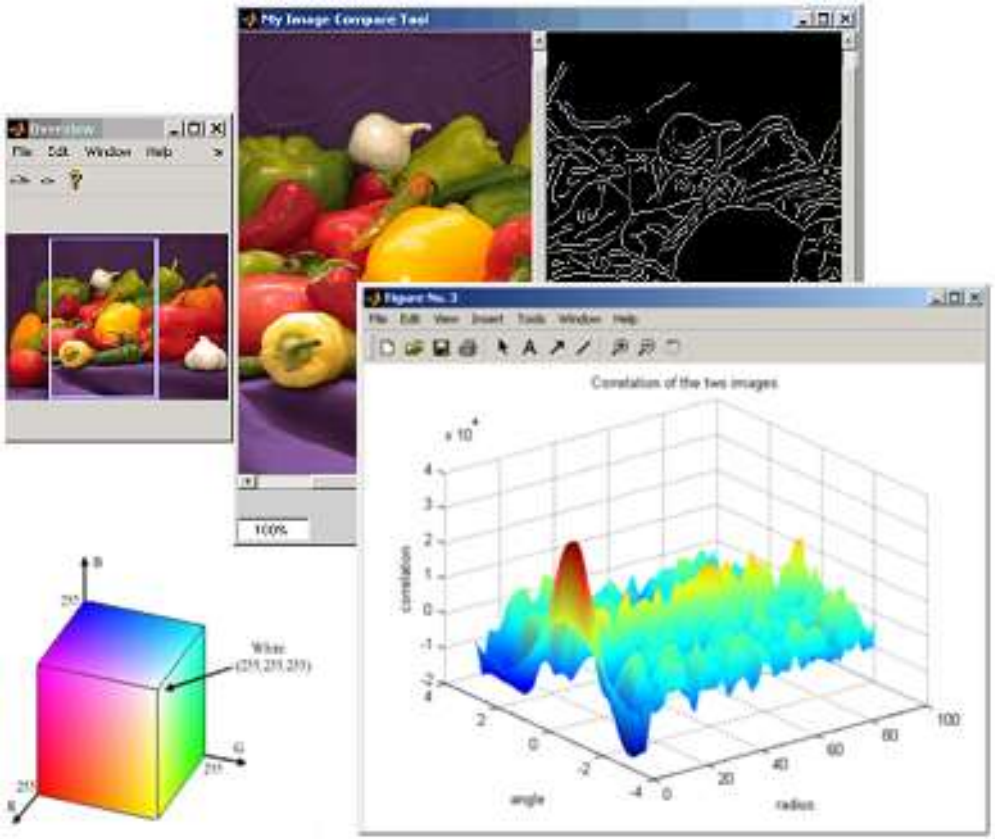
Digital Image Processing



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DIGITAL IMAGE PROCESSING

LECTURE -5

Image Segmentation-2

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12-B Status from UGC

Edge Detection

Gray Image A

Gradient Operator Output out

Sobel Operator Output out

Laplacian Operator L8 Output Image Out8

Edge Linking

Edge Linking

- Ideally discontinuity detection technique should identify pixels lying on the boundary between regions.
- In practice, there may be breaks in boundary and spurious intensity discontinuities
  - Due to non-uniform illumination
  - Presence of noise
- Edge linking procedure assemble edge points into meaningful boundaries. There are two approaches for Edge linking
  - Local Processing
  - Global Processing

Local Processing

❑ Procedure for Local Processing:

- ❖ Take an edge detected image
- ❖ Analyse each pixel in a small neighbourhood of every points (x, y)
  - All points that are similar in nature are linked.
  - This forms a boundary of pixels that are similar in nature.
- ❖ Similarity decision based on
  - Strength of the response of gradient operator.
  - Direction of the gradient
- ❖ Edge pixels (x', y') and (x, y) are similar if
  - $|\nabla f(x,y) - \nabla f(x',y')| \leq T$
  - $|\alpha(x,y) - \alpha(x',y')| \leq A$

Where T is a non-negative threshold

A is angle threshold

Local Processing

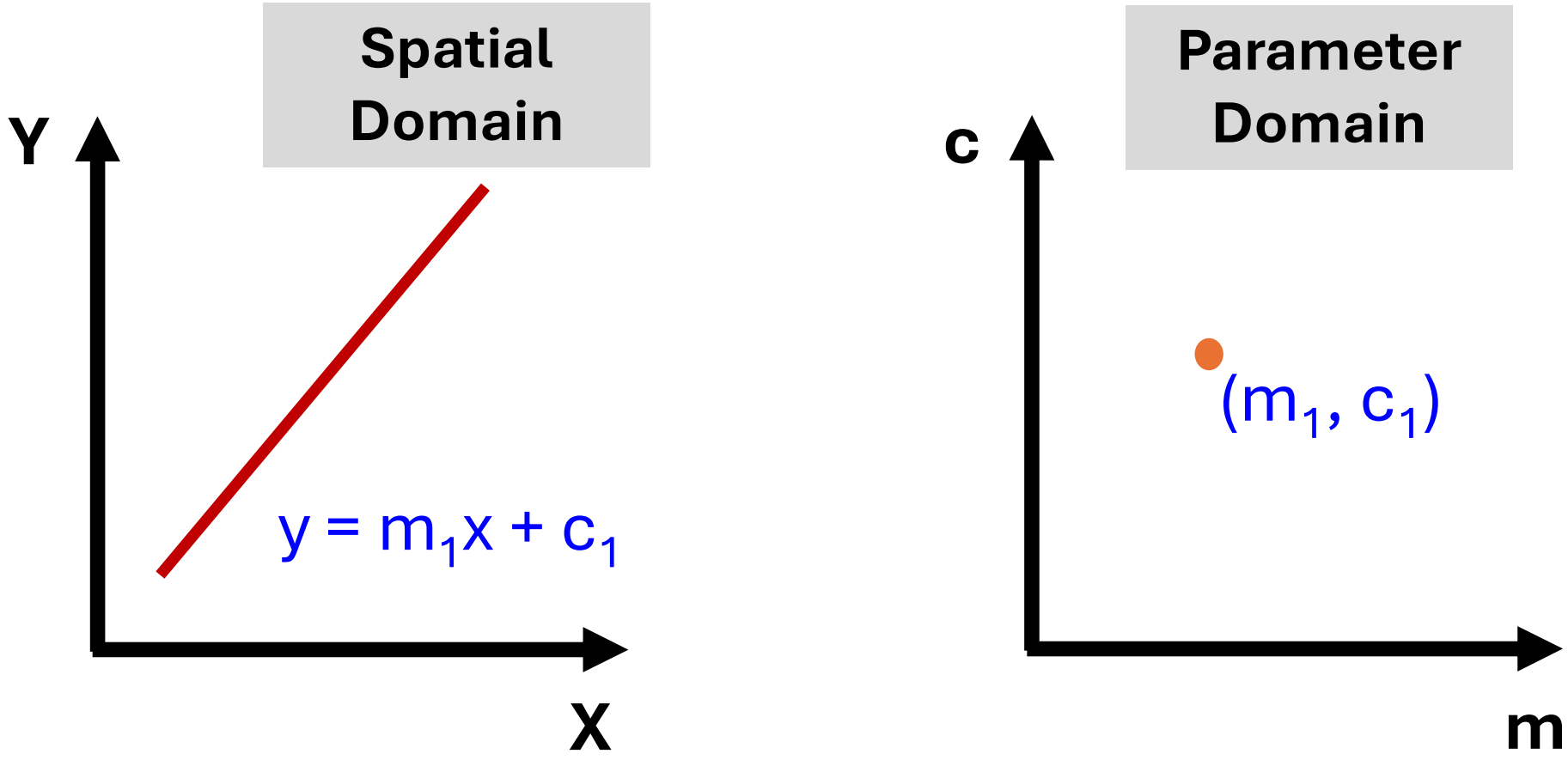
- If both condition are satisfied then these two points (x,y) and (x',y') can be linked together i.e. **(x', y')** $\in$ $\mathbf{N_{XY}}$
- Since edge discontinuity are present in digital image and the neighbourhood, we considered in local processing is small Neighbourhood.
- So, if (x', y') does not belong to the small neighbourhood of (x, y) in that case (x', y') cannot link with (x,y).
- So, in such cases local processing technique does not help to link edge points.

Global Processing

- The method discussed in the previous section is applicable in situation in which knowledge about pixels belonging to individual objects is available.
- Often, we have to work in unstructured environment in which all we have is an edge map and no knowledge about where objects of interest might be.
- In such situations, all pixels are candidates for linking, and thus have to be accepted or eliminated based on pre-defined global properties.
- **Example:** HOUGH Transform

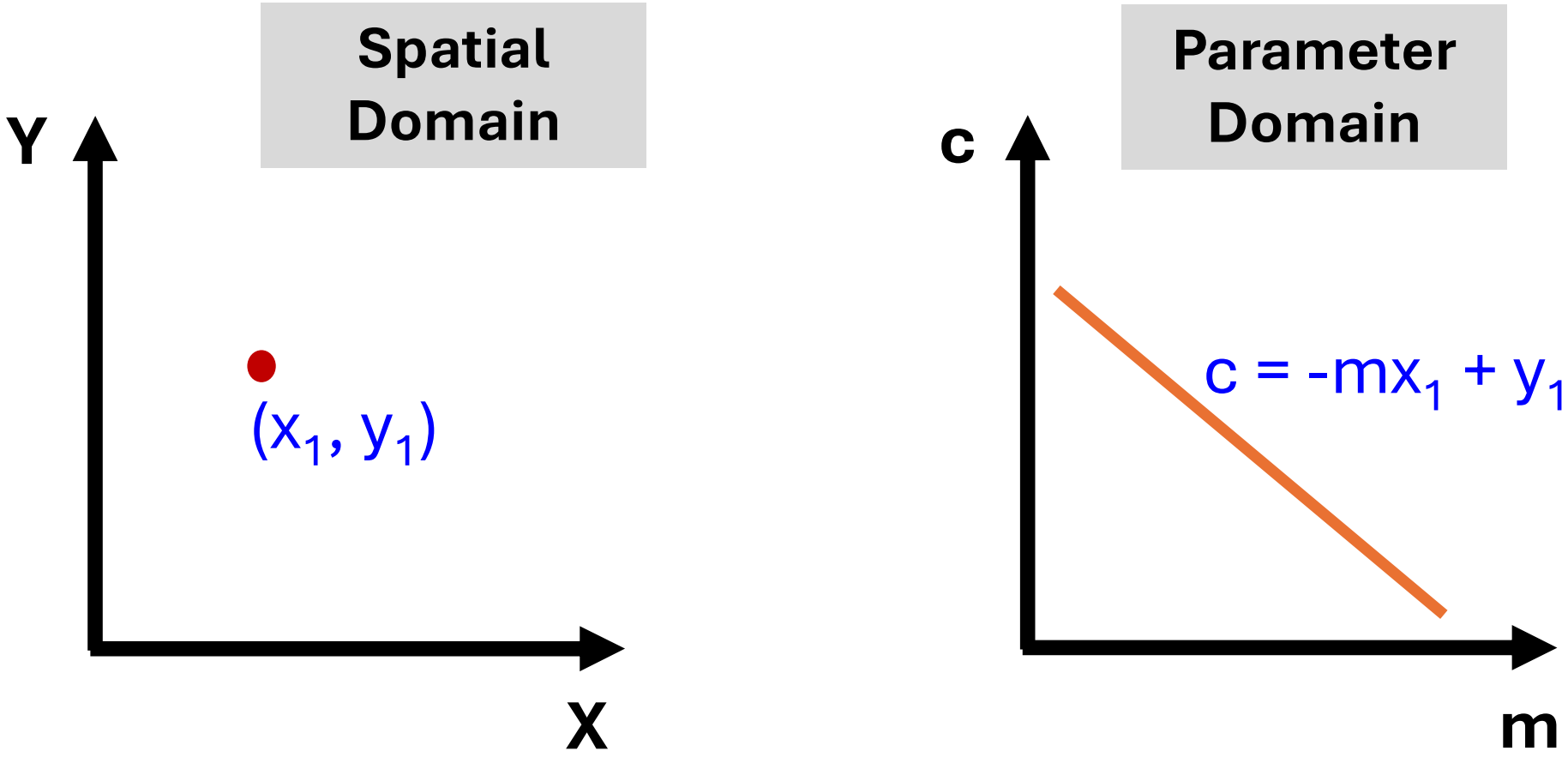
Hough Transform

❖ **Spatial Domain and Parameter Domain**



Hough Transform

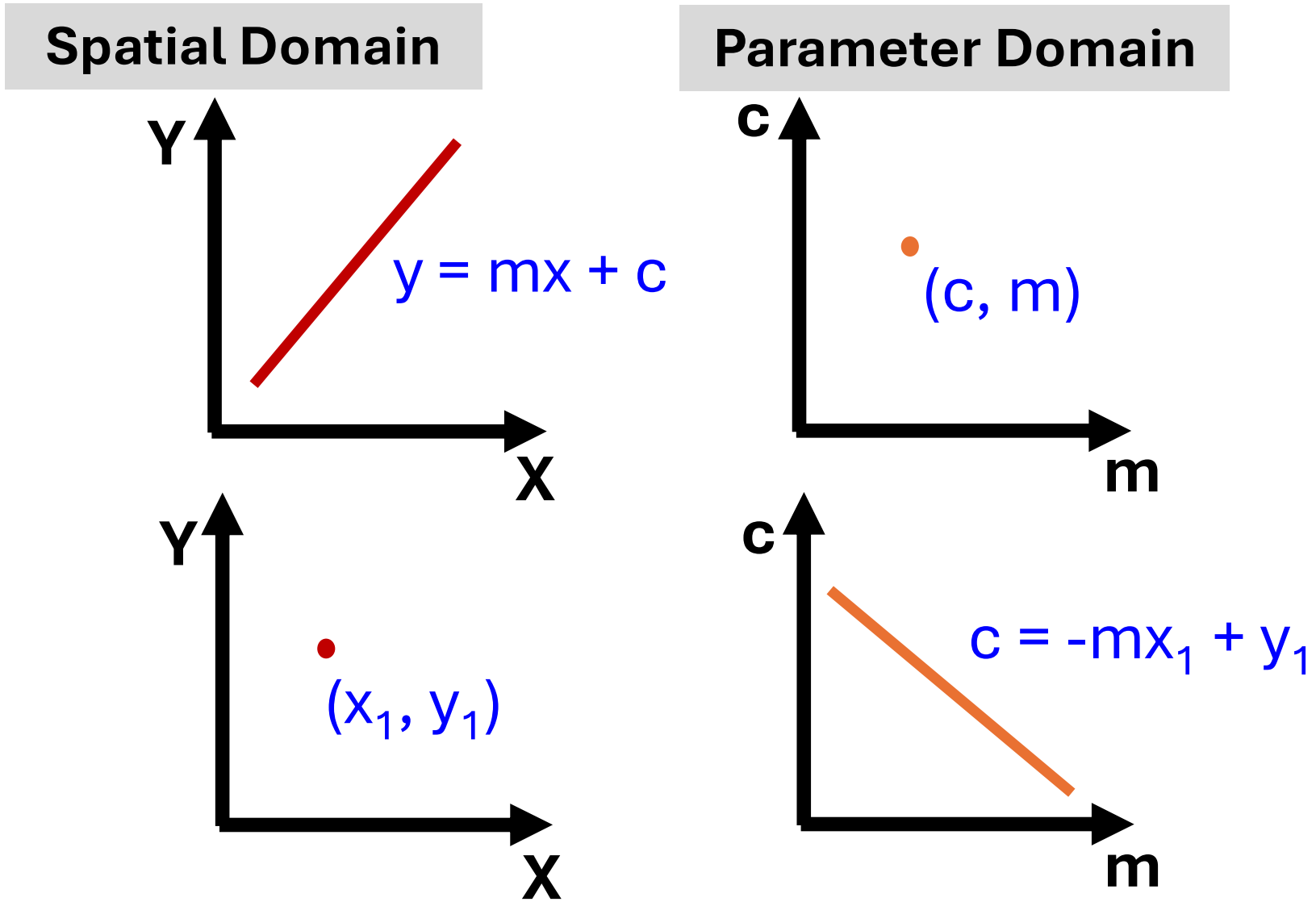
❖ **Spatial Domain and Parameter Domain**



$y_1 = mx_1 + c$

$c = -mx_1 + y_1$

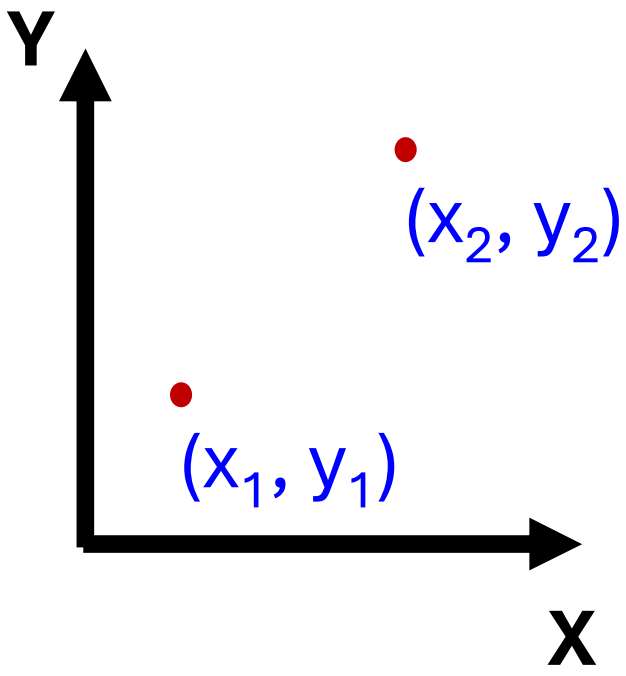
Hough Transform



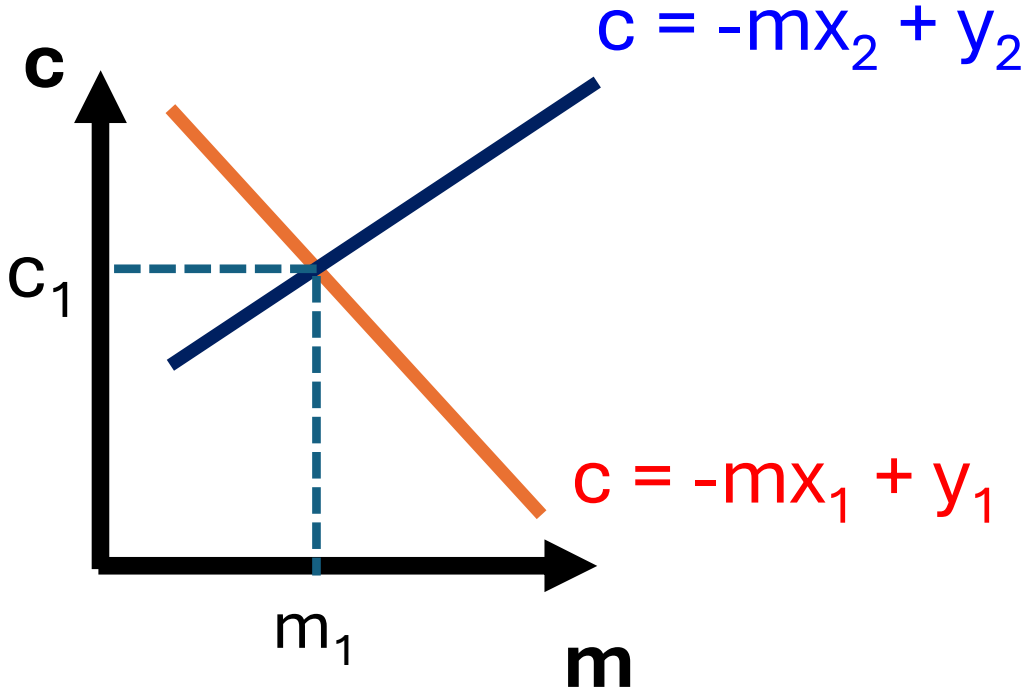
- Line in spatial domain is equivalent to point in parameter domain
- Point in spatial domain is equivalent to line in parameter domain

Hough Transform

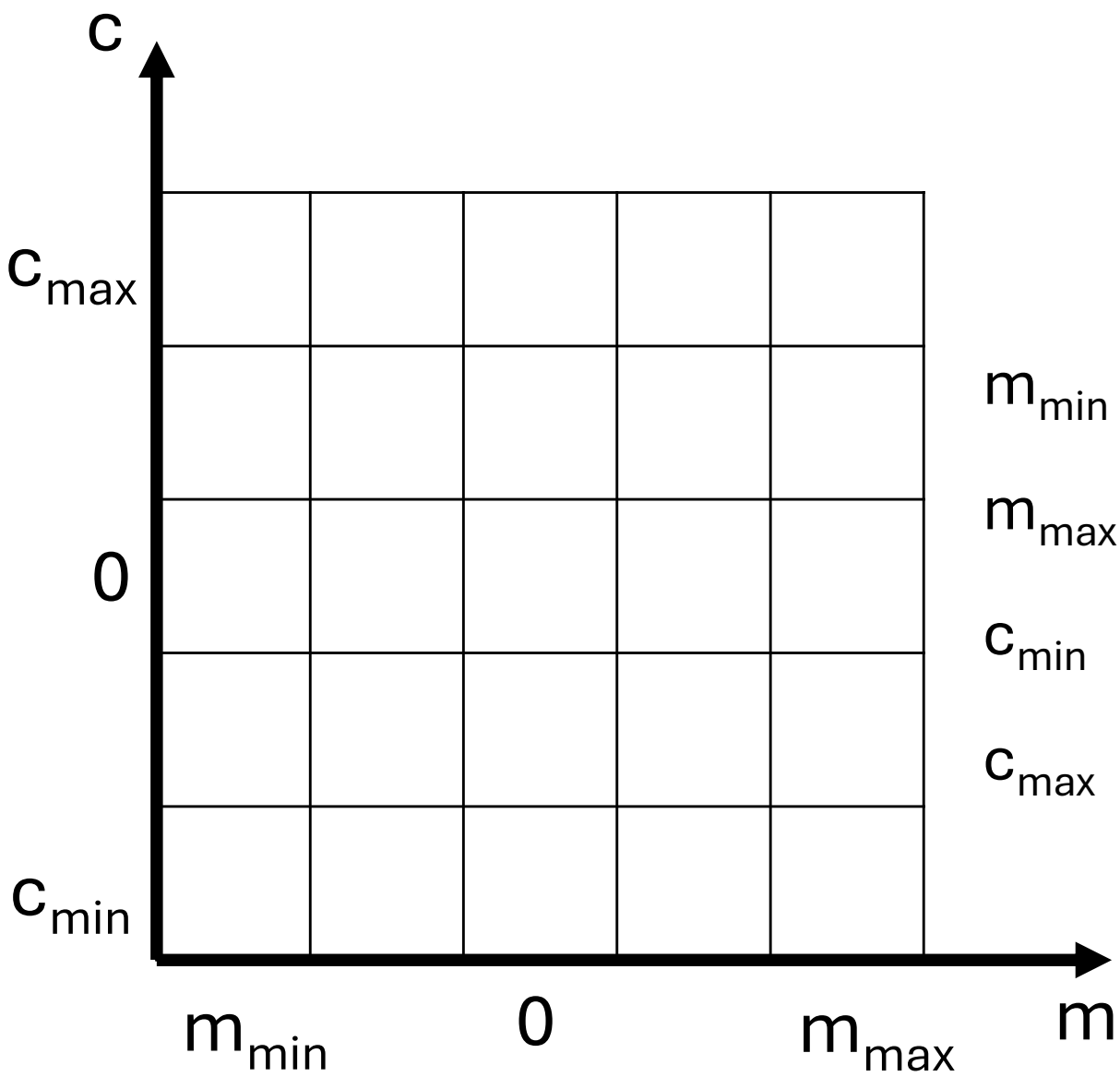
Spatial Domain



Parameter Domain



Hough Transform



m_{min} Minimum slope value

m_{max} Maximum slope value

c_{min} Minimum intercept value

c_{max} Maximum intercept value

Hough Transform

Example 1

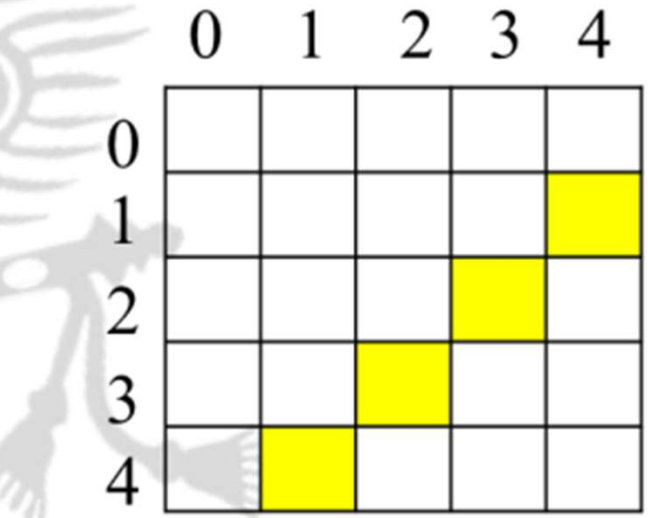


Image {(4,1),(3,2),(2,3),(1,4)}

Hough Transform

Step 1:

- Known
  - -1.2<=m<=-0.8
  - step_m = 0.1
  - m = -0.8, -0.9, -1.0, -1.1, -1.2
  - c = -mx+y

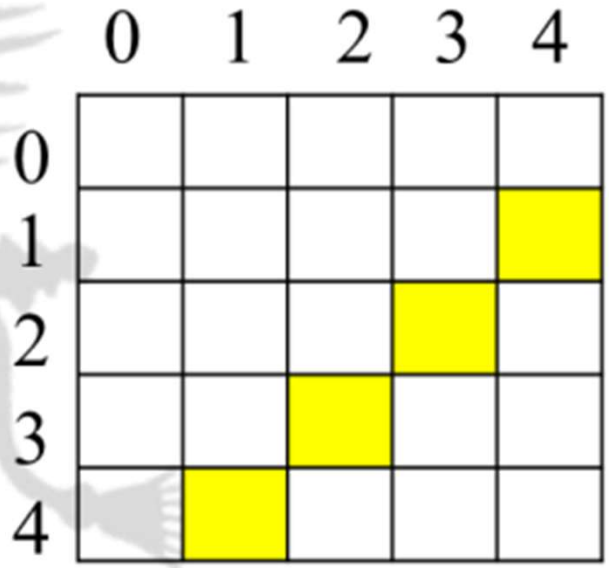


Image {(4,1),(3,2),(2,3),(1,4)}

Hough Transform

$$c = -mx1 + y1$$

- Step 2:
  - Compute c

(x,y) = (4,1)
c = -4m+1

m	c
-0.8	4.2
-0.9	4.6
-1.0	5.0
-1.1	5.4
-1.2	5.8

(x,y) = (3,2)
c = -3m+2

m	c
-0.8	4.4
-0.9	4.7
-1.0	5.0
-1.1	5.3
-1.2	5.6

(x,y) = (2,3)
c = -2m+3

m	c
-0.8	4.6
-0.9	4.8
-1.0	5.0
-1.1	5.2
-1.2	5.4

(x,y) = (1,4)
c = -m+4

m	c
-0.8	4.8
-0.9	4.9
-1.0	5.0
-1.1	5.1
-1.2	5.2

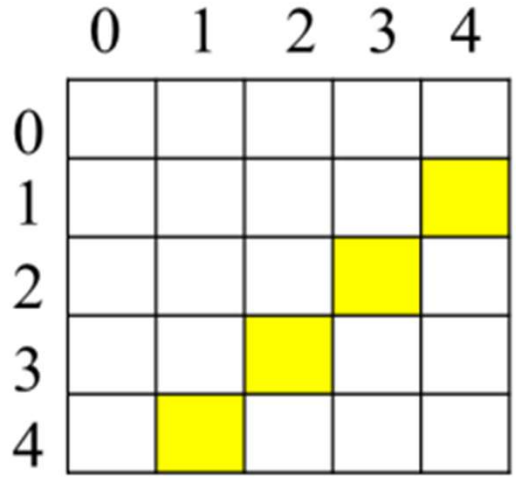


Image {(4,1),(3,2),(2,3),(1,4)}

Hough Transform

- Step 3:
  - Find min and max of c

- Range: 4.2 to 5.8
- Interval: 0.1

(x,y) = (4,1), c = -4m+1

m	c
-0.8	4.2
-0.9	4.6
-1.0	5.0
-1.1	5.4
-1.2	5.8

(x,y) = (3,2), c = -3m+2

m	c
-0.8	4.4
-0.9	4.7
-1.0	5.0
-1.1	5.3
-1.2	5.6

(x,y) = (2,3), c = -2m+3

m	c
-0.8	4.6
-0.9	4.8
-1.0	5.0
-1.1	5.2
-1.2	5.4

(x,y) = (1,4), c = -m+4

m	c
-0.8	4.8
-0.9	4.9
-1.0	5.0
-1.1	5.1
-1.2	5.2

C_{MIN}	**4.2**	**4.4**	**4.6**	**4.8**
C_{MAX}	5.8	5.6	5.4	5.2

Hough Transform

- Step 4:
  - Voting

(x,y) = (4,1)
c = -4m+1

m	c
-0.8	4.2
-0.9	4.6
-1.0	5.0
-1.1	5.4
-1.2	5.8

(x,y) = (3,2)
c = -3m+2

m	c
-0.8	4.4
-0.9	4.7
-1.0	5.0
-1.1	5.3
-1.2	5.6

(x,y) = (2,3)
c = -2m+3

m	c
-0.8	4.6
-0.9	4.8
-1.0	5.0
-1.1	5.2
-1.2	5.4

(x,y) = (1,4)
c = -m+4

m	c
-0.8	4.8
-0.9	4.9
-1.0	5.0
-1.1	5.1
-1.2	5.2

	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8
-0.8	1		1		1		1										
-0.9					1	1	1	1									
-1.0									4								
-1.1										1	1	1	1				
-1.2											1		1		1		1

Hough Transform

- Step 5:
  - Find equation

	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8
-0.8	1		1		1		1										
-0.9					1	1	1	1									
-1.0									4								
-1.1										1	1	1	1				
-1.2											1		1		1		1

- m =-1.0
- c = 5.0
- y = -x+5

Problems in Hough Transform

- This particular form of Hough Transform i.e. mapping from XY plane (spatial domain) to the parameter domain has a serious problem

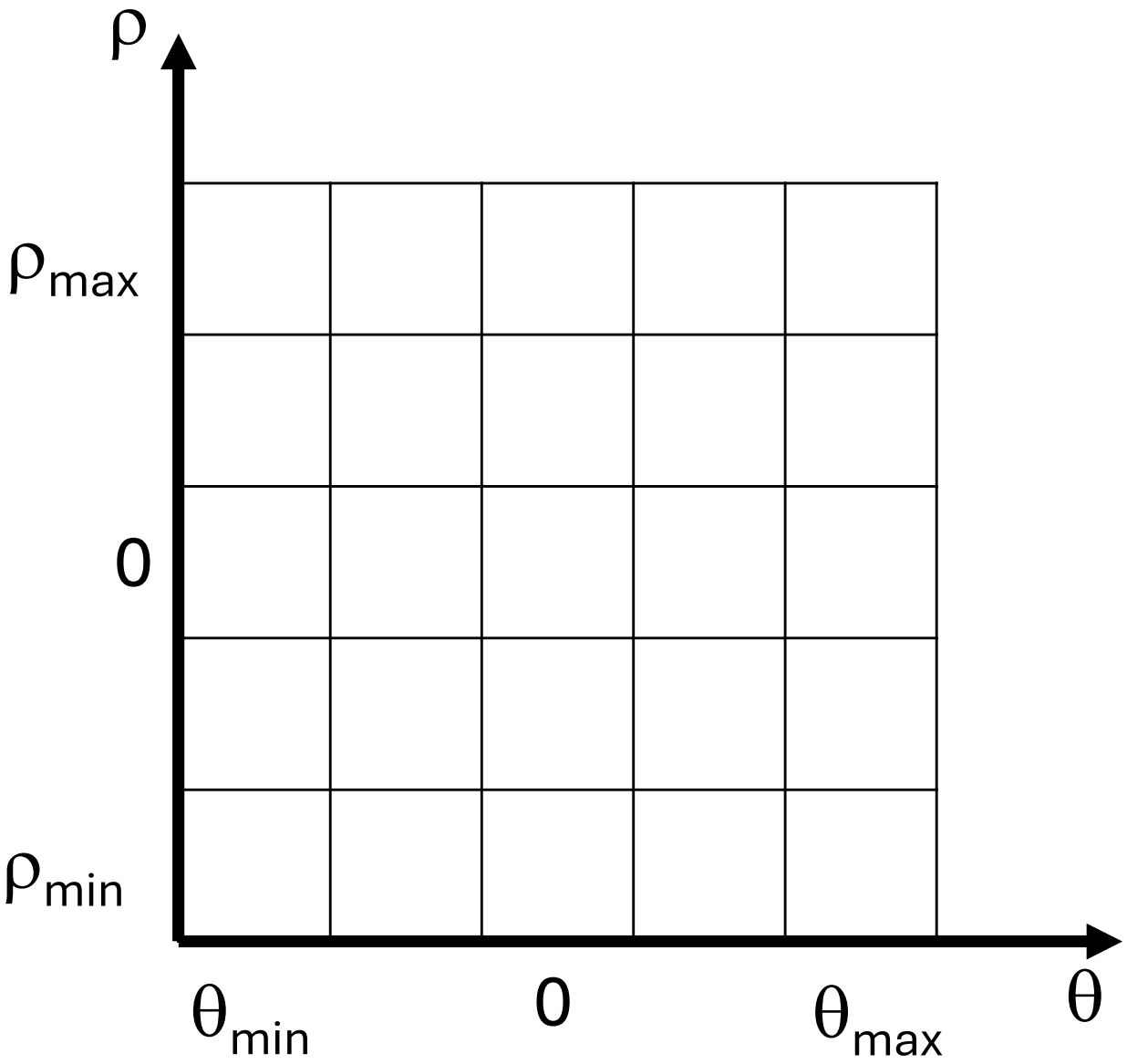
  - The problem is in mc-plane, we are trying to find out the slope and intercept value of the straight line

  - The problem comes when this ***lines are vertical***. In this case, the slope (m) is very large and in this method, we can't handle this much large value.

  - So, to overcome this problem; instead of using slope-intercept form of straight line, we will use the normal representation of the straight line.

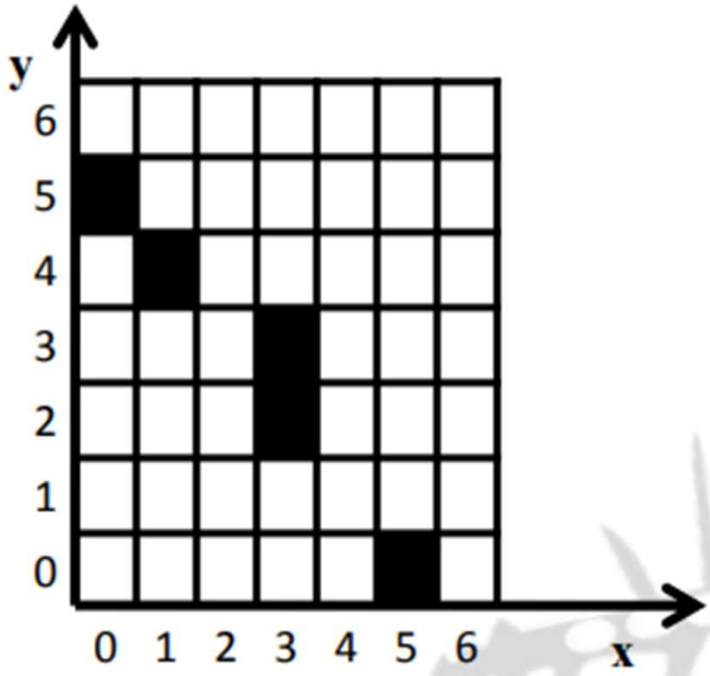
$$\rho = x\cos\theta + y\sin\theta$$

Hough Transform



Hough Transform

Example 2



$$p = x \cos\theta + y \sin\theta$$

Edgels: (0,5), (1,4), (3,2), (3,3), (5,0)

Hough Transform

Step 1

$$p = x \cos\theta + y \sin\theta$$

$p = 0 \cos\theta + 5 \sin\theta$ (0,5)

$p = 1 \cos\theta + 4 \sin\theta$ (1,4)

$p = 3 \cos\theta + 2 \sin\theta$ (3,2)

$p = 3 \cos\theta + 3 \sin\theta$ (3,3)

$p = 5 \cos\theta + 0 \sin\theta$ (5,0)

Hough Transform

Step 2

	0 cos θ + 5 sin θ	1 cos θ + 4 sin θ	3 cos θ + 2 sin θ	3 cos θ + 3 sin θ	5 cos θ + 0 sin θ
0	0	1	3	3	5
30	2.5	2.9	3.9	4	4.3
45	3.5	3.5	3.5	4.2	3.5
60	4.3	3.9	3.2	4	2.5
90	5	4	2	3	0

Hough Transform

Step 3

- The equation for the edge will be:

$$3.5 = x \cos 45 + y \sin 45$$

Thank You