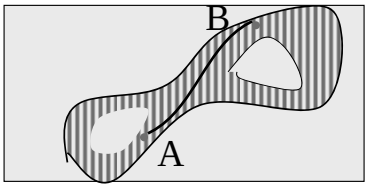
Multiple Objects

Need to SEGMENT image into separate COMPONENTS (regions).

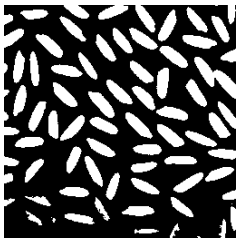
Connected Component:

Maximal Set of Connected Points:

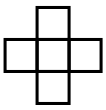


Points A and B are connected: Path exists between A and B along which b(x,y) is constant.

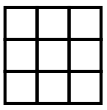
Connected Components



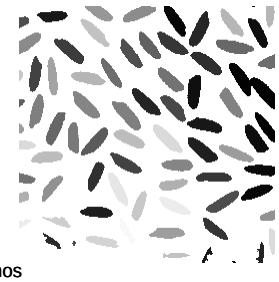
Label all pixels that are connected



4-way connected



8-way connected



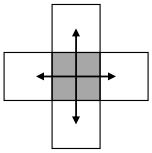
Region Growing Algorithm (Connected Component Labeling)

- Start with “seed” point where bij=1.
- Assign LABEL to seed point.
- Assign SAME LABEL to its NEIGHBORS (b=1).
- Assign SAME LABEL to NEIGHBORS of NEIGHBORS.

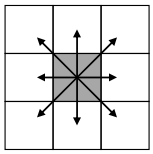
Terminates when a component is completely labeled. Then pick another UNLABELED seed point.

What do we mean by NEIGHBORS?

Connectedness



4-Connectedness (4-c)

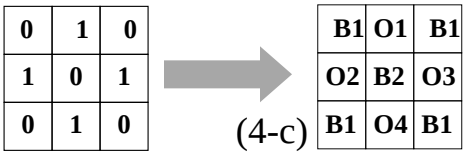


8-Connectedness (8-c)

Neither is perfect!

What do we mean by NEIGHBORS?

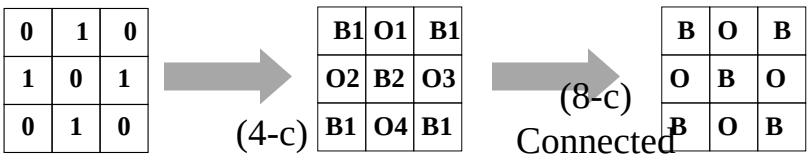
Jordan's Curve Theorem: Closed curve -> 2 connected regions



Hole without closed curve!

What do we mean by NEIGHBORS?

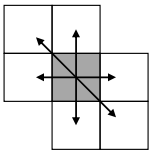
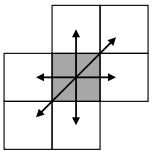
Jordan's Curve Theorem: Closed curve -> 2 connected regions



Hole without closed curve!

Connected background with closed ring!

Solution: Introduce Assymetry

Use:  or 

(a) (b)

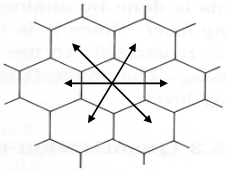
Using (a)

0	1	0
1	0	1
0	1	0

B	O1	B
O2	B	O1
B	O2	B

Two separate line segments.

Hexagonal Tesselation



Above assymetry makes SQUARE grid like HEXAGONAL grid.

Sequential Labeling Algorithm

D	B
C	A

Raster Scan →

Note: B,C,D are already labeled

Sequential Labeling Algorithm

D	B
C	A

Raster Scan →

Note: B,C,D are already labeled

a.

X	X
X	0

Label(A) = background

b.

D	X
X	1

Label(A) = label(D)

Sequential Labeling Algorithm

D	B
C	A

Raster Scan →

Note: B,C,D are already labeled

c.

0	0
C	1

Label(A) = label(C)

d.

0	B
0	1

Label(A) = label(B)

d.

0	B
C	1

If Label(B) = label(C), then Label(A)=Label(B)= Label(C)

Sequential Labeling Algorithm

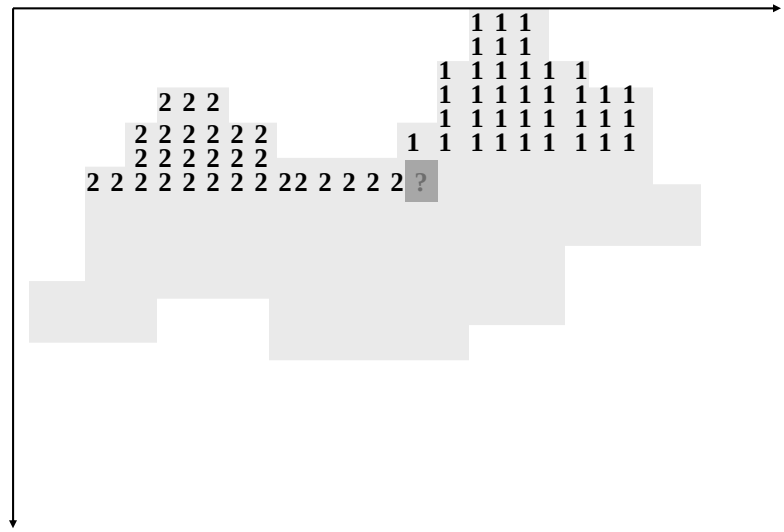
	D B	Raster Scan →
	C A	Note: B,C,D are already labeled
a.	X X X 0	Label(A) = background
b.	D X X 1	Label(A) = label(D)
c.	0 0 C 1	Label(A) = label(C)
d.	0 B 0 1	Label(A) = label(B)
d.	0 B C 1	If Label(B) = label(C), then Label(A)=Label(B)= Label(C)

Sequential Labeling (Cont.)

What if B & C are labeled but label(B) $\neq$ label(C) ?

Sequential Labeling (Cont.)

What if B & C are labeled but label(B) ≠ label(C) ?



Sequential Labeling (Cont.)

Solution: Let: Label(A)=Label(B) =2
& create an EQUIVALENCE TABLE.

Resolve Equivalences in SECOND PASS.

2 ≡ 1
7 ≡ 3,6,4
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