f(x+s, y+t)$$

$$\text{where } a = \frac{m-1}{2}, \quad b = \frac{n-1}{2}$$

$$x = 0, 1, 2, \dots, M-1, \quad y = 0, 1, 2, \dots, N-1$$

(b) Padding is defined to be ones if erosion is performed and zeroes if dilation is performed



Answer according to Question no. 2

(b)

A

0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	1	0
0	0	1	1	0	1	1	1	0
0	0	1	1	1	1	1	0	0
0	0	0	1	1	1	0	0	0
0	0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0
0	0	1	0	1	1	0	0	0
0	0	0	0	0	0	0	0	0

$A \ominus B$

0	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

$$B(A) = A - (A \ominus B)$$

1	0	0	0	0	0	1
0	0	1	0	1	1	1
0	1	1	1	1	1	0
0	0	1	1	1	1	0
0	0	0	1	0	0	0
0	0	1	0	1	0	0
0	1	1	0	1	1	0

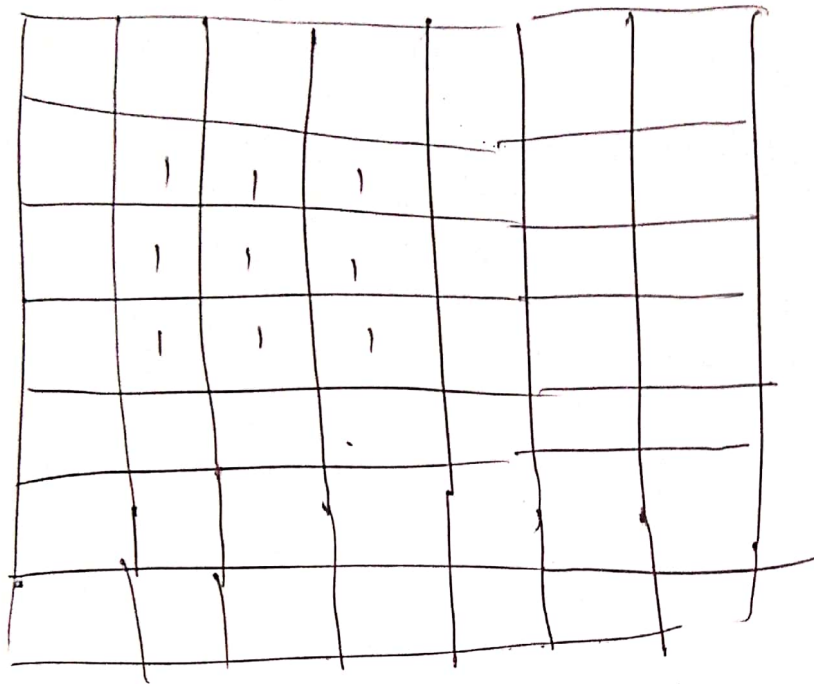
(Boundary extraction)

(a) Spatial kernel

connected components:

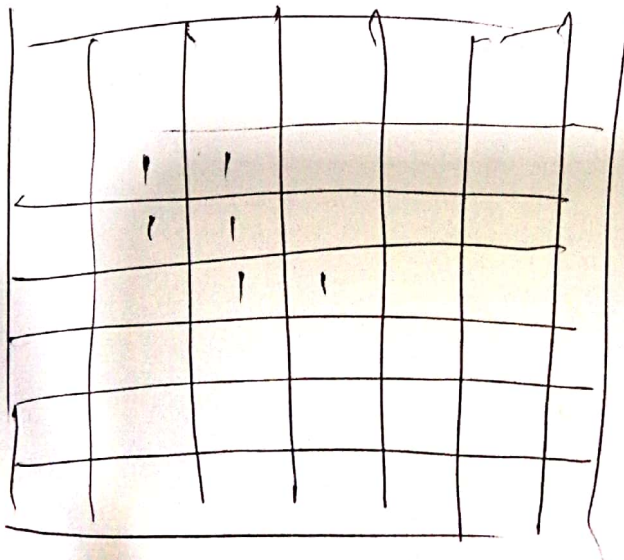
$$x_0 \oplus B_1$$

$$x_k = (x_{k-1} \oplus B_1) \cap A$$



$$x_0 \oplus B_1$$

$$(x_0 \oplus B_1) \cap A = x_1$$



30)

Answer according to Question no. 3

70	30	40
90	50	20
70	90	40

10	90	50
10	70	90
90	50	60

- a) Prewitt operator is used for edge detection in an image. It detects two types of edges
- ✓ Horizontal edges
 - ✓ Vertical edges

The sobel operator is called sobel filter where it is used in image ~~filter~~ processing and computer vision particularly with edge detection algo. where it creates an image emphasizing edges.

- c) Edge is a boundary between ~~in~~ different image segments.

In image processing, histogram is used for graphical representation of digital image. A 2D horizontal axis of graph is used to represent tonal variations where a vertical axis is used to represent the no. of pixels in particular pixel.

b)

0	0	0	0	0	0	0
0	50	60	70	30	40	0
0	50	10	20	50	20	0
0	20	10	70	20	90	0
0	30	20	50	60	70	0
0	10	30	40	60	70	0
0	0	0	0	0	0	0

Zero padding

0	1	0
1	-4	1
0	1	0

Negative mask

We know

$$\Delta \cdot \nabla^2 f = \frac{\partial^2 f}{\partial^2 x} + \frac{\partial^2 f}{\partial^2 y}$$

$$\frac{\partial^2 f}{\partial^2 x} = f(x+1, y) + f(x-1, y) - 2f(x, y)$$

$$\frac{\partial^2 f}{\partial^2 y} = f(x, y+1) + f(x, y-1) - 2f(x, y)$$

$$\nabla^2 f = [f(x+1, y) + f(x-1, y) + f(x, y+1) + f(x, y-1) - 4f]$$

for value 50, $\nabla^2 f = 60 + 80 - 4 \times 50 = -6$

60, $\nabla^2 f = 70 + 10 + 50 - 4 \times 60 = -110$

70, $\nabla^2 f = 60 + 30 + 90 - 4 \times 70 = -100$