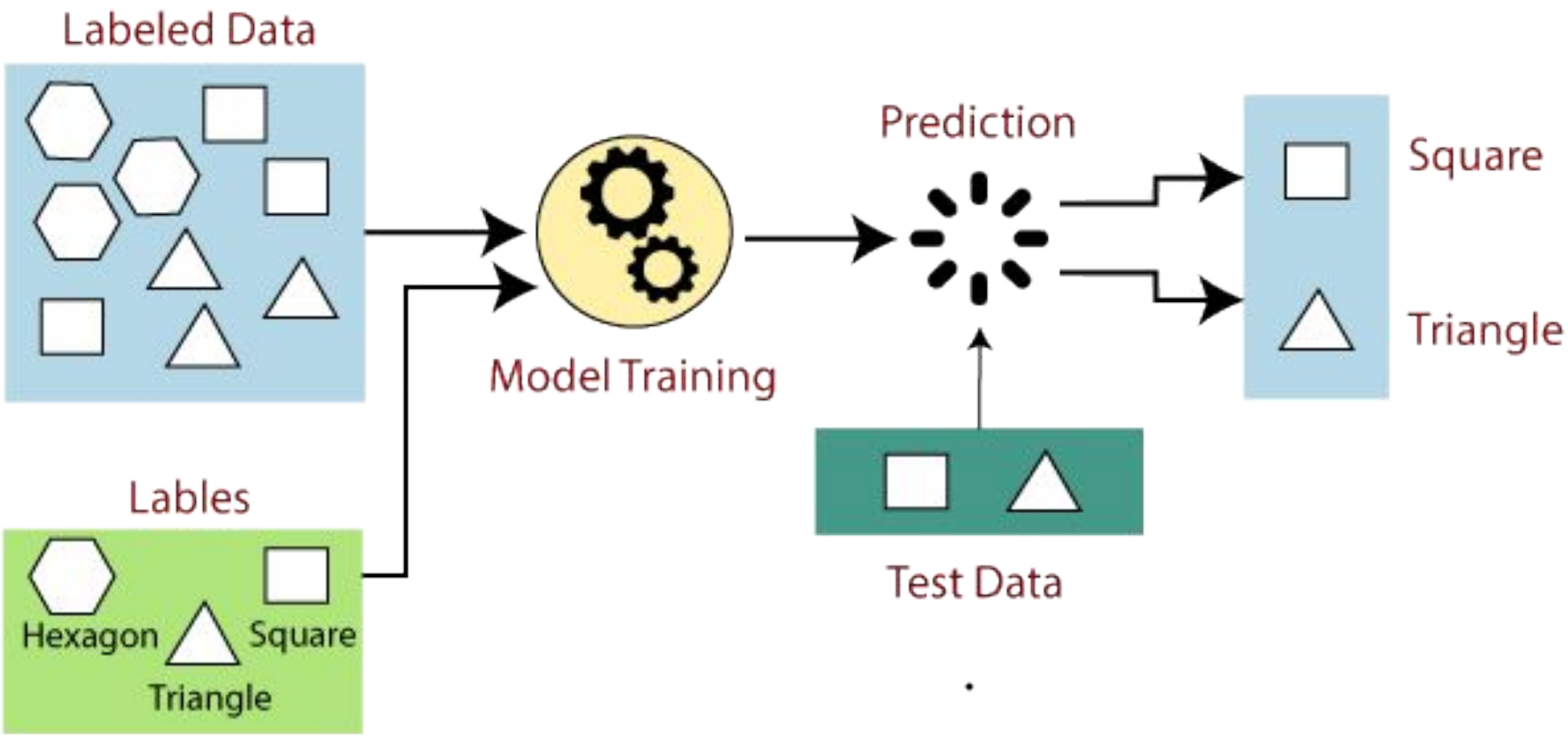
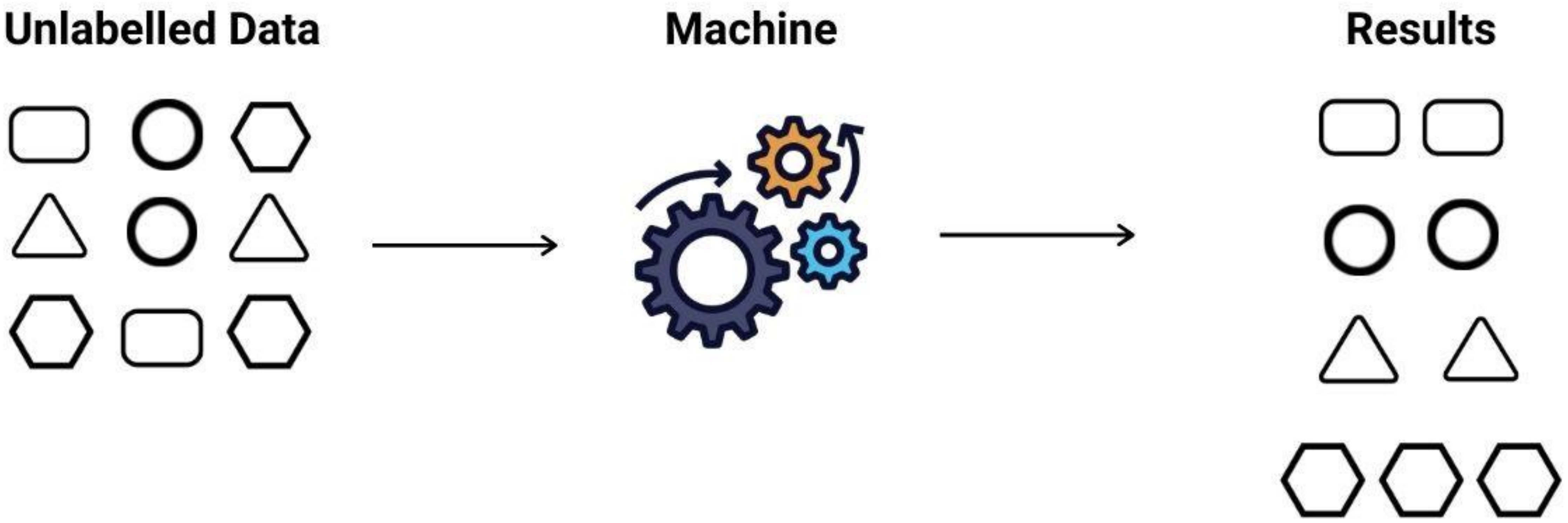
Pattern Recognition

Module 1

Supervised Learning



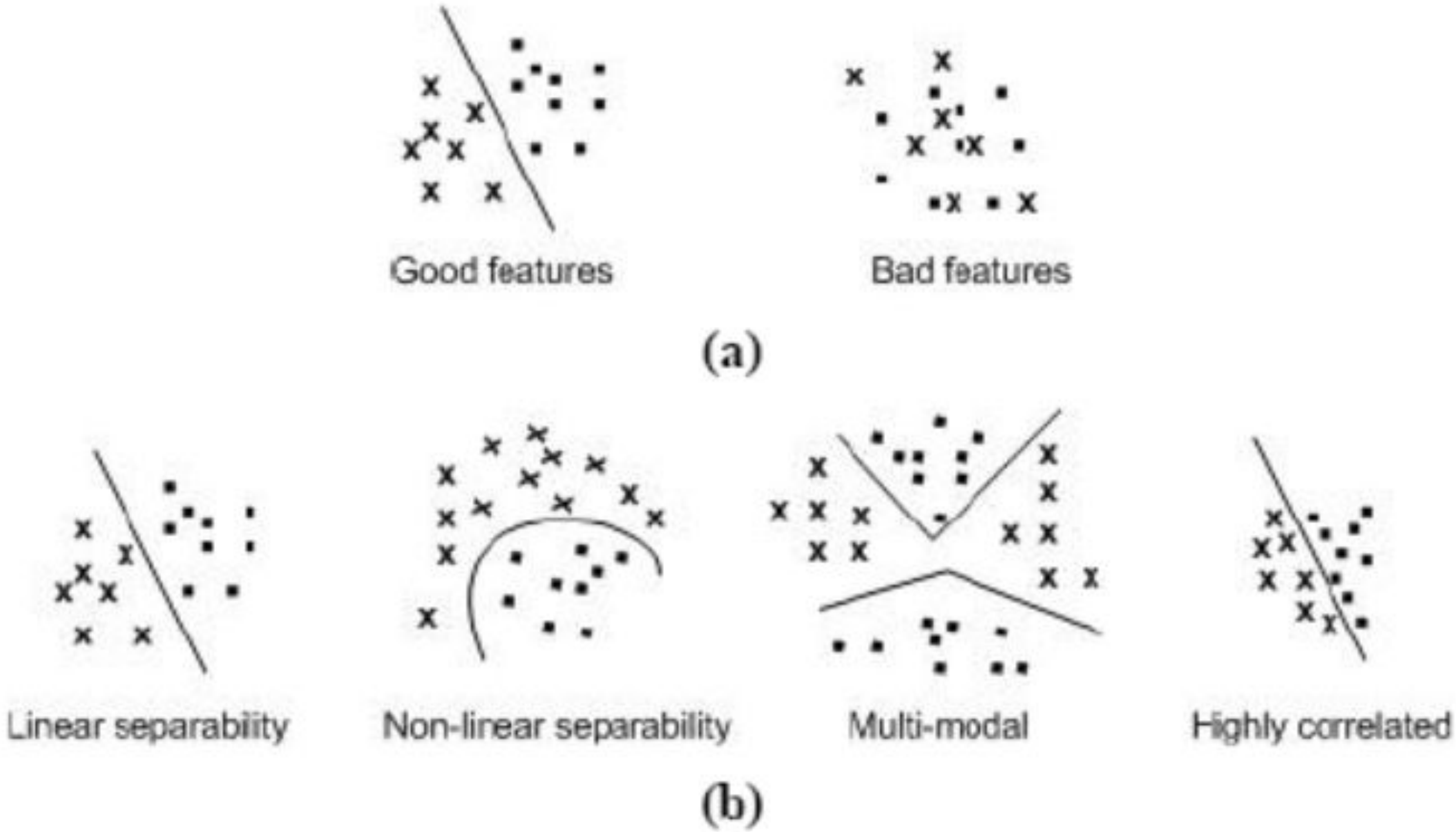
Unsupervised Learning



Features

- **Pattern recognition system should recognize familiar patterns quickly and accurate**
- Feature can be defined as any distinctive aspect, quality or characteristic which, may be symbolic (i.e., color) or numeric (i.e., height).
- The combination of d features is represented as a d-dimensional column vector called a feature vector. The d-dimensional space defined by the feature vector is called feature space.

Features


Good features
Bad features
(a)
Linear separability
Non-linear separability
Multi-modal
Highly correlated
(b)

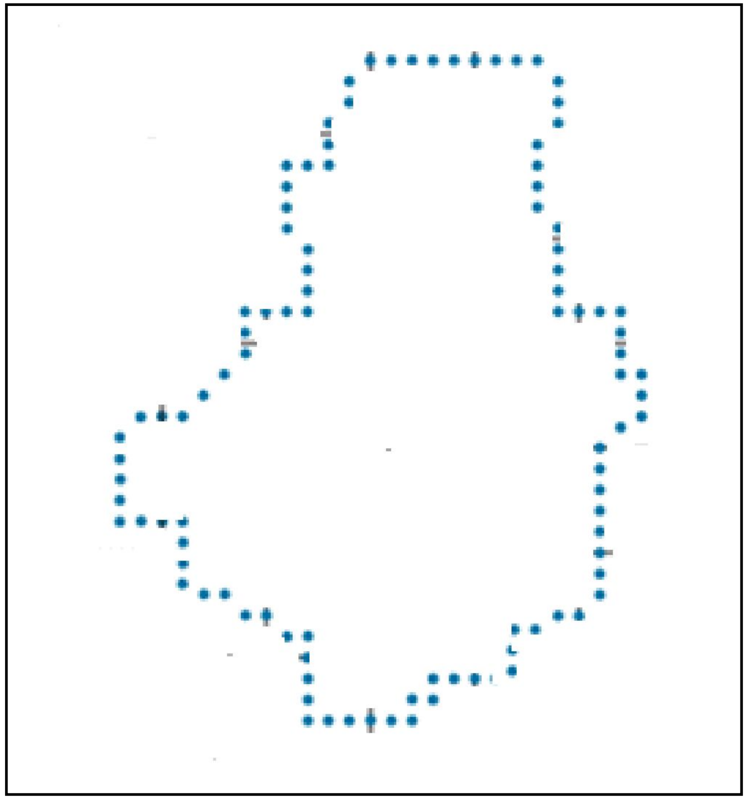
Features

Often the features are obtained from Shape and Region

- Boundary:
- The shape of the object
- Region:
- Color
- Area/perimeter covered
- Texture

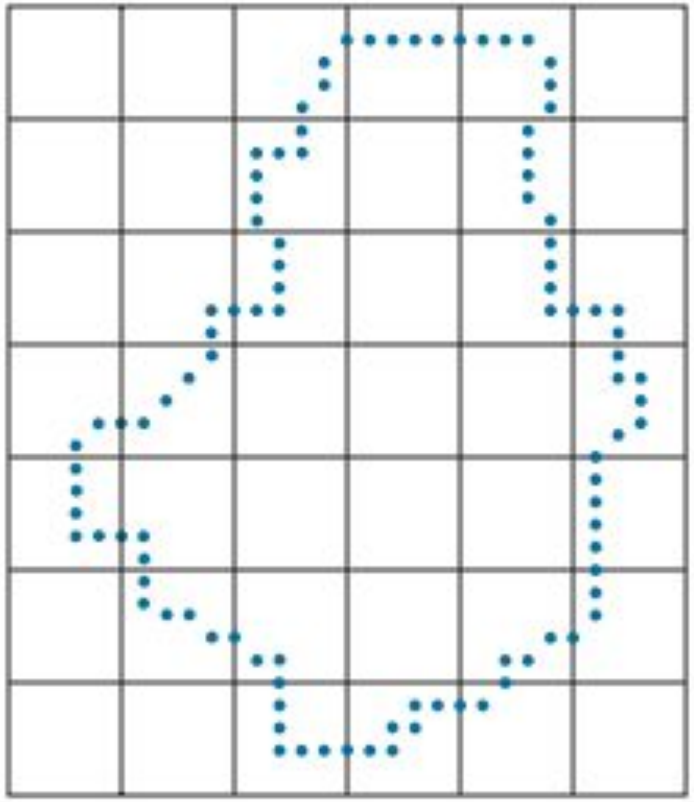
Features from shape

- Let the shape of an object be defined as a set of points linked a particular manner



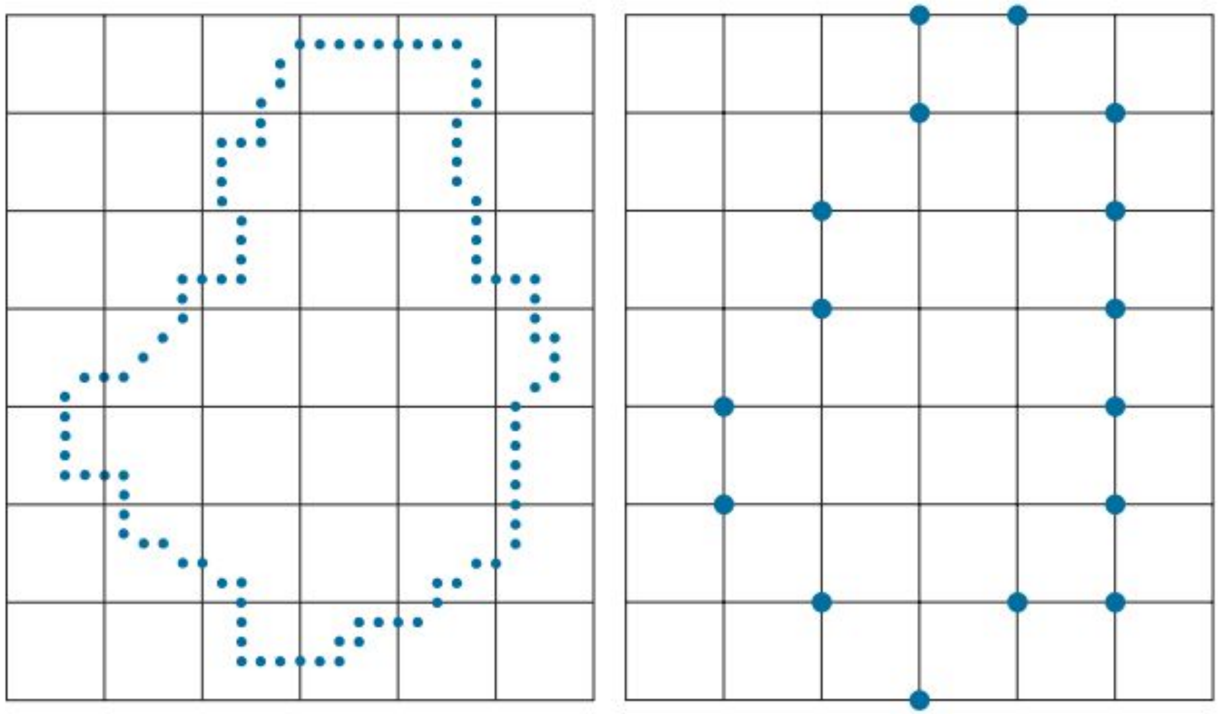
Features from shape

- Let us resample the boundary by selecting a larger grid spacing



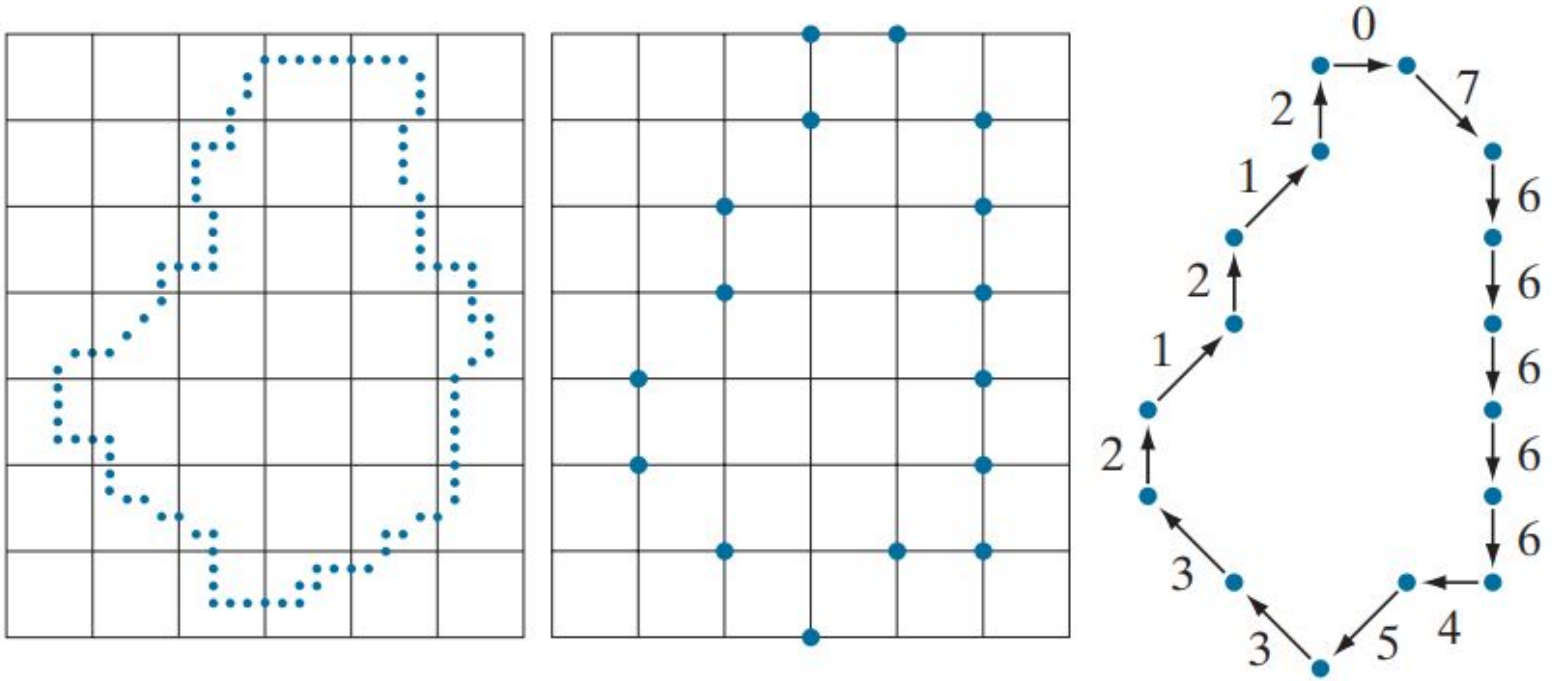
Features from shape

- Then, as the boundary is traversed, a boundary point is assigned to a node of the coarser grid, depending on the proximity of the original boundary point to that node



Chain Code Features

- Then the resampled boundary obtained in this way can be represented by a 4- or 8-code.



Chain Codes

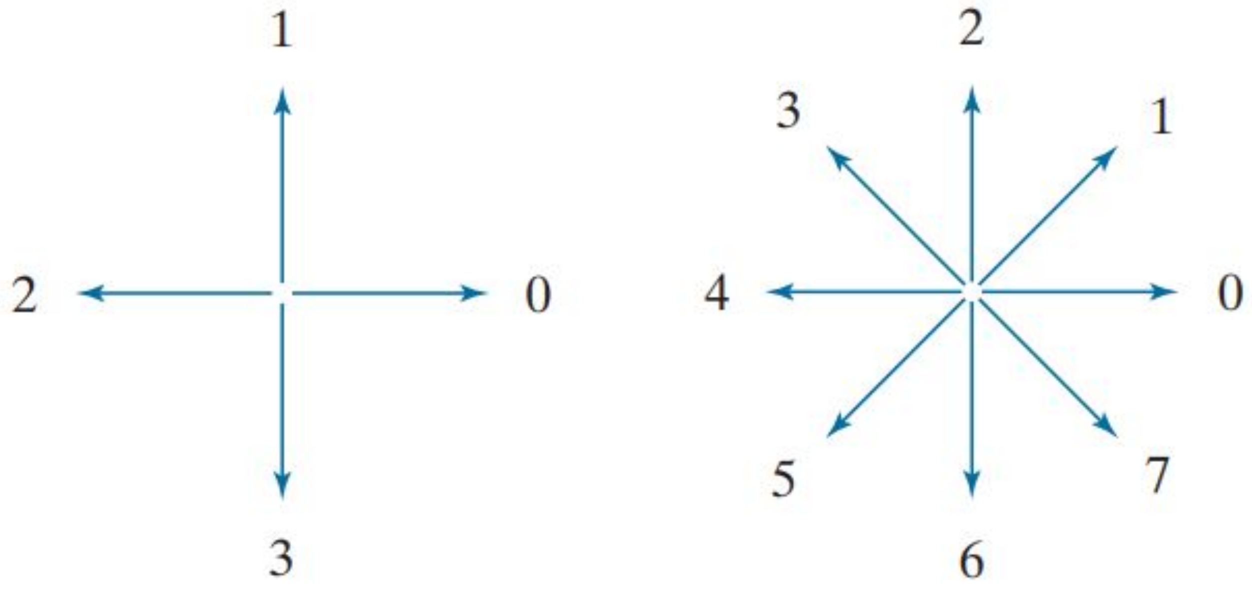
- Chain codes are used to represent a boundary by a connected sequence of straight line segments of specified length and direction.
- We assume in this section that all curves are closed, simple curves s (i.e., curves that are closed and not self intersecting).
- Typically, a chain code representation is based on 4- or 8-connectivity of the segments.

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

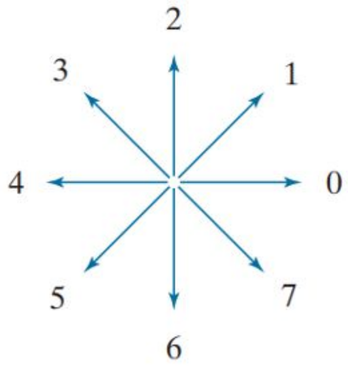
Chain Codes

- Typically, a chain code representation is based on 4- or 8-connectivity of the segments.

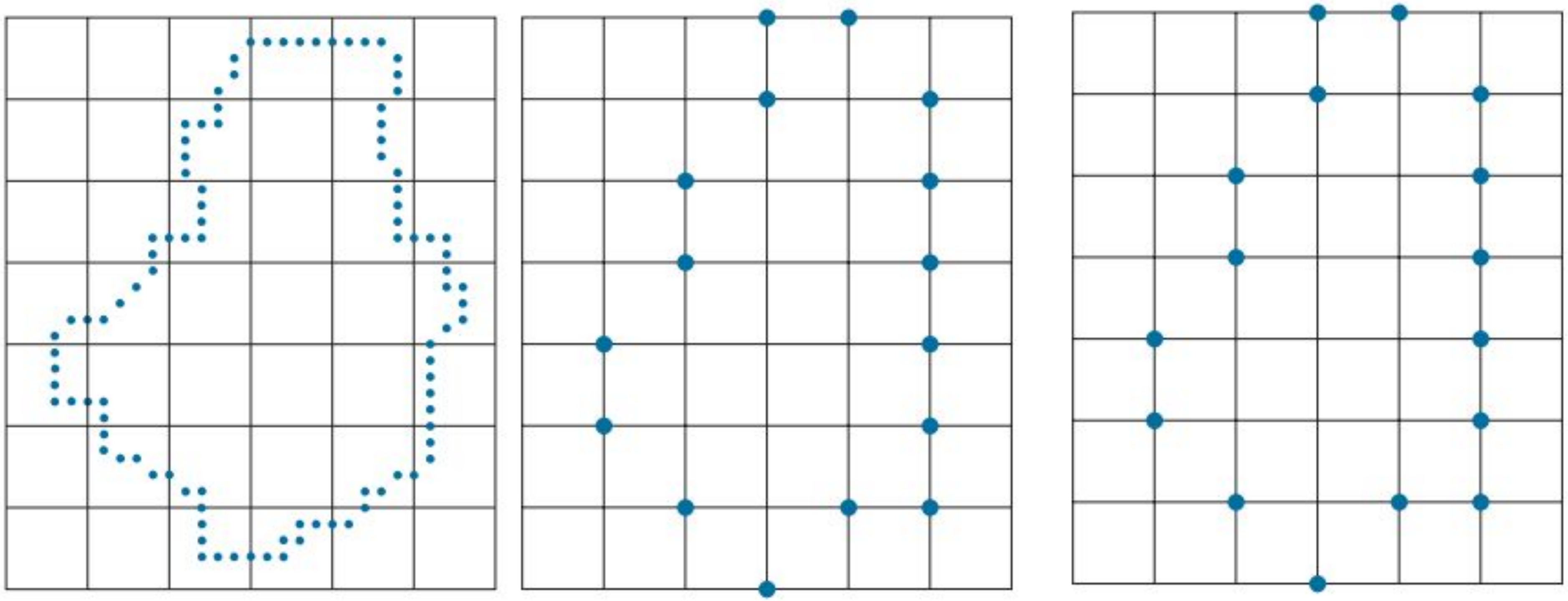
Direction numbers for (a) 4-directional chain code, and (b) 8-directional chain code.



Chain Codes (8 Connectivity)

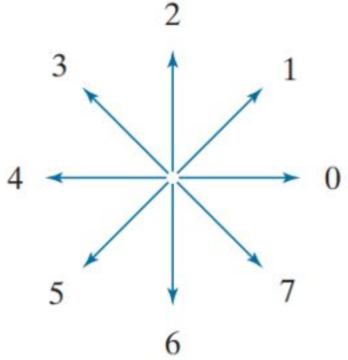


- We fix one starting point and start assigning directions

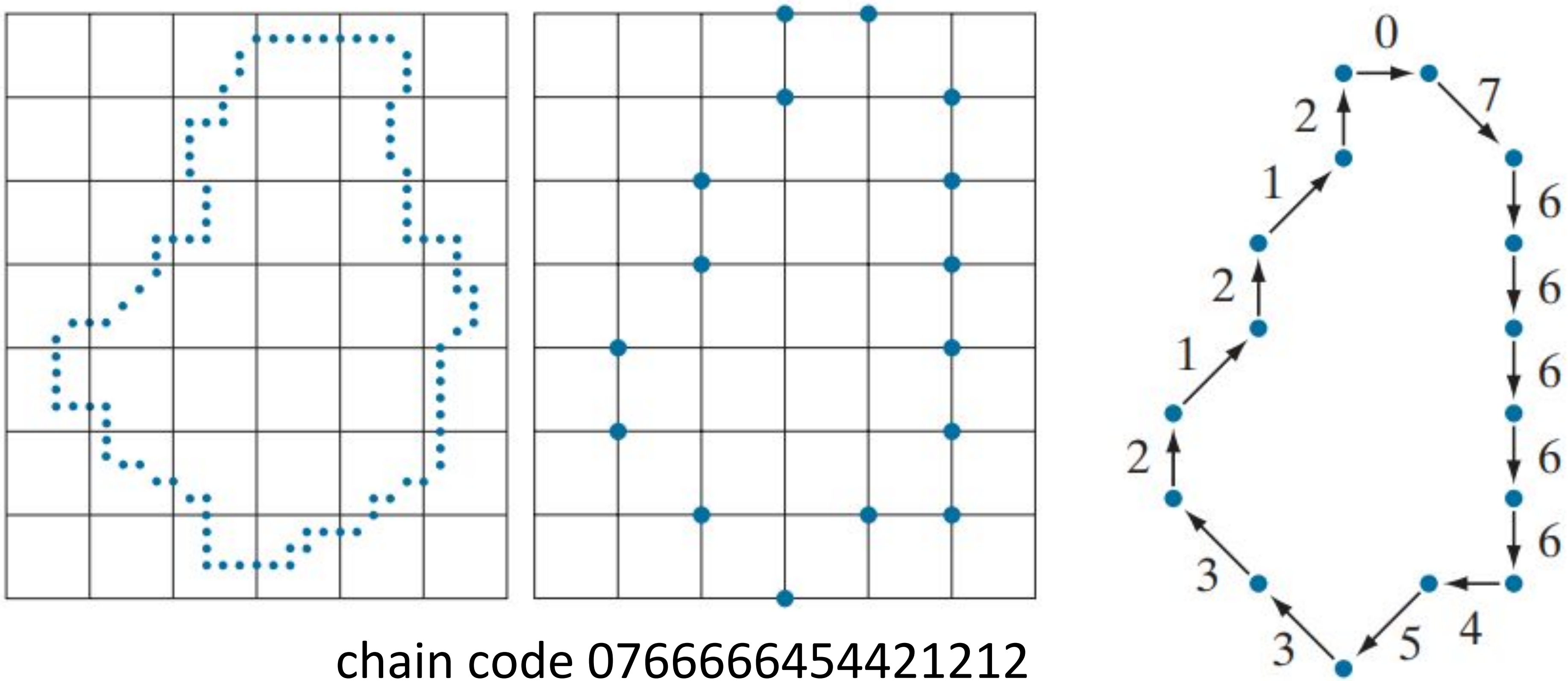


- the spacing of the resampling grid is determined by the application in which the chain code is used.

Chain Codes (8 Connectivity)

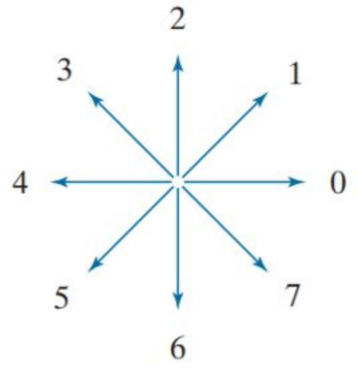


- The numerical value of a chain code depends on the starting point.



chain code 0766666454421212

Chain Codes (8 Connectivity)



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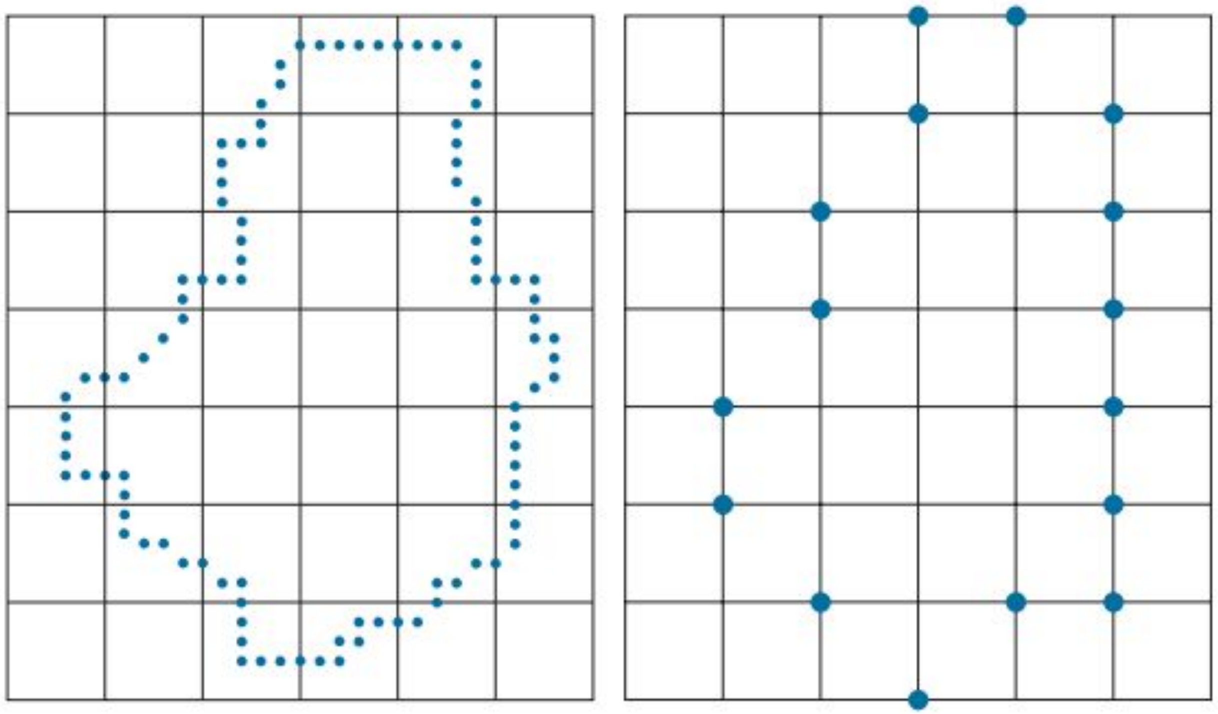
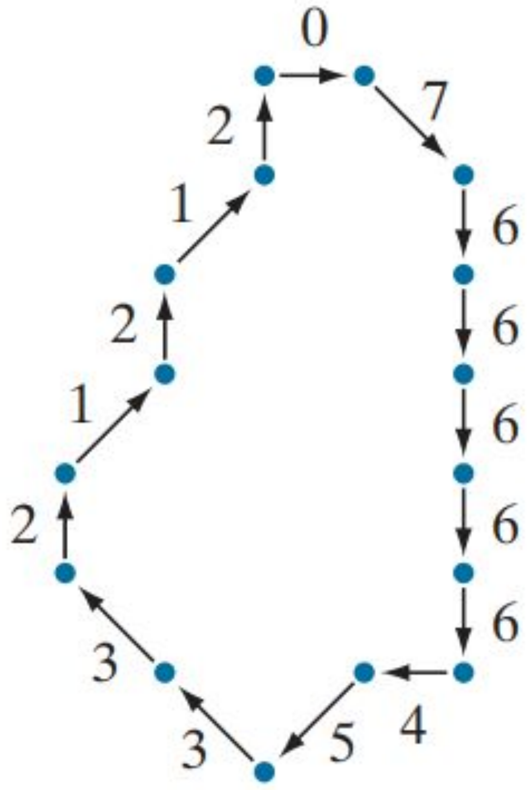
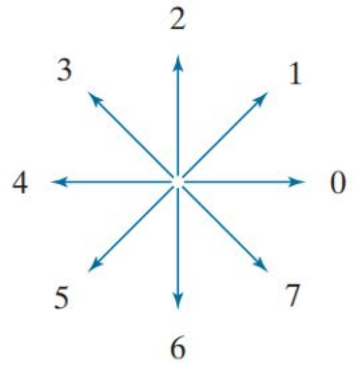




chain code 76666645442121 20

Chain Codes (8 Connectivity)



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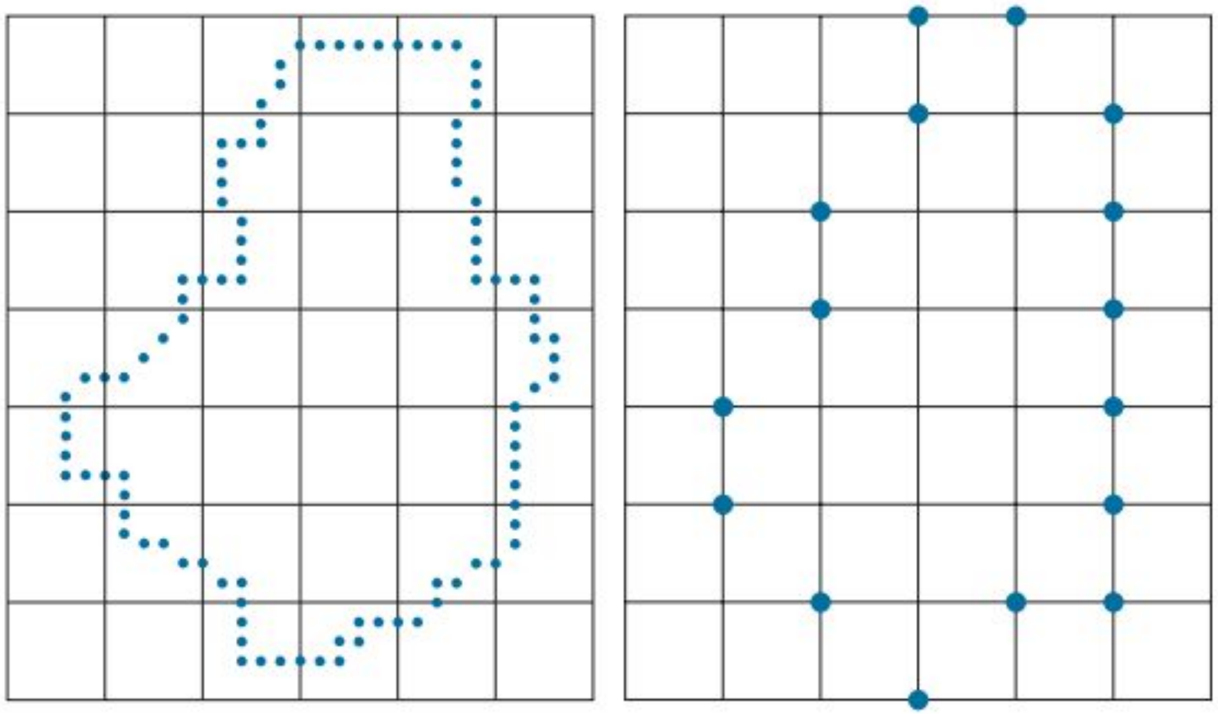
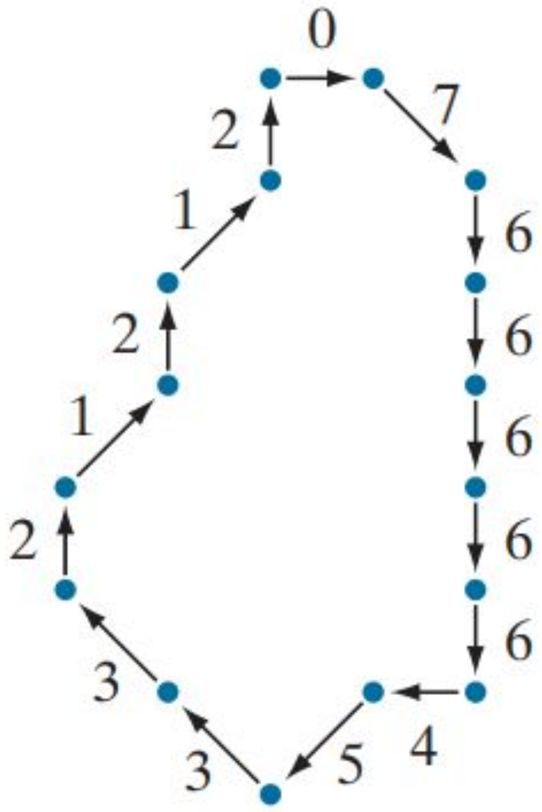




chain code 66666454421212 07

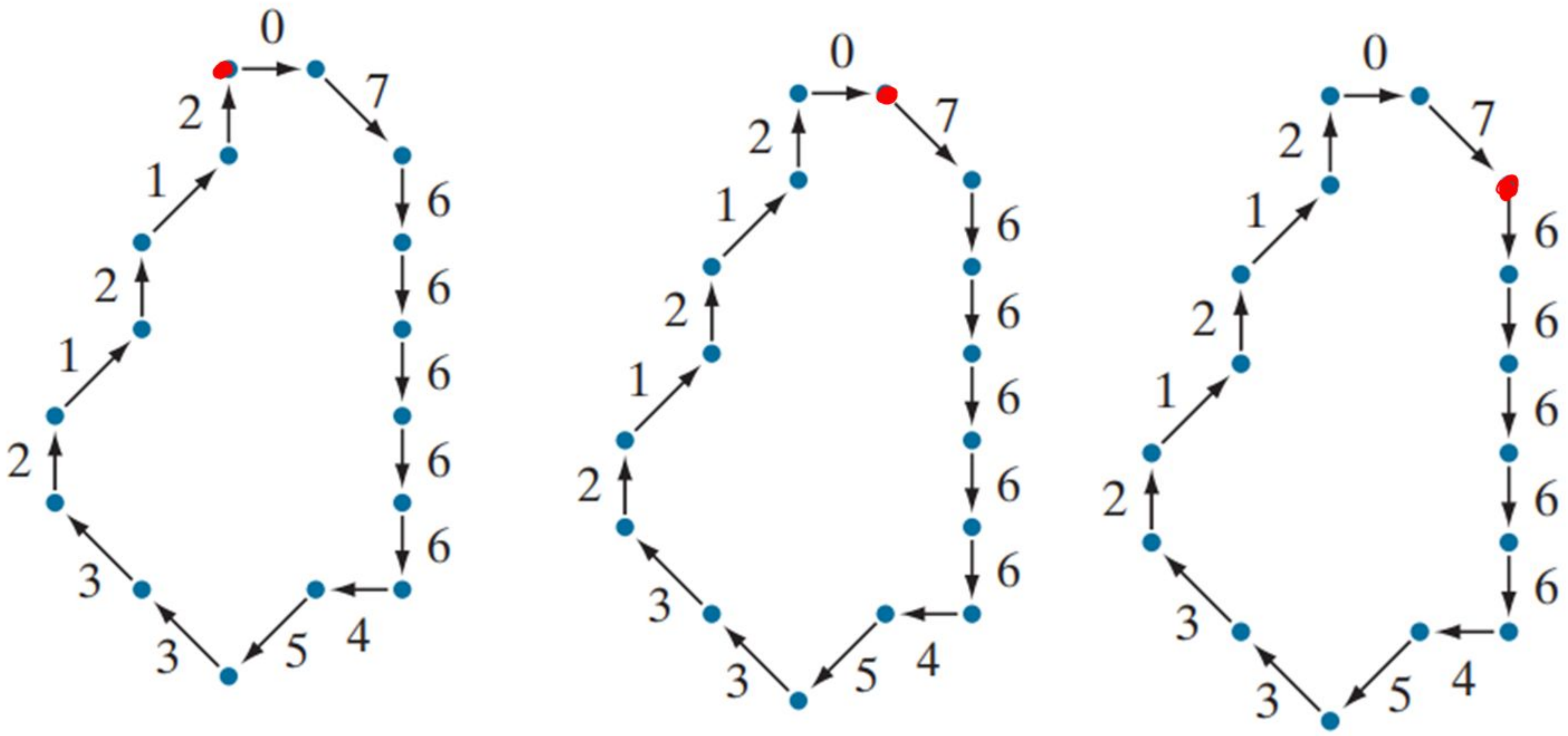
Normalize chain code

The code can be normalized with respect to the starting point by a straightforward procedure:

- We simply treat the chain code as a circular sequence of direction numbers and redefine the starting point so that the resulting sequence of numbers forms an integer of minimum/ maximum magnitude.

Normalize chain code

Form integer of minimum/ maximum magnitude



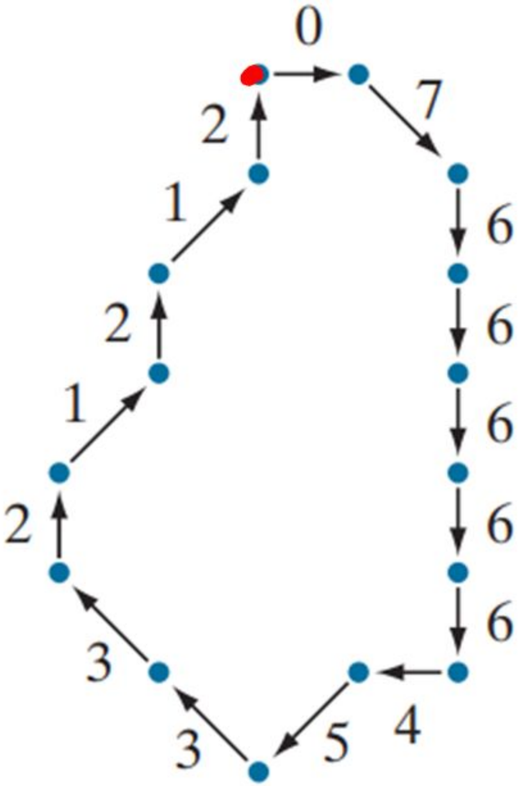
0766666454421212

7666664544212120

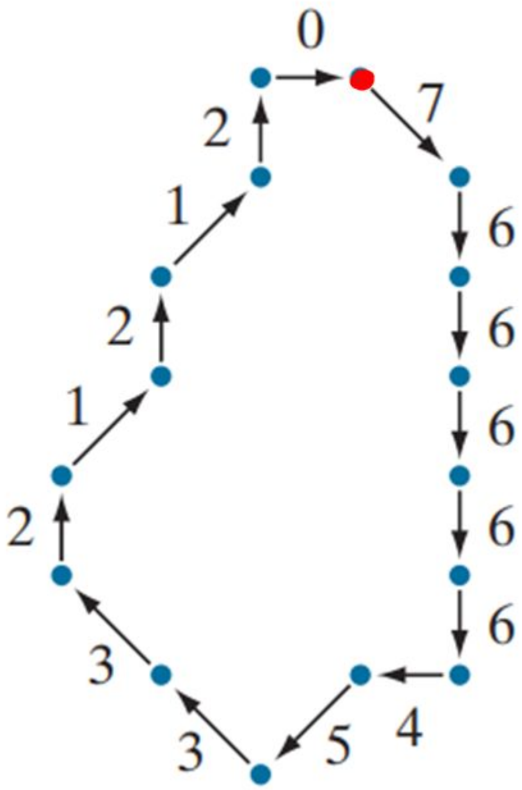
6666645442121207

Normalize chain code

Form integer of minimum/ maximum magnitude



0766666454421212



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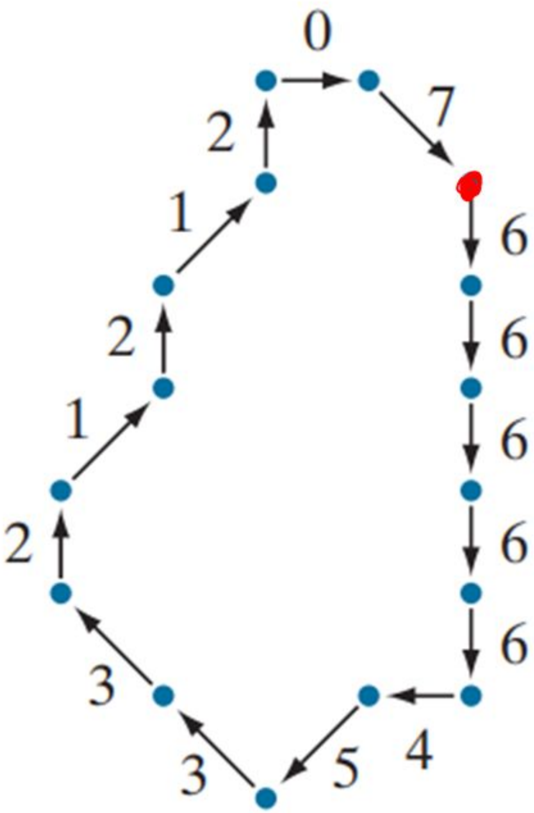
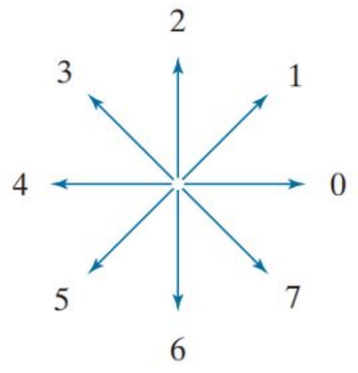
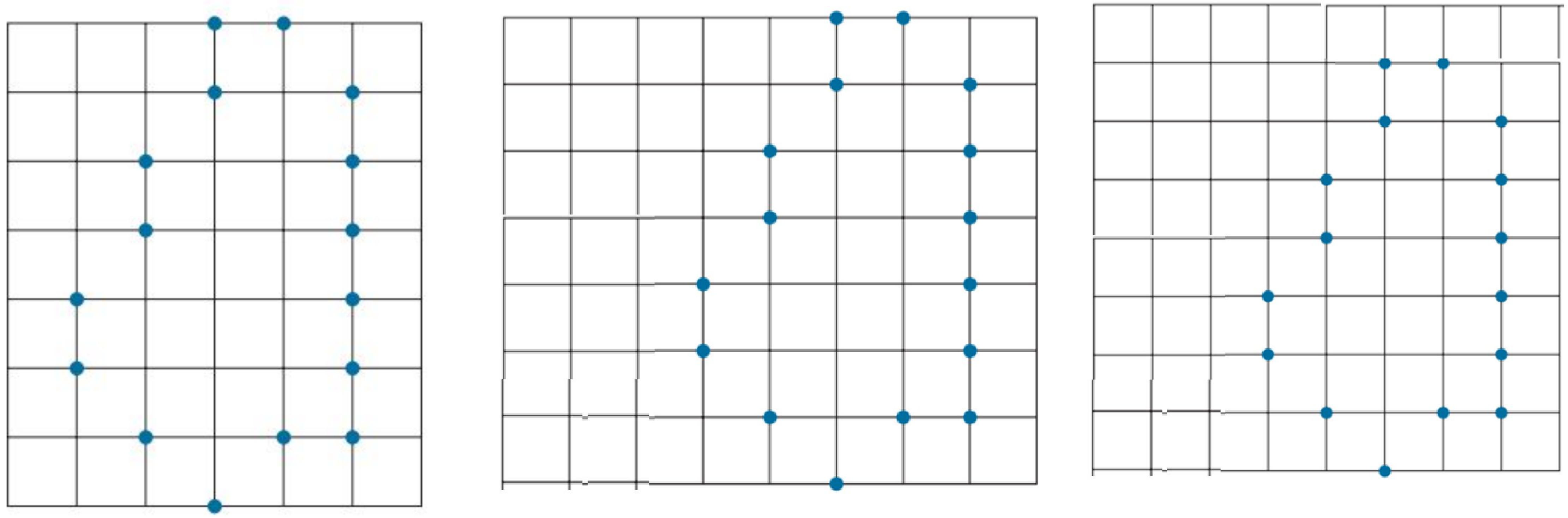


6666645442121207

Chain Codes –Invariant to translation

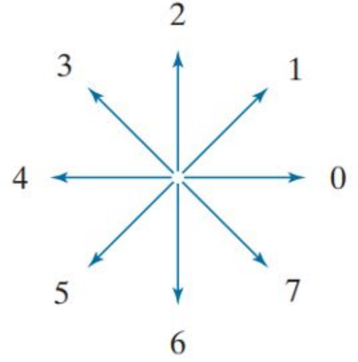


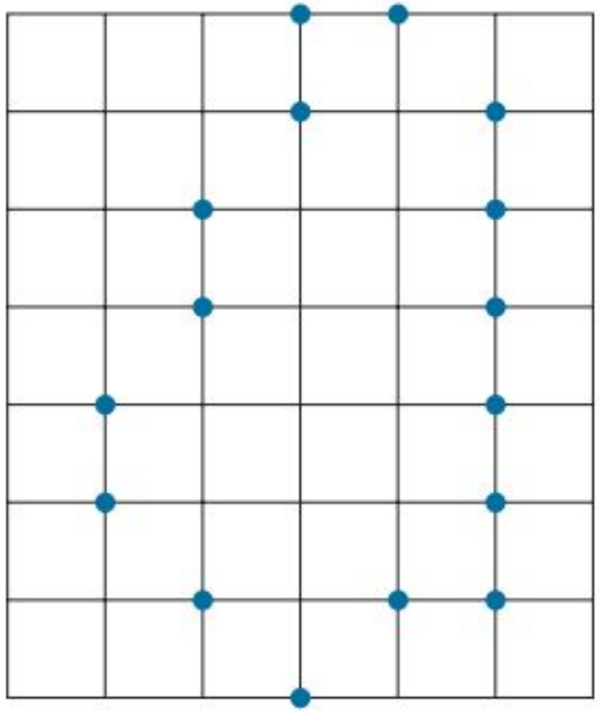
- For the same starting point



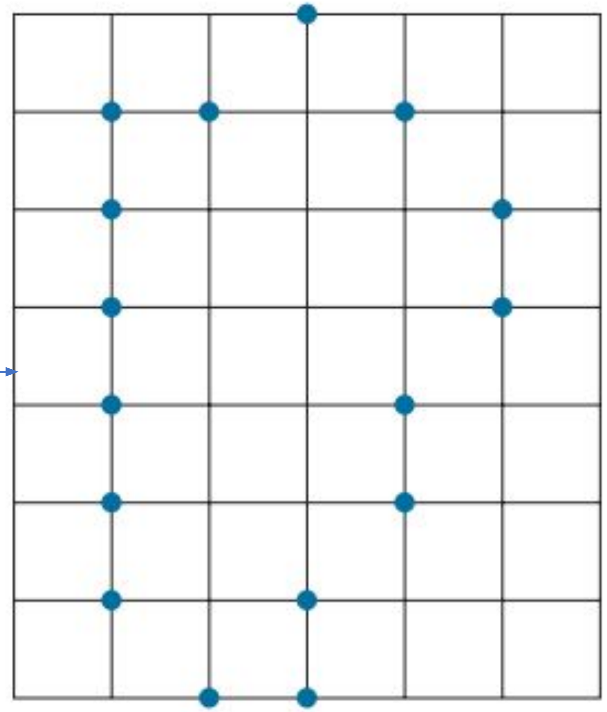
chain code 7666664544212120

Chain Codes and rotation





chain code 0766666454421212



chain code

Properties

- Chain Codes depend upon starting points
- Chain Code are not affected by translations provided the starting point is fixed
- They change if the object is rotated…
- Then how to write a robust feature.

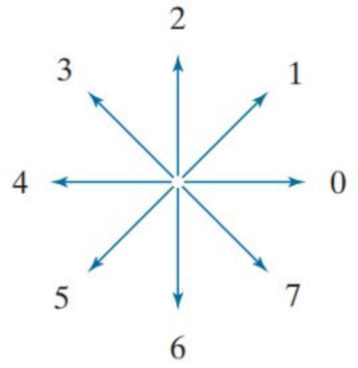
How to write Normalized chain codes?

The code can be normalized with respect to the starting point by a straightforward procedure:

- We simply treat the chain code as a circular sequence of direction numbers and redefine the starting point so that the resulting sequence of numbers forms an integer of minimum magnitude.

- **We can normalize also for rotation** (in angles that are integer multiples of the directions) by using the first difference of the chain code instead of the code itself.

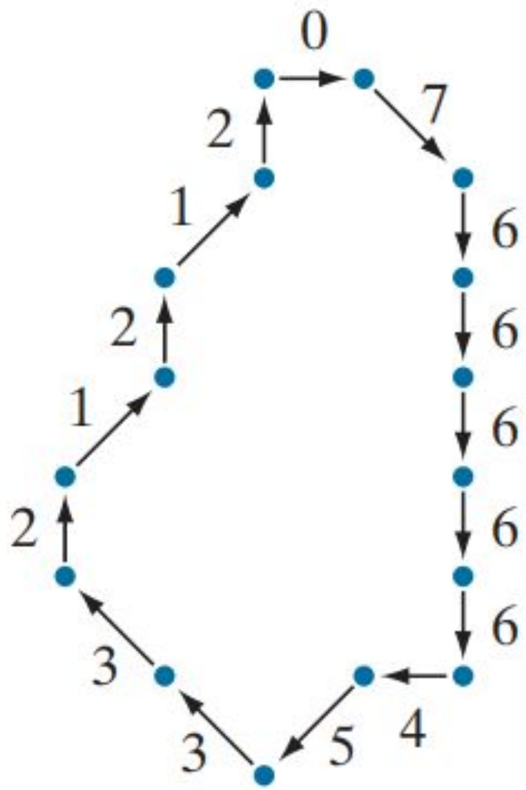
Normalized chain codes



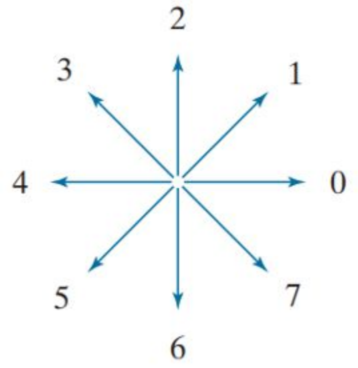
- First Difference of chain code:

This difference is obtained by counting the number of direction changes (in a counterclockwise direction) that separate two adjacent elements of the code.

chain code 0 7 6 6 6 6 6 4 5 4 4 2 1 2 1 2



Normalized chain codes



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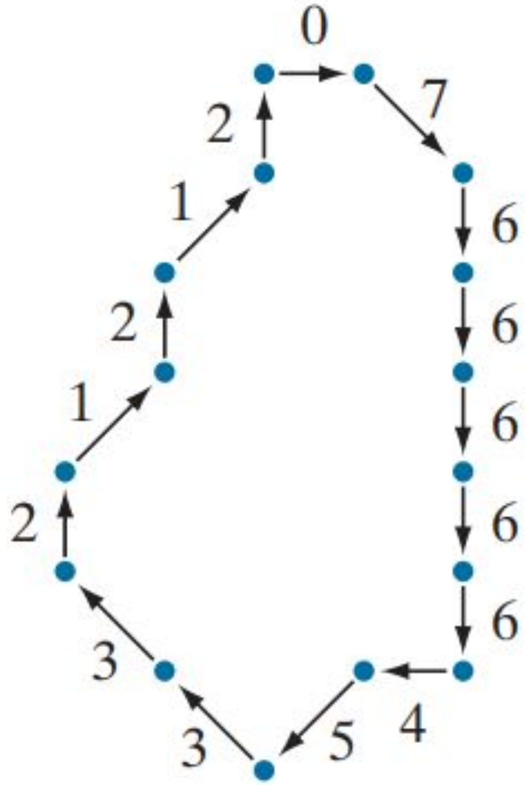
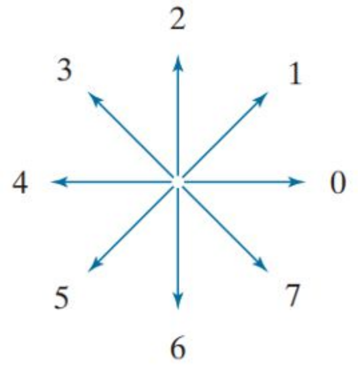


chain code   0 7 6 6 6 6 6 4 5 4 4 2 1 2 1 2

chain code   7 7 0 0 0 0 6 1 7 0 6 7 3 7 1

Normalized chain codes



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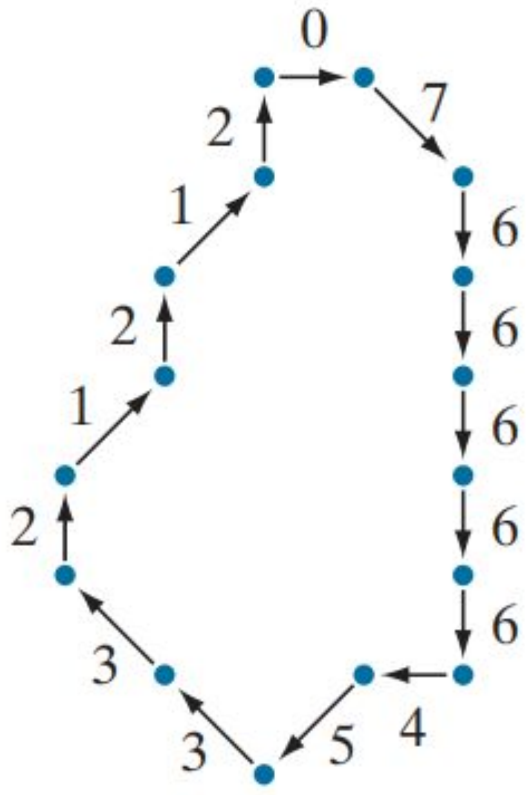
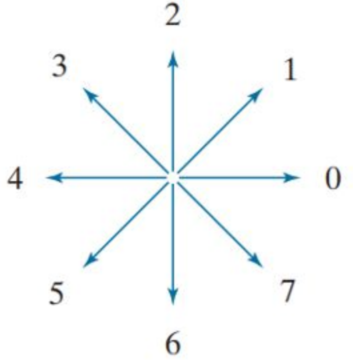
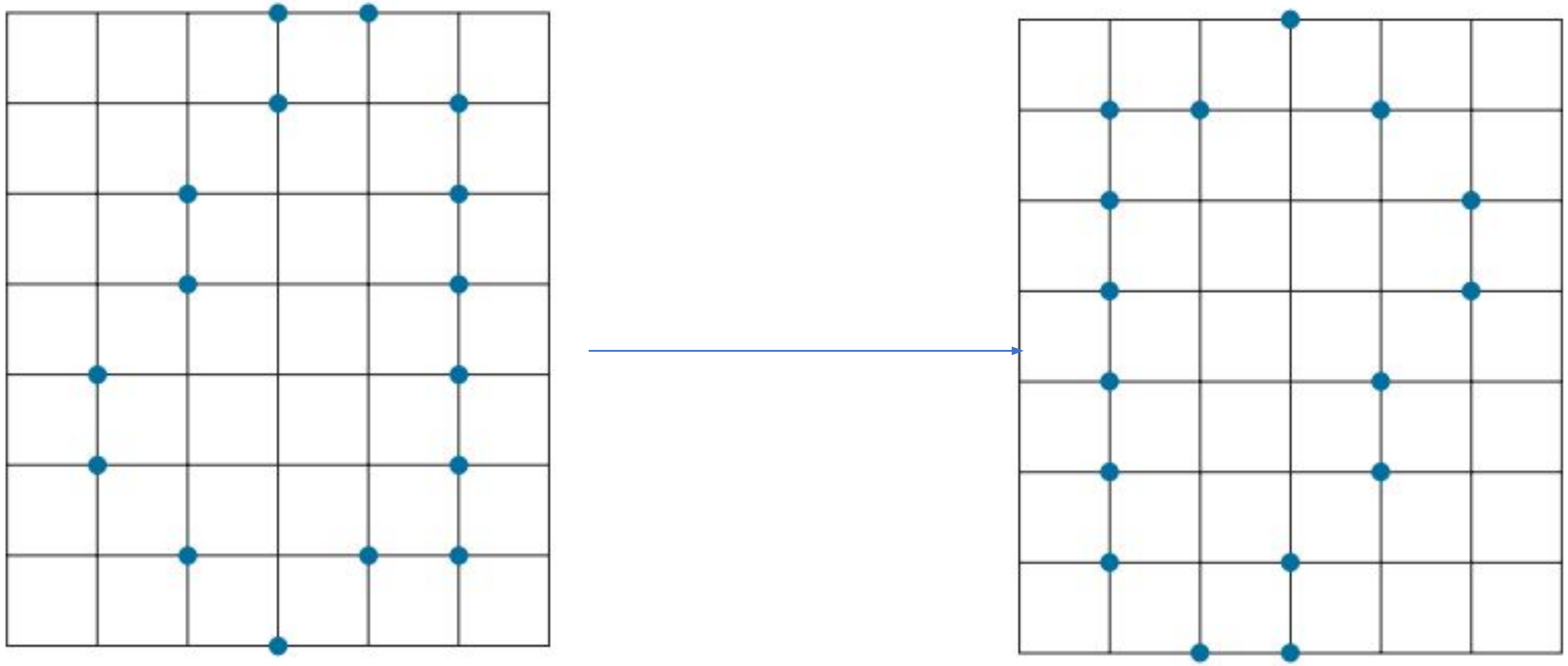


chain code 0 7 6 6 6 6 6 4 5 4 4 2 1 2 1 2

chain code 6 7 7 0 0 0 0 6 1 7 0 6 7 3 7 1

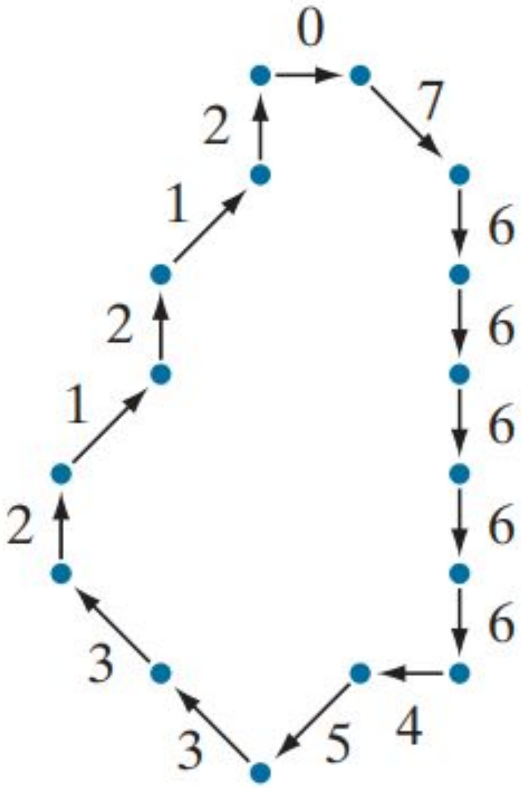
Chain Codes and rotation



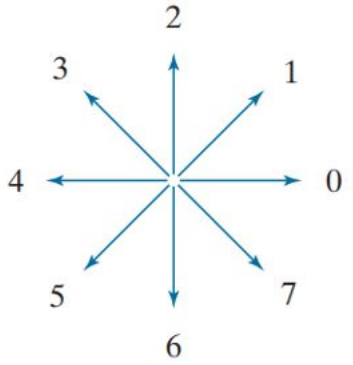


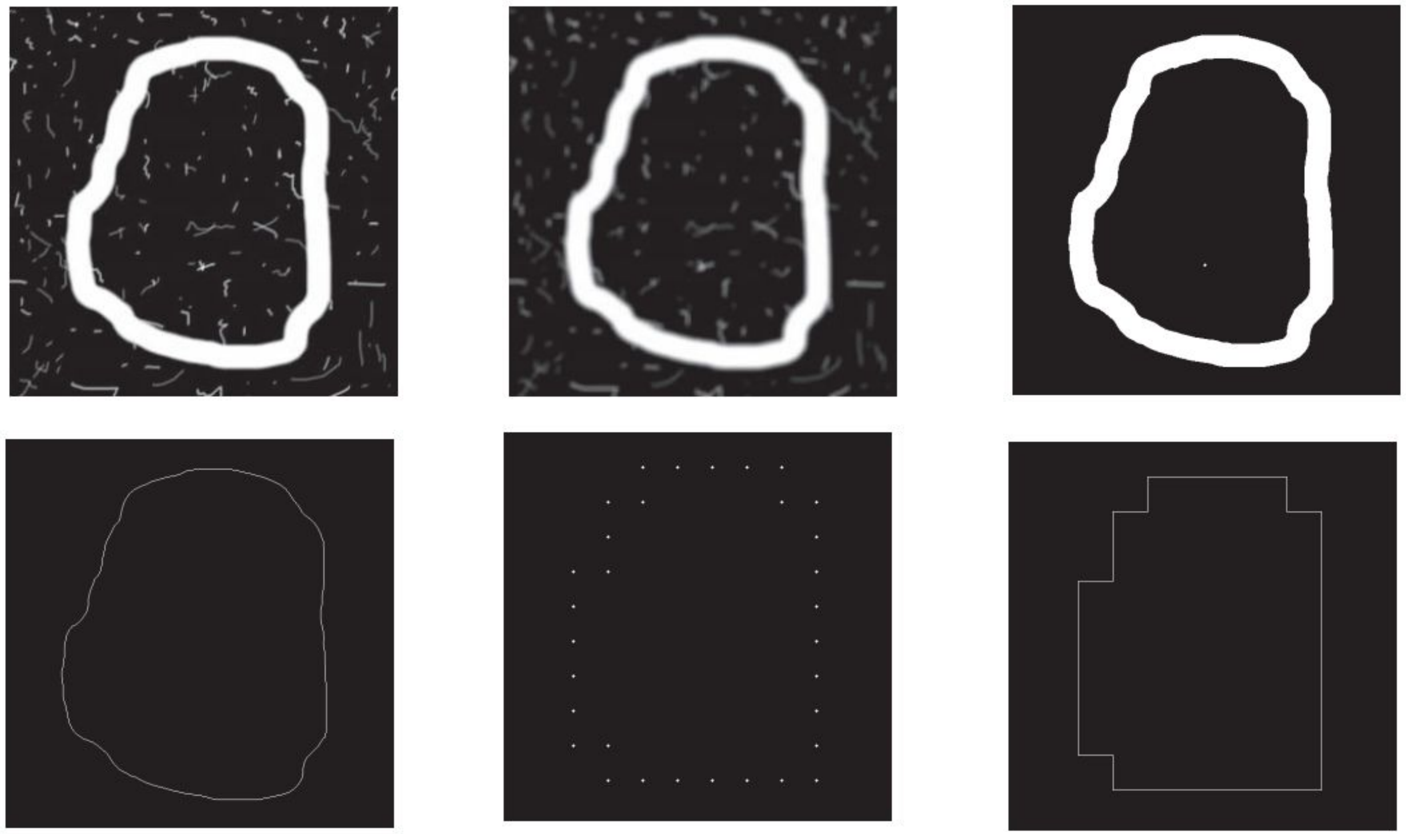
chain ccode:

chain code


0
7
2
6
1
6
2
6
1
6
2
6
3
4
3
5

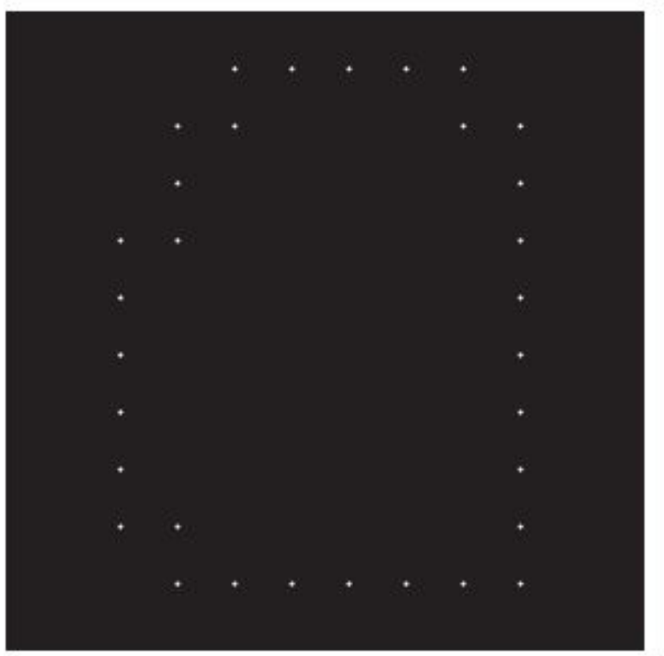
Application of freeman chain code

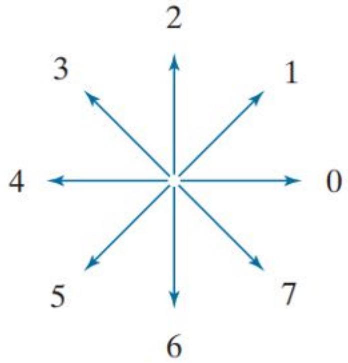




Application of freeman chain code

- Take simplified boundary





SHAPE NUMBERS

- The shape number of a Freeman chain-coded boundary is defined as the **first difference of smallest magnitude**.
- Again rearranged to form smallest magnitude number using **circular shift**
- The order, n, of a shape number is defined as the number of digits in its representation.
- Moreover, n is even for a closed boundary, and its value limits the number of possible different shapes

Shape Numbers

- Four connectivity

	Order 4	Order 6
Chain code:	0 3 2 1	0 0 3 2 2 1
Difference:	3 3 3 3	3 0 3 3 0 3
Shape no.:	3 3 3 3	0 3 3 0 3 3