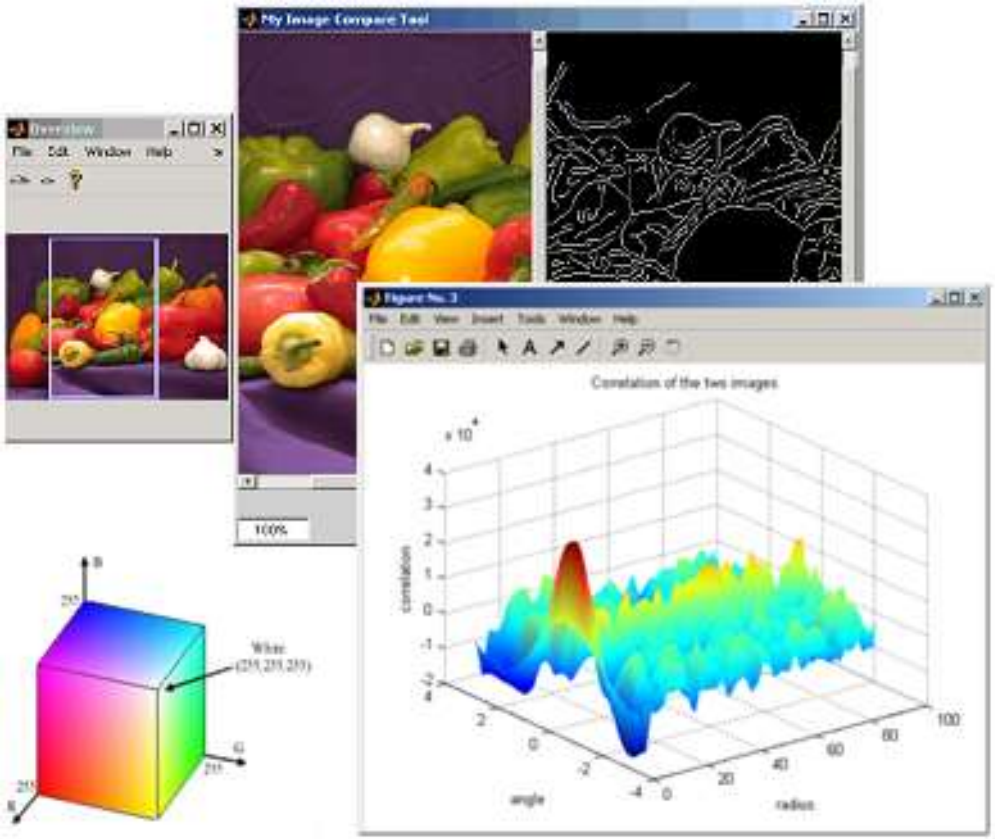
Digital Image Processing



DIGITAL IMAGE PROCESSING

LECTURE -16

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Image Representation and Description

Image Representation and Description

- After an image has segmented into regions or their boundaries using methods such as those in previous chapters, the resulting set of segmented pixels usually have to be converted into a form suitable for further computer processing.
- Typically, the step after segmentation is **Feature Extraction**, which consist of
  - Feature detection
  - Feature description.
- **Feature Detection** refers to finding the features in an image, region or boundary.
- **Feature Description** assigns quantitative attributes to the detected features.
- Features Processing methods are subdivided into three principles categories depending on whether they are applicable to **boundaries**, **regions** or **whole image**.

Image Representation and Description

- To represent and describe information embedded in an image in other forms that are more suitable to visualize and understand
- **Benefits**
  - Easier to understand
  - Require fewer memory
  - faster to be processed
- **What kind of information we can use?**
  - Boundary, shape
  - Region
  - Texture
  - Relation between regions

Boundary Processing

Boundary Processing

An ordered list of points representing the boundary of an object

Boundary as a sequence of connected point

		1	1	1	1	
	1			1		
		1		1		
	1			1		
	1	1	1	1		

		B0	1	1	1	
	1			1		
		1		1		
	1			1		
	1	1	1	1		

	C0	B0	1	1	1	
	1			1		
		1		1		
	1			1		
	1	1	1	1		

	C0	B0	**1**	1	1	
	1			1		
		1		1		
	1			1		
	1	1	1	1		

	C0	B0	**1**	1	1	
	1			1		
		1		1		
	1			1		
	1	1	1	1		

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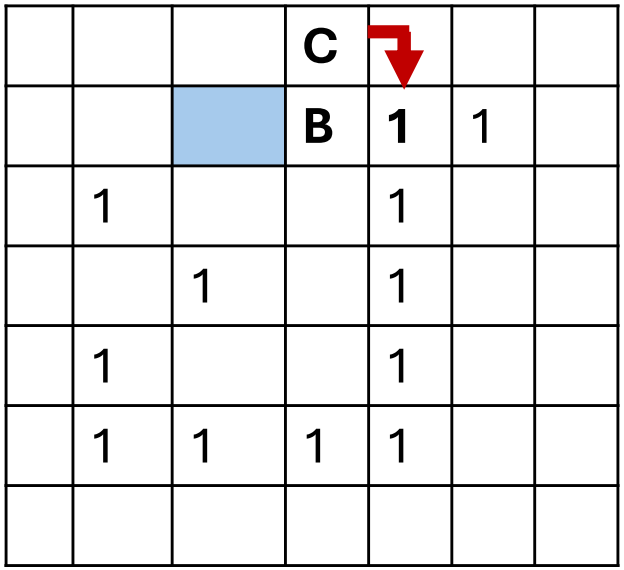
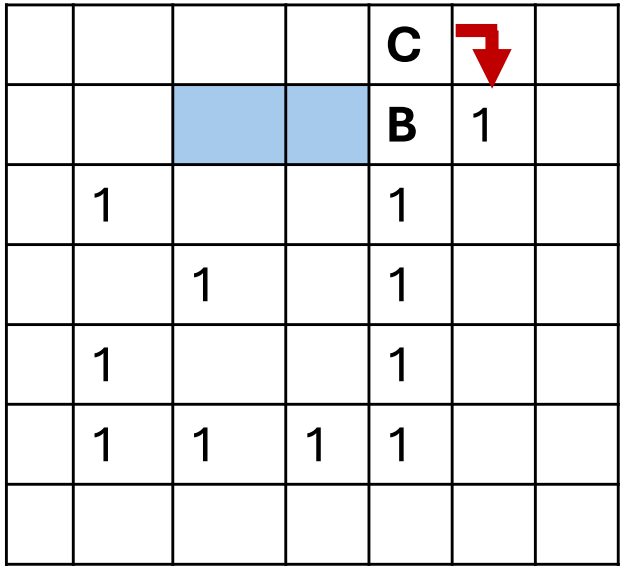
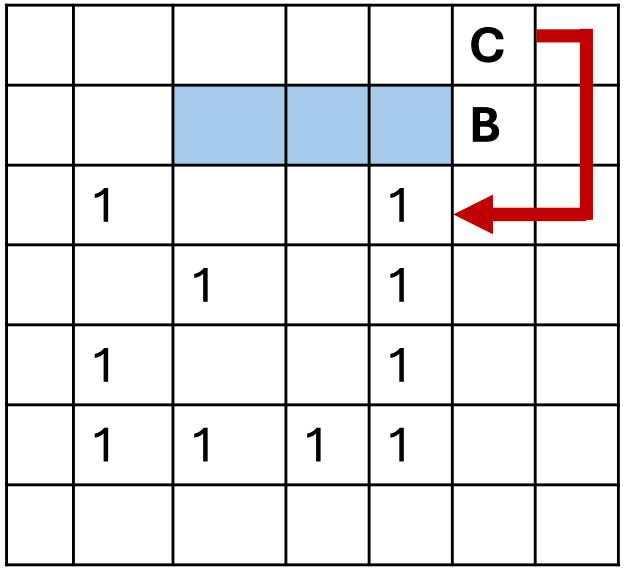
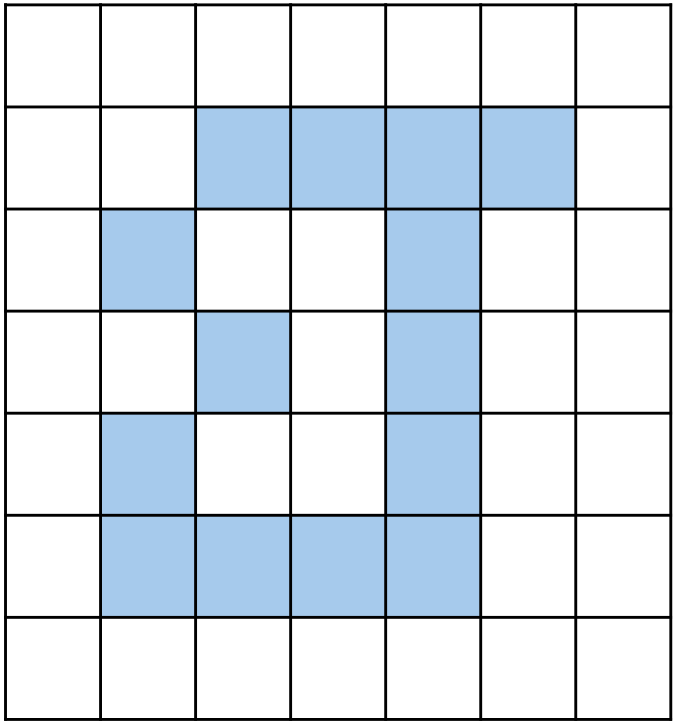
Boundary Processing









Boundary Processing

❑ Technique 1: Boundary Following (Tracing)

The following algorithm traces the boundary of a 1-valued region, R, in a binary image:

1. Let the starting point, B_0, be the uppermost-leftmost point in the image that is labelled 1.
2. Denote by C_0, the west neighbour of B_0. (Clearly the C_0 always be the background point)
3. Examine the 8-neighbors of B_0, starting at C_0 and proceeding in a clockwise direction.
4. Let B_1 denote the first neighbour encountered whose value is 1 and let C_1 be the (background) point immediately preceding B_1 in the sequence.
5. Store the locations of B_0 for use in

Boundary Processing

6. Let $B = B_0$ and $C = C_0$
7. Let the 8-neighbours of B, starting at C and proceeding in a clockwise direction, be denoted by $N_1, N_2, \ldots N_8$. Find the first neighbour labelled 1 and denote it by N_K.
8. Let $B = N_K$ and $C = N_{K-1}$
9. Repeat steps 7 and 8 until $B = B_0$. The sequence of B points found when the algorithm stops is the set of ordered boundary points.

This algorithm referred to as ***Moore Boundary Tracing Algorithm*** after Edward F. Moore, a pioneer in cellular automata theory.

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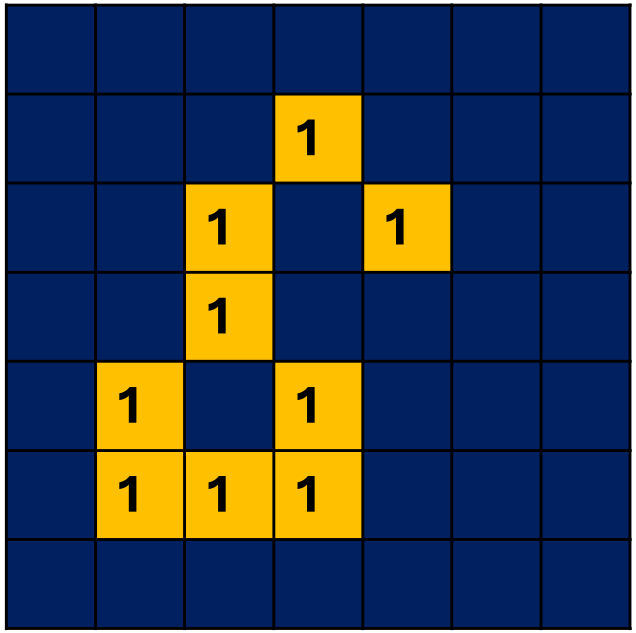
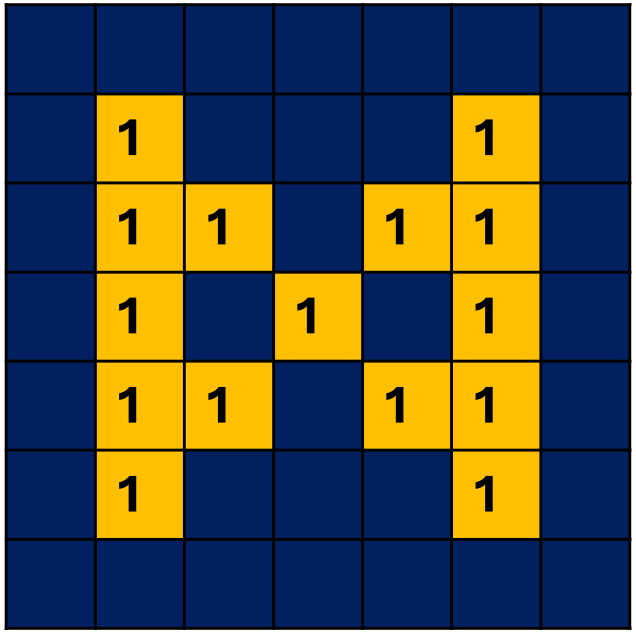
Boundary Processing

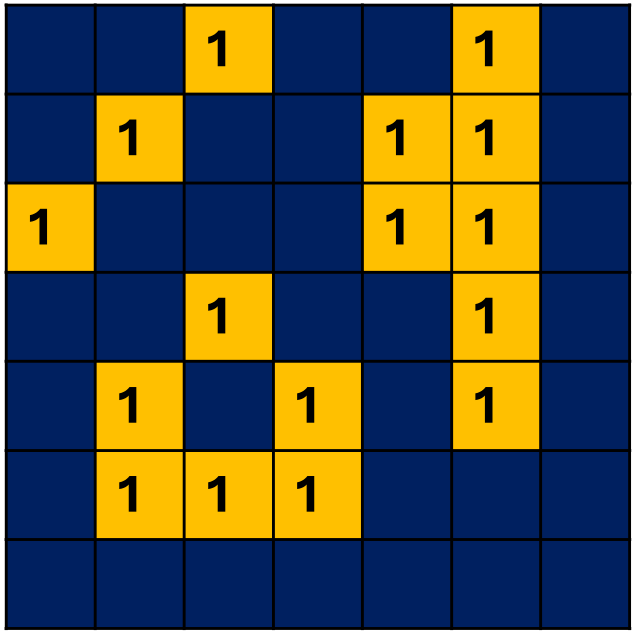
The algorithm works equally well with more complex boundaries (***Closed boundary with branch*** or ***Self intersecting boundary*** or ***Multiple Boundaries***)



Closed boundary with branch



Self-intersecting boundary



Multiple Boundaries

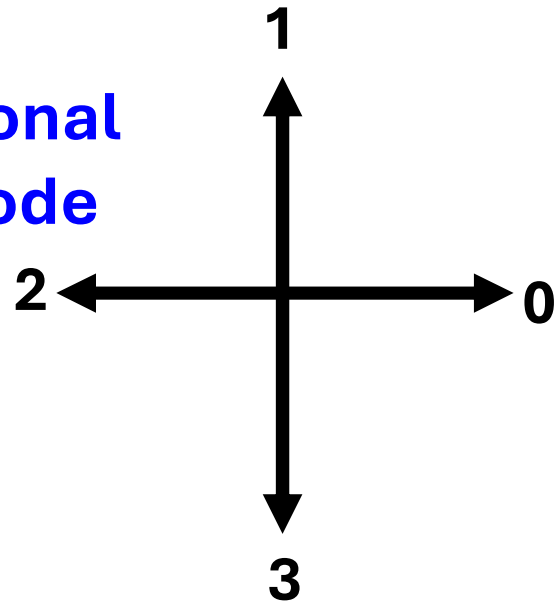
Limitation: This algorithm based on following a boundary in the **clockwise direction**, but you will find it easier to have just one algorithm and then reverse the order of the result to obtain a sequence in the opposite direction.

Chain Code

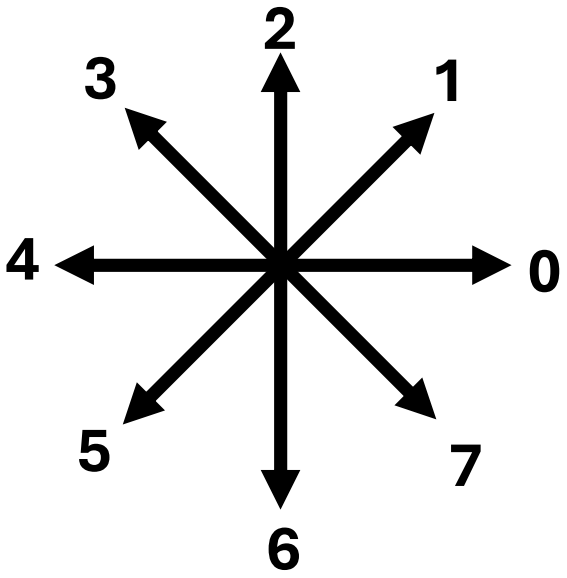
Chain Code

- A chain code representation is based on 4- or 8-connectivity of the segments.
- **Chain Code:** represent an object boundary by a connected sequence of straight-line segments of specified length and direction.
- The direction of each segment is coded by using a numbering scheme.

4-Directional Chain Code

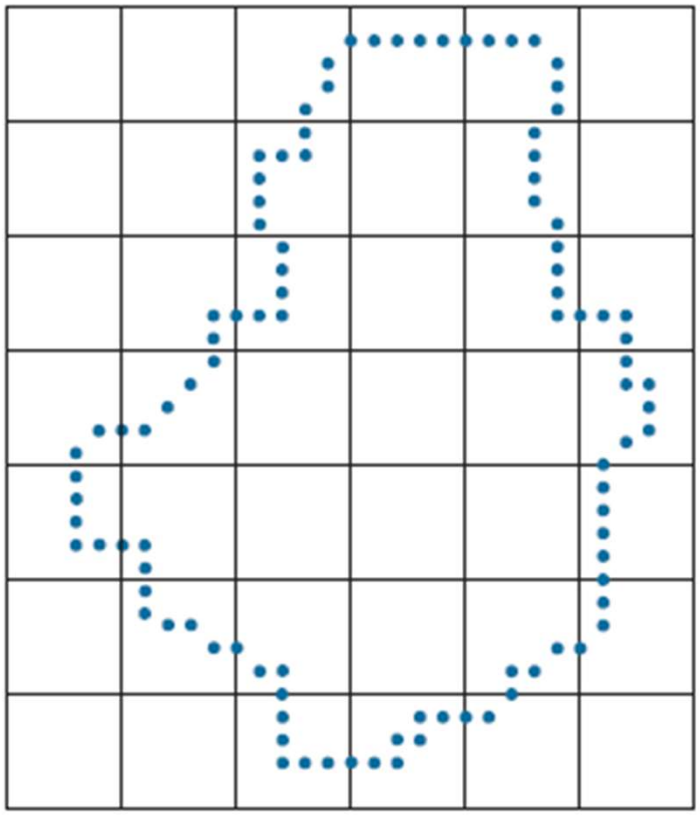


8-Directional Chain Code

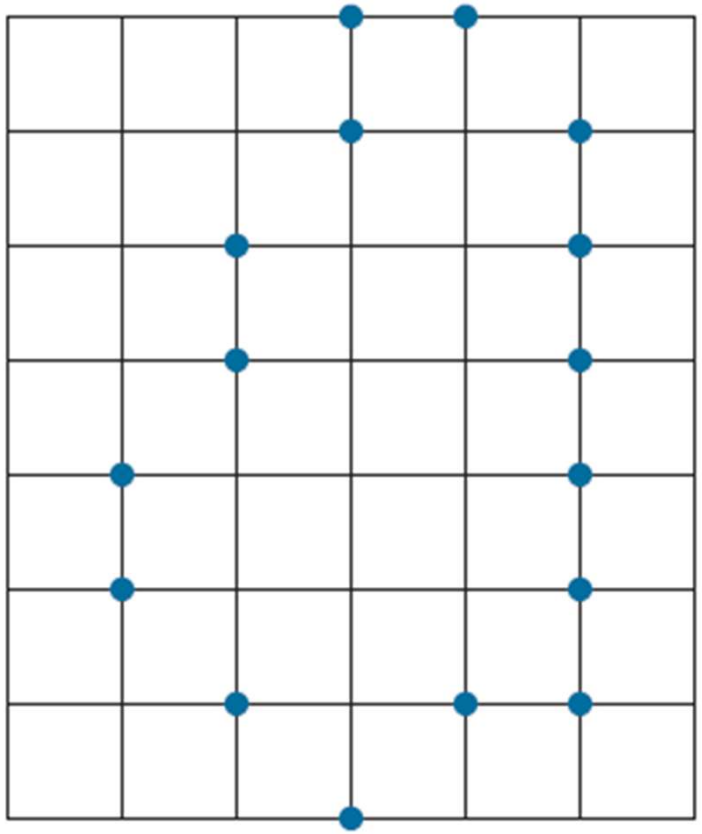


- A boundary code formed as a sequence of such directional numbers is referred to as a Freeman chain code.

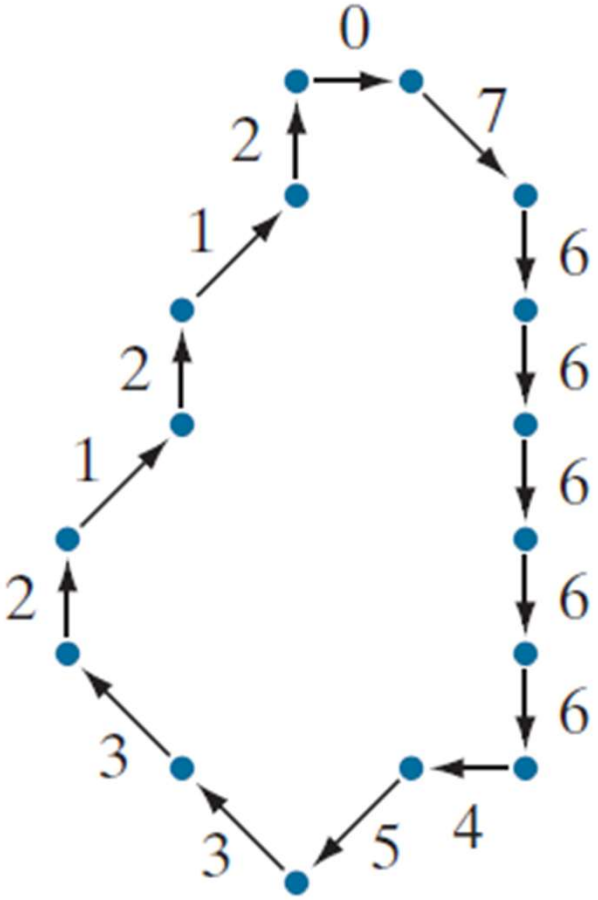
Chain Code



Original Image



Resampled

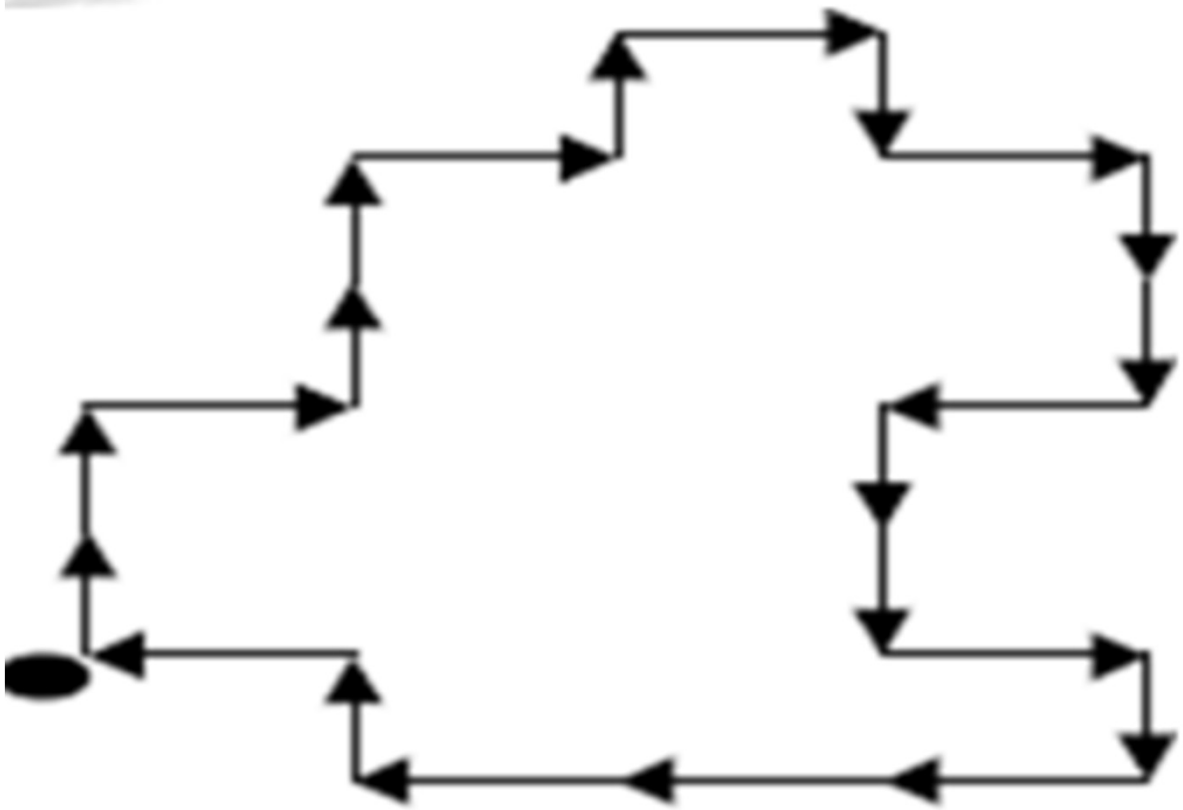


8-Directional Chain Code Boundary

Chain Co de of this Digital Image:

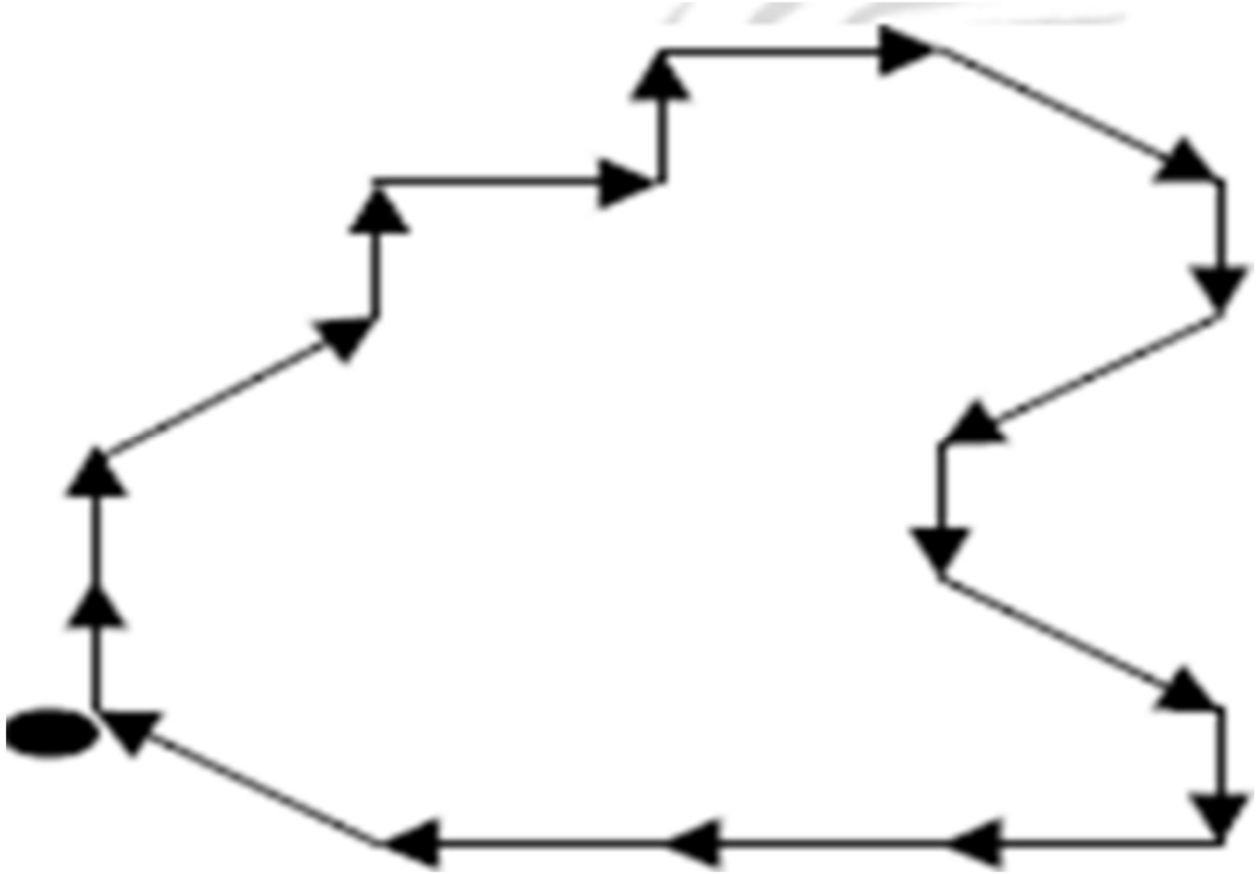
Chain Code

Example 1: Find the 4 directional Chain Code for the following



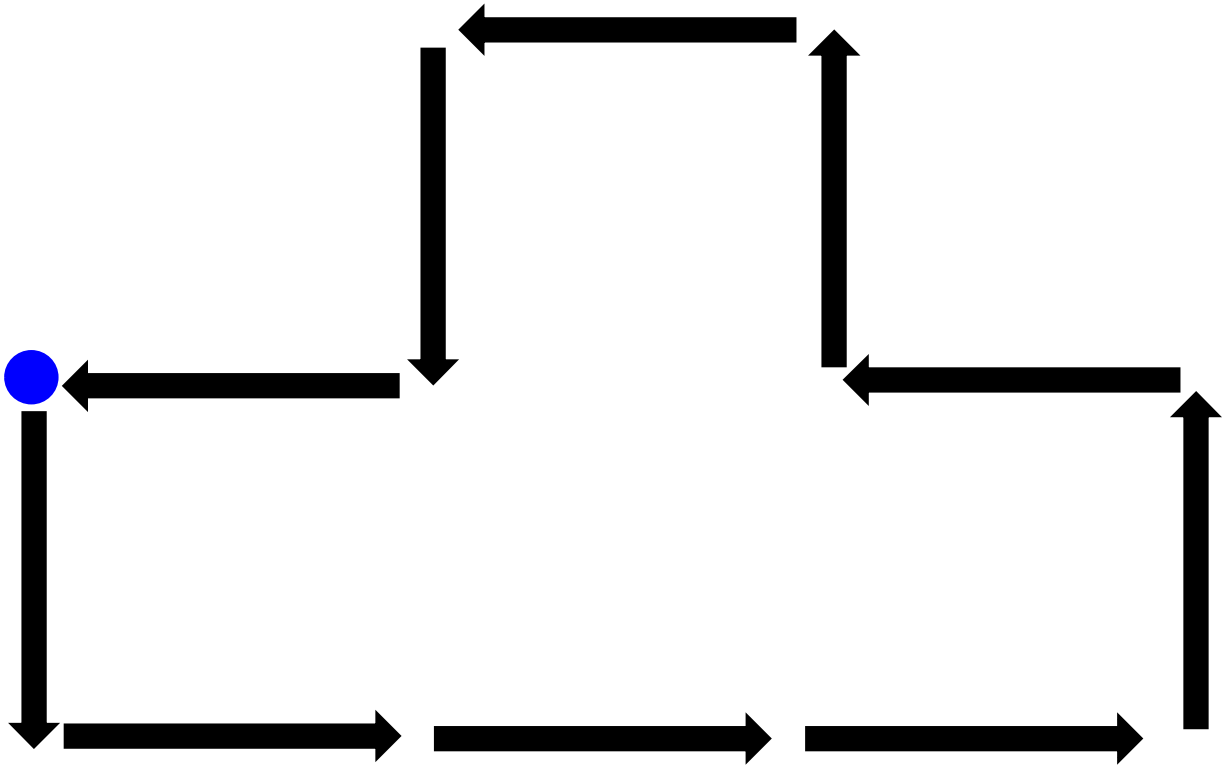
Chain Code

Example 2: Find the 8 directional Chain Code



Chain Code

Example 3: Write down the 4-directional Chain code for the following image:



Chain Code

❑ Advantages of Chain Code:

- This can also take care of scaling i.e. By varying the grid spacing, we can have the same boundary represented at different scales.

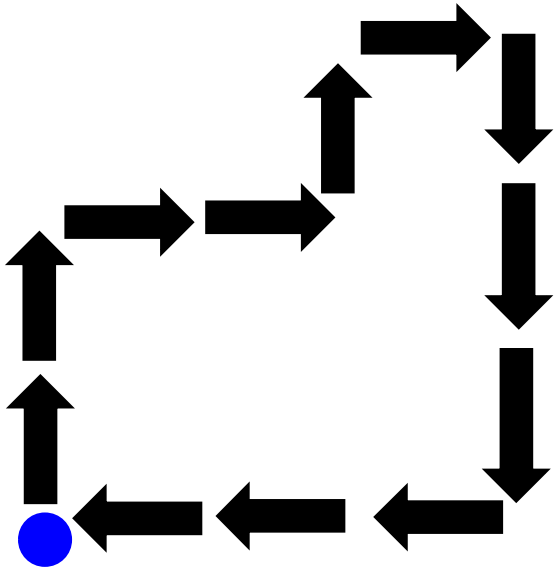
❑ Disadvantages:

- Chain code in this case is not rotation invariant.
- The resulting chain codes are quite long
- Any small change along the boundary due to noise causes changes in the code
- Dependent on the starting point
- Dependent on the orientation

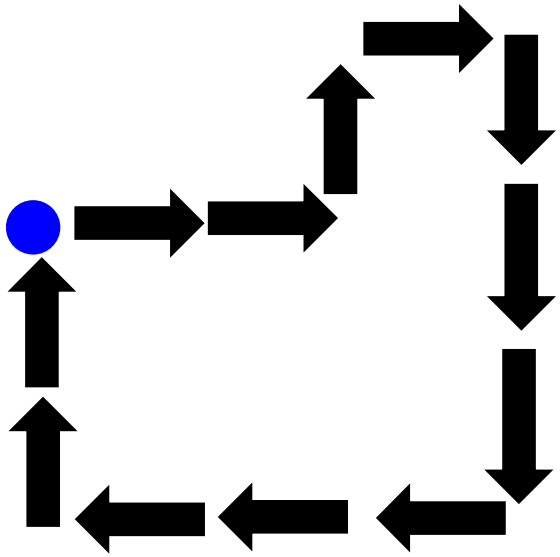
Chain Code

❑ 1st Disadvantage of Chain Code:

- Chain code are Dependent on the starting point



Object 1



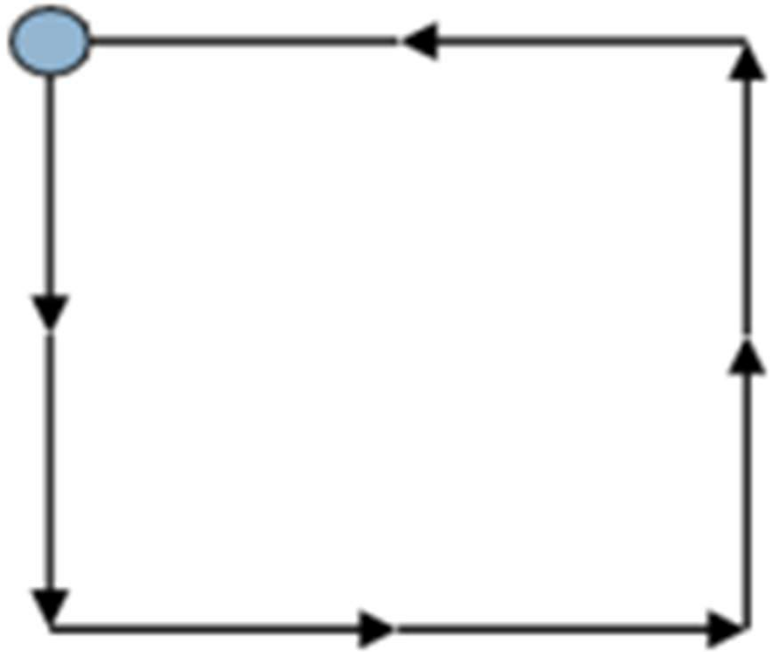
Object 2

To overcome the limitation **(Dependent on Starting point)** of chain code, we use **Normalised Chain code.**

Normalized Chain Code

Normalised Chain Code

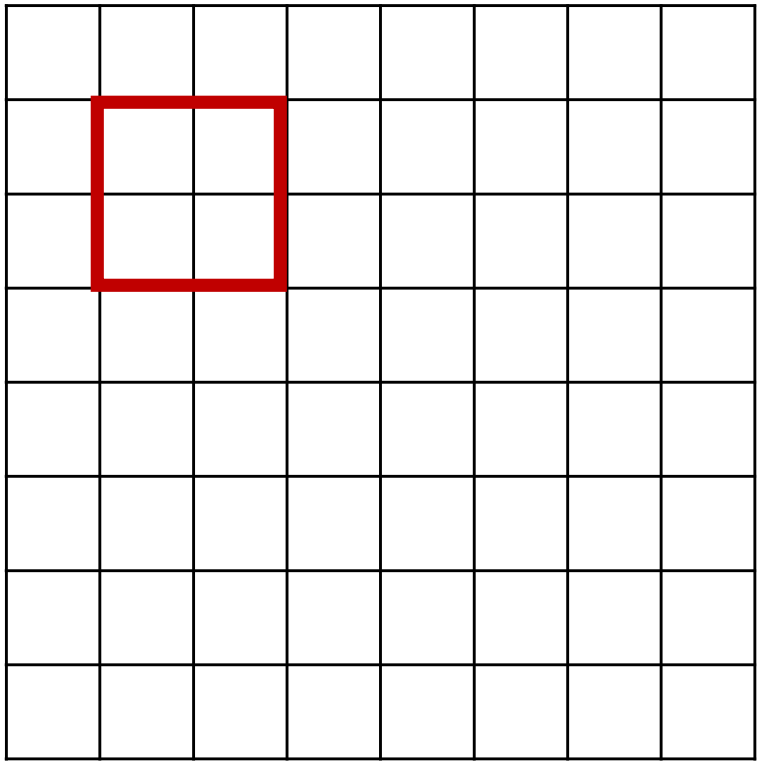
Example 3: Write down the 4-Direction Chain Code and Normalised Chain Code for the following.

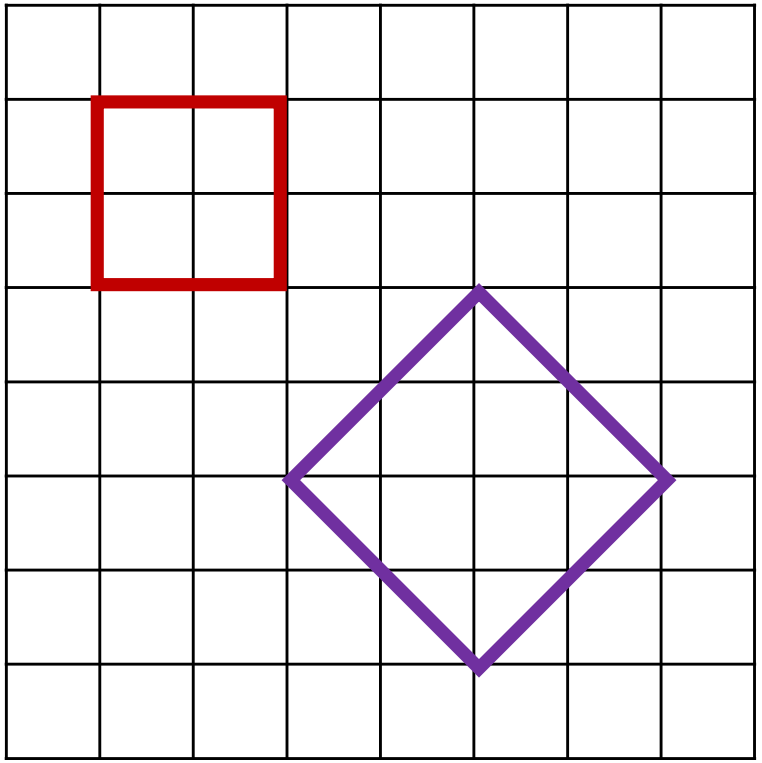


Chain Code

❑ 2nd Disadvantages of Chain Code:

- Chain code in this case is not rotation invariant.





To Overcome this limitation (Rotation Invariant) of Chain Code, We use **Differential Chain Code**

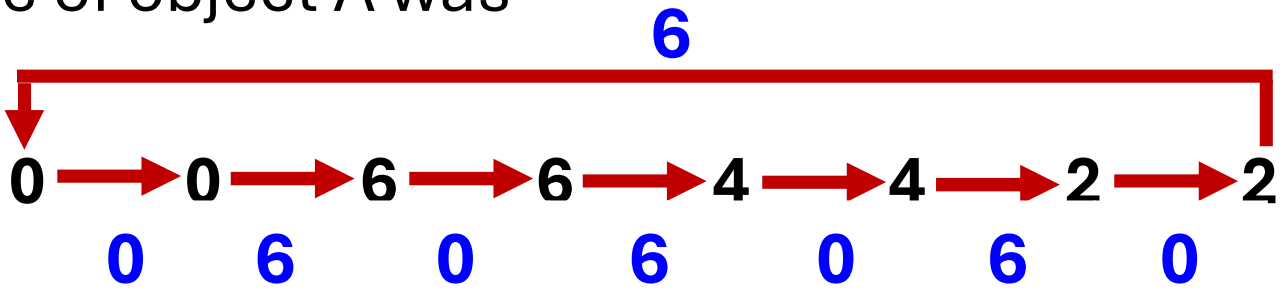
Differential Chain Codes

Differential Chain Codes

- Once I get the first order chain code from this procedure, Then I take two subsequent code and try to find out if from the first code, I have to move to the second code then how many rotations I have to perform.

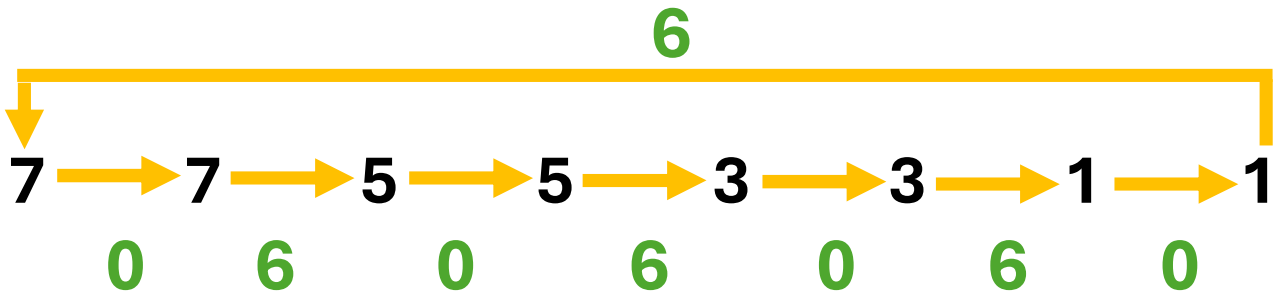
❑For Example:

- Chain Code of object A was



So, for the Differential Chain Code of Object A is **0 6 0 6 0 6 0 6**

- Similarly Chain code for Object B was:



So, for the Differential Chain Code of Object B is **0 6 0 6 0 6 0 6**

Differential Chain Code

- So, instead of using direct chain code if we use the differential chain code, we can observe it is ***rotation invariant***.

- Differential chain code is ***translational invariant*** as well as ***scale invariant*** also.

Shape Number and Order

Shape Number and Order

- The **Shape Number** of a boundary obtained from a chain code is defined as the smallest magnitude of the circular first difference

- The **Order of the Shape Number** is defined as the number of digits in its representation

Shape Number and Order

Example: Consider the following circular first difference

1 3 1 0 3 0

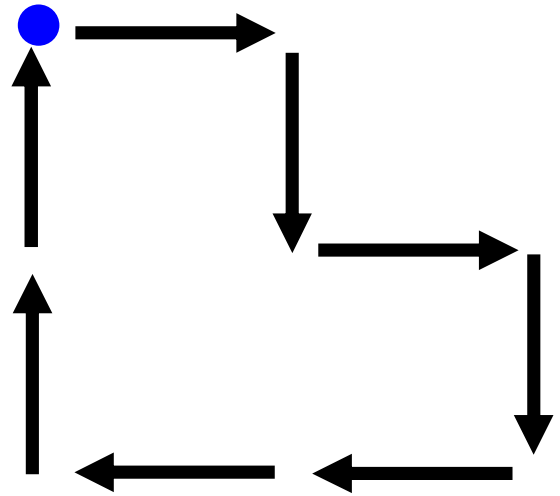
1	3	1	0	3	0
3	1	0	3	0	1
1	0	3	0	1	3
0	3	0	1	3	1
3	0	1	3	1	0
0	1	3	1	0	3

The smallest number is 0 1 3 1 0 3. This is called as the **Shape Number**

Order of the Shape number: Number of Digits used in the Shape Number = 6

Differential Chain Codes

Example 3: Find the shape number & order of the given boundary



4- Directional Chain Code:

First Difference:

Circular First Difference:

Shape Number:

Order:

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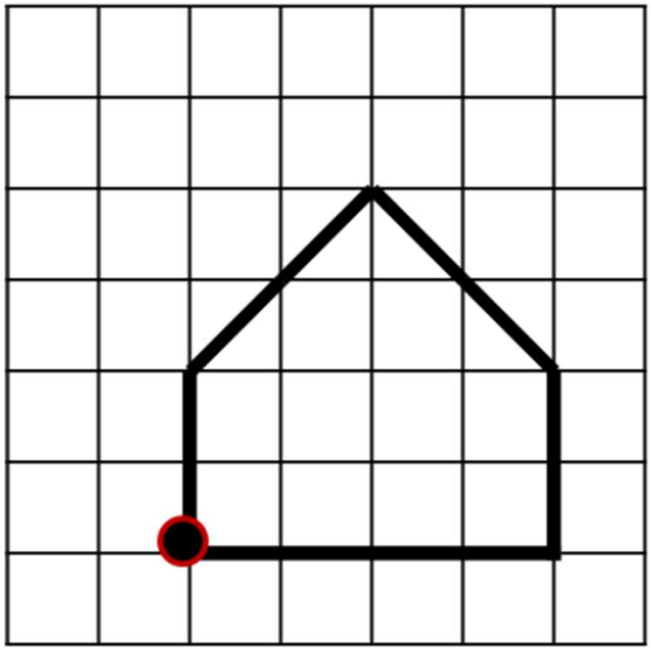
University End Sem Questions

Ques1: Find the following shape-description of the given shape (black circle is the origin and move in the clockwise direction):



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Even Semester 2023-24

i. Chain code

ii. First difference

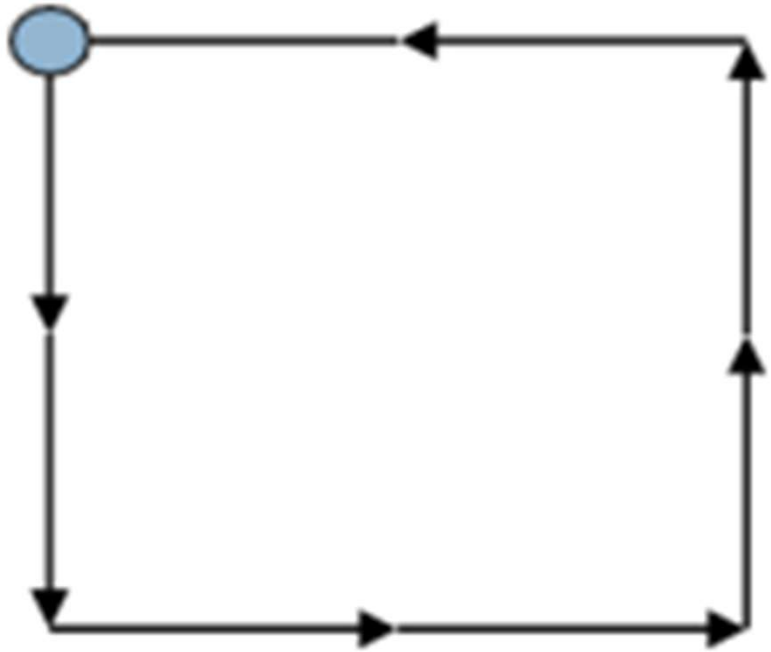
iii. Circular first difference

iv. Shape number

v. Order

University End Sem Questions

Ques 2: Find the normalized chain code for the image as shown in Fig. 3. Assume 4 directional chain code.



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Session 2023-24

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Ques3: Discuss the merits and demerits of chain code. Find the shape number of the following highlighted shape as shown in Fig. 9. Considering 4 direction chain code, dot is in clockwise the starting point and direction.

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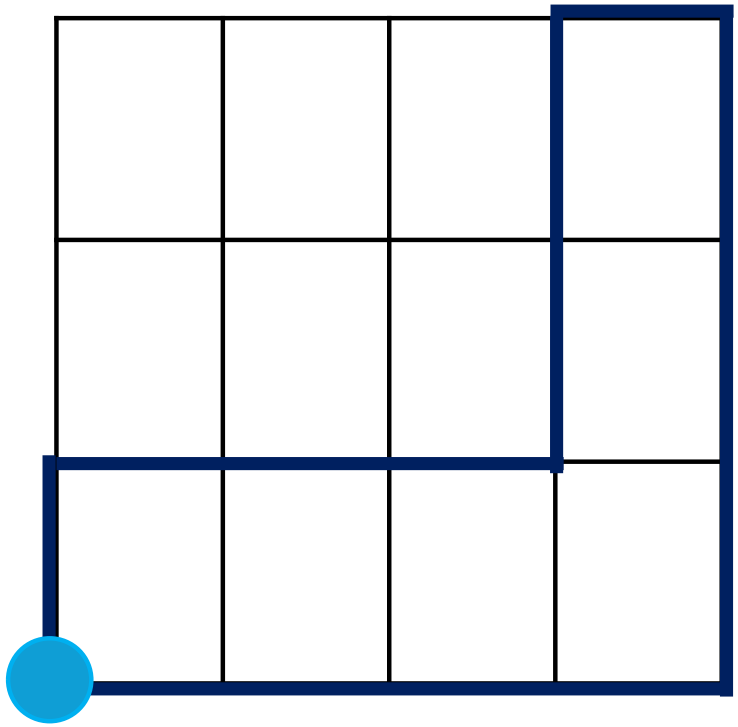

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Ques 4: Find the following shape description of the given shape.(Black circle is the origin)

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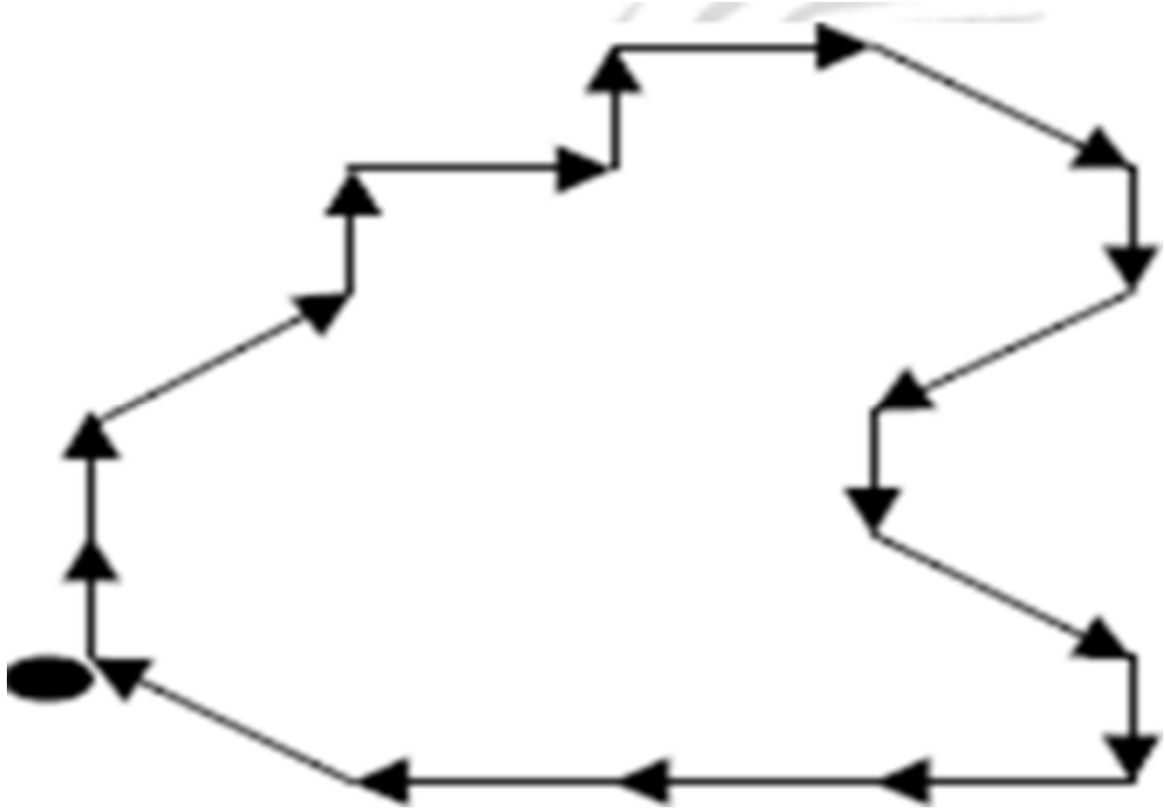
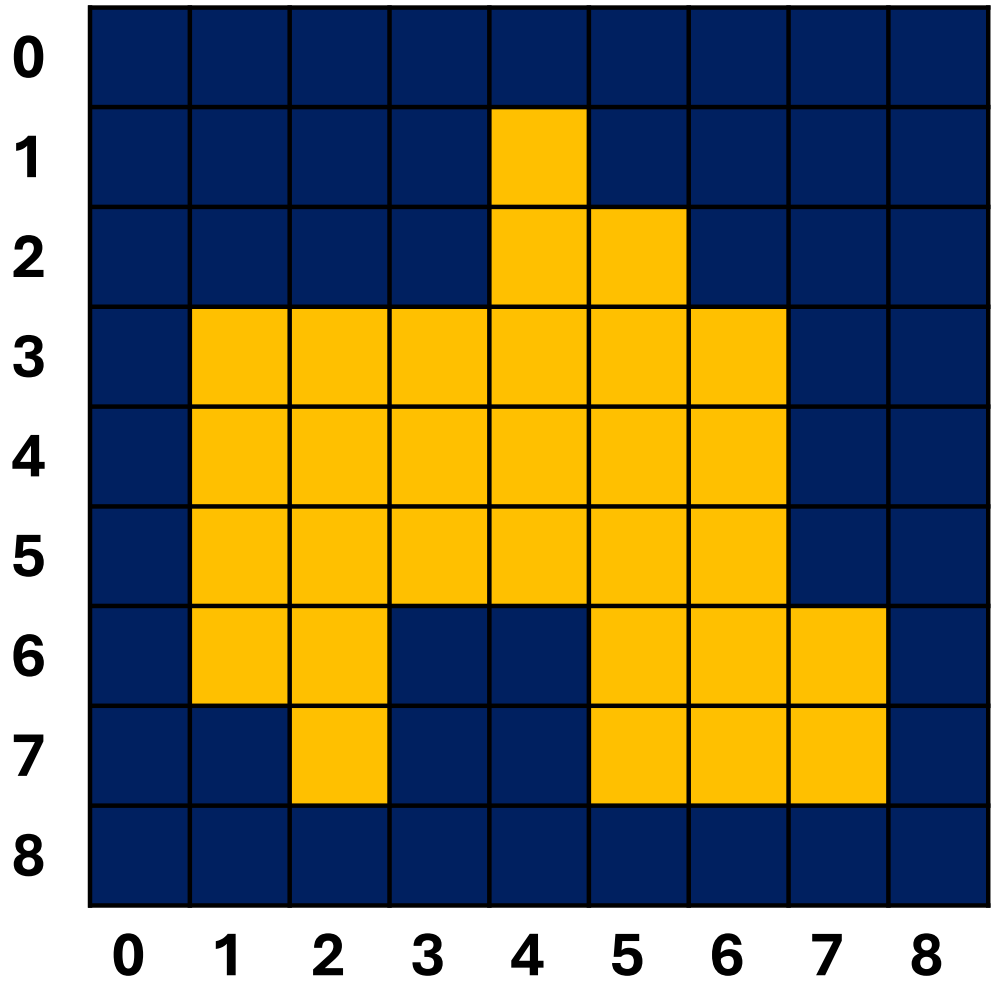


I. Chain code
II. First Difference
III. Circular First Difference
IV. Shape Number
V. Order

University End Sem Questions

Ques 5: In the following image, find the 8-chain code. Select the starting point, as the leftmost pixel in the first row of the object (i.e. the pixel at [1,4]). Transverse the boundary in clockwise direction, from pixel to pixel



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Ques 6: What do you mean by Chain Code. What are the limitation of chain code? What are the advantages of shape number. Find the shape number of the following diagram

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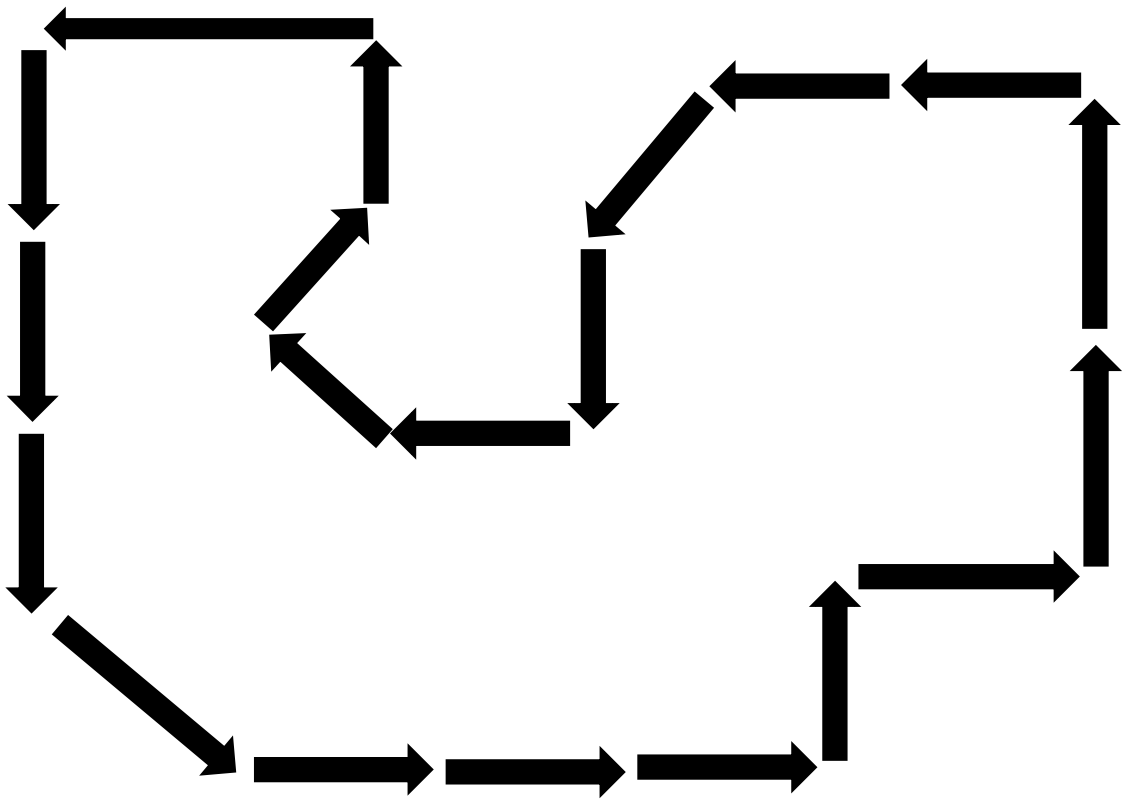

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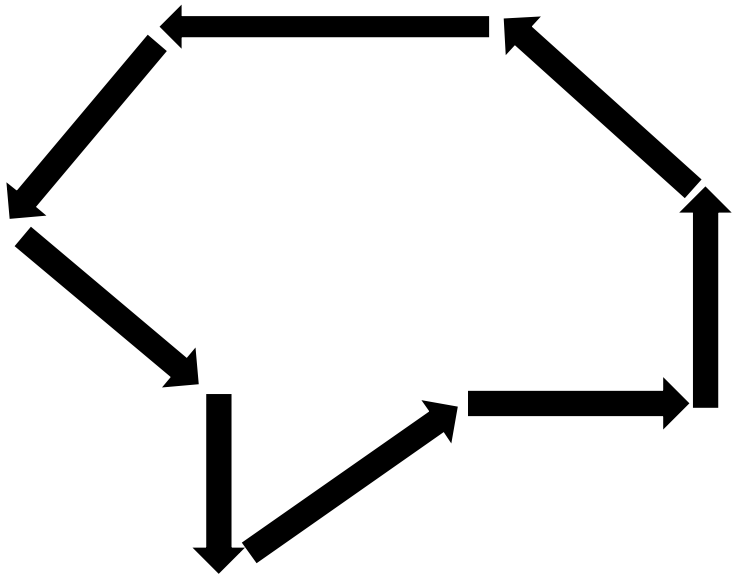
Ques 7: Discuss the problems with chain code? For the following boundary (in the clockwise direction)



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Compute the chain code (8-directional) that is

- Invariant to the starting point
- Invariant to both starting point and rotation.

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Ques 8: Boundary is considered as a sequence of connected points. Explain the boundary following algorithm in detail.

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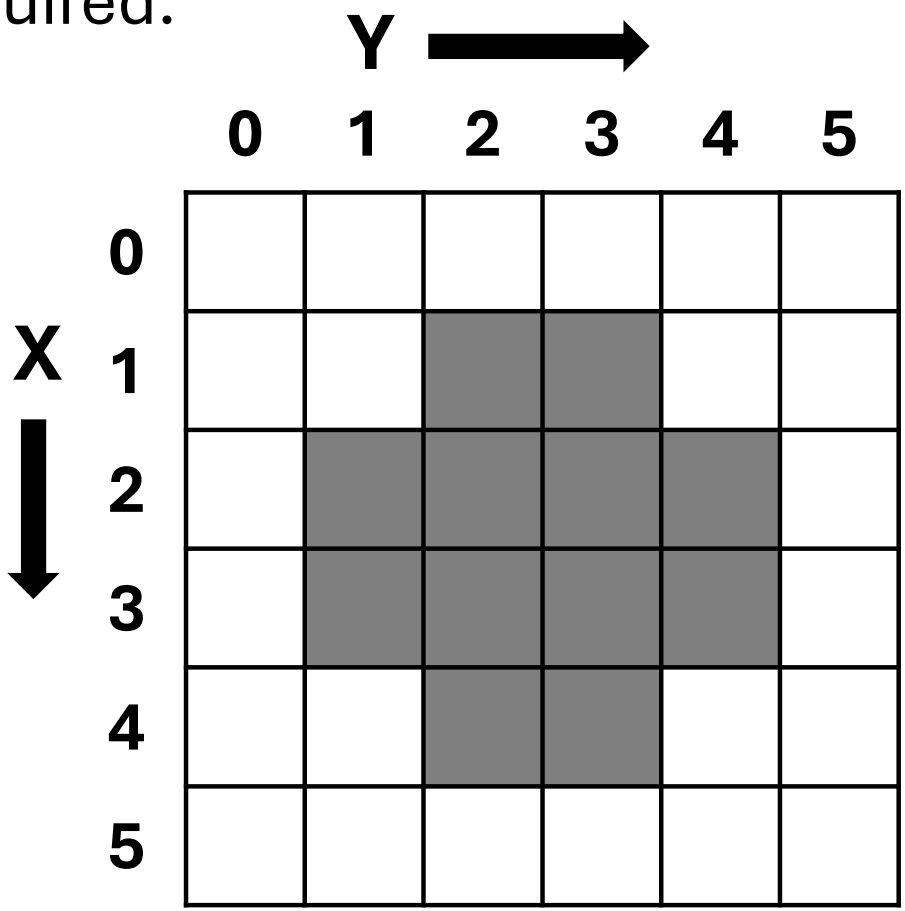
Ques 9: Apply boundary tracking algorithm to extract the boundary pixel in the following images. You need to give the coordinates of the pixels in the sequence in which they are extracted if the algorithm starts from the uppermost-leftmost pixel. Give your answer in the table provided. The first two entry have been given. Add as many rows as required.



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Coordinate of Pixel From Where The Clockwise Search Started	Coordinate of Boundary Pixel Extracted
(1,1)	(1,2)
(0,2)	(1,3)

Thank You