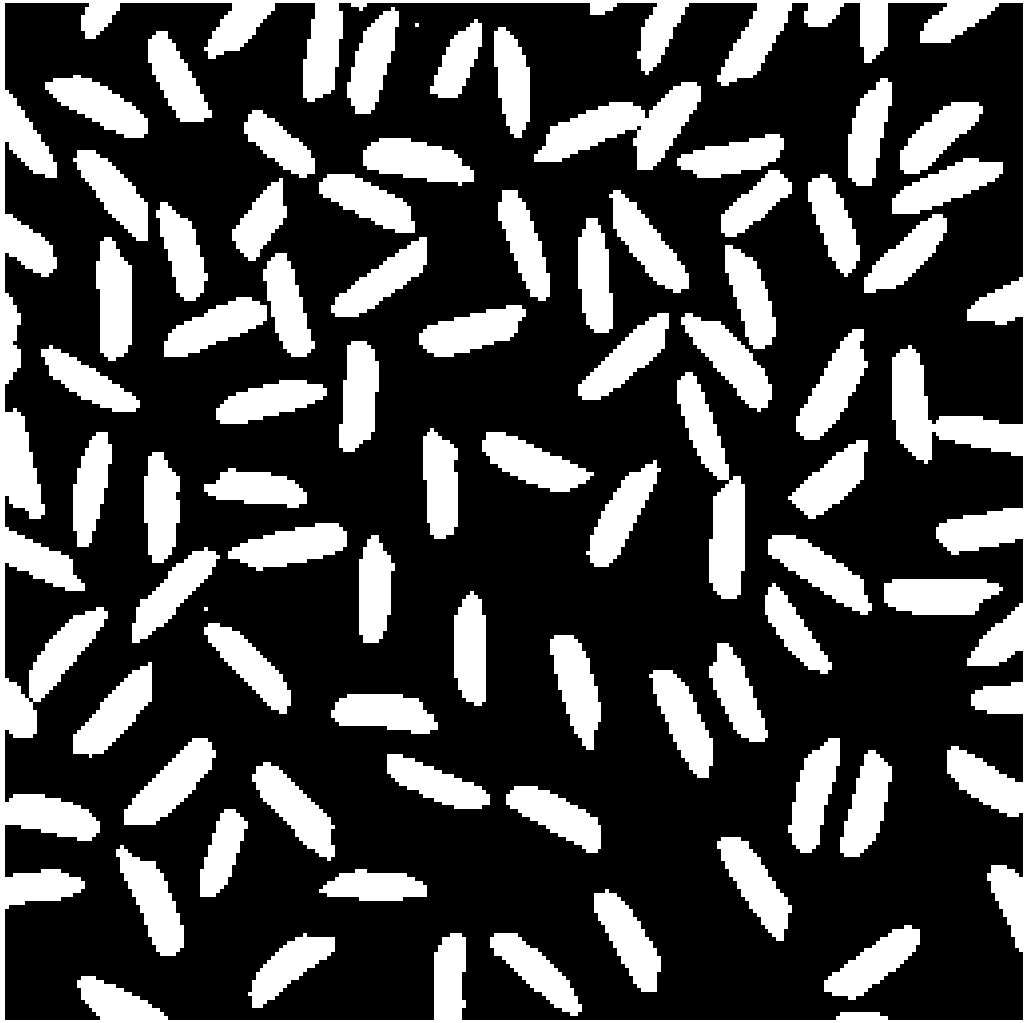
二值图像处理
BINARY IMAGE PROCESSING

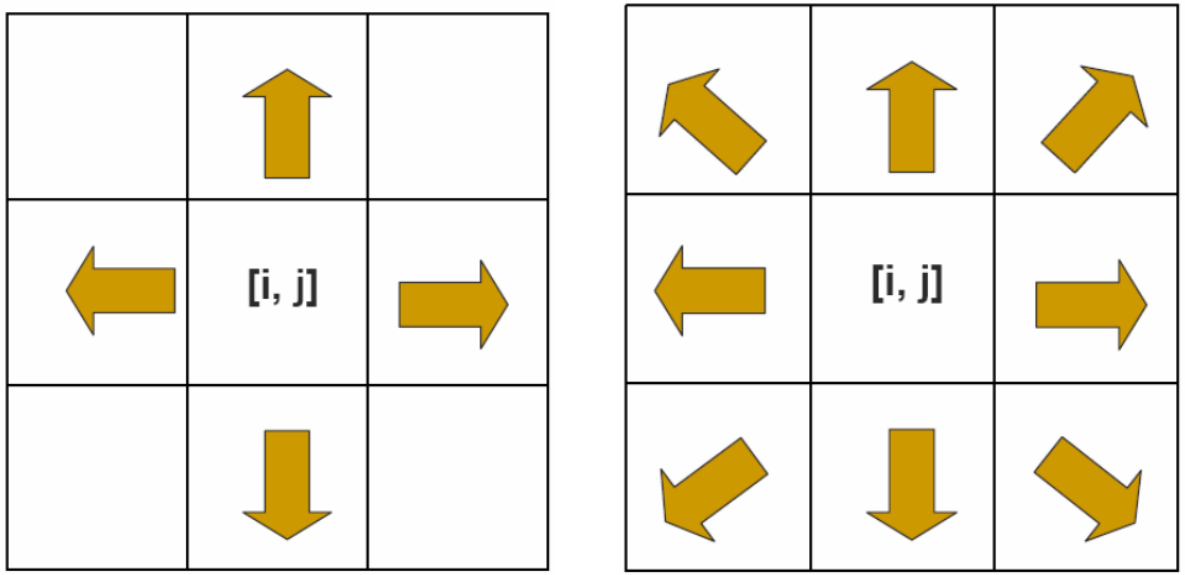


距离与邻域(Distance & Neighbors)

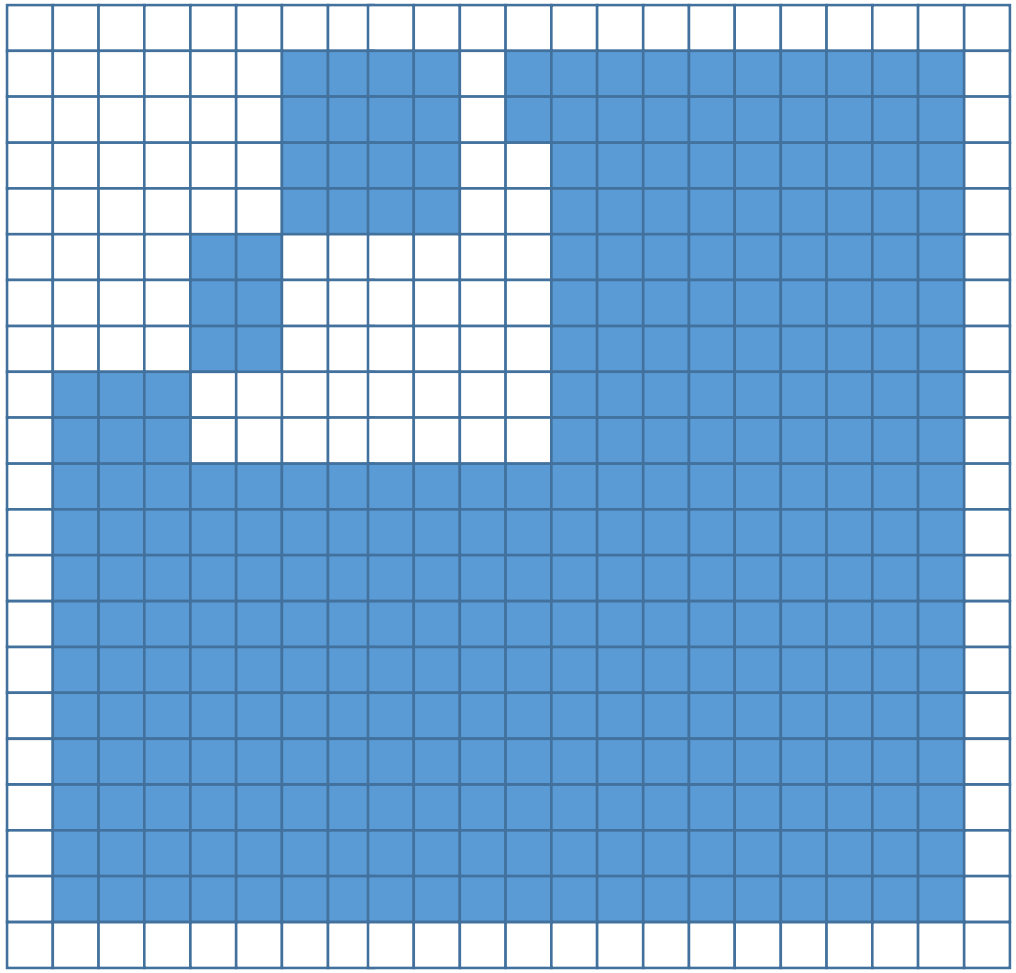
$$d_4 = |\Delta x| + |\Delta y|$$

$$d_8 = \max(|\Delta x|, |\Delta y|)$$

$$d = \sqrt{(\Delta x)^2 + (\Delta y)^2}$$



连通性（Connectness）

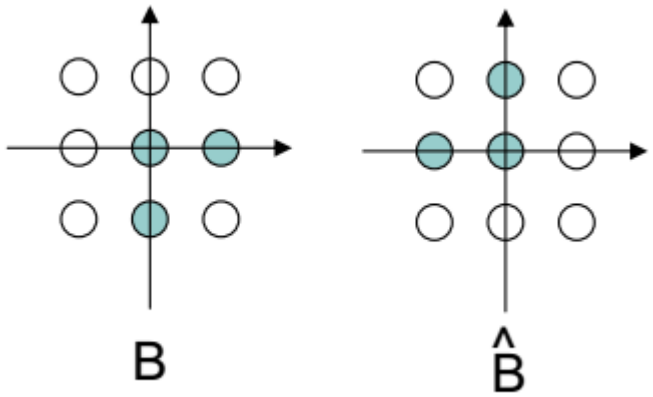


平移　Translation Operator

$$(A)_z = \{w \mid w = a + z, a \in A\}$$

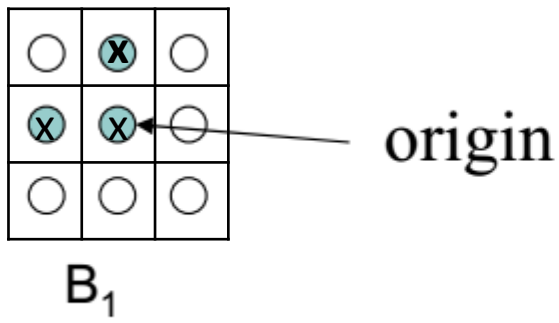
镜像　Reflection Operator

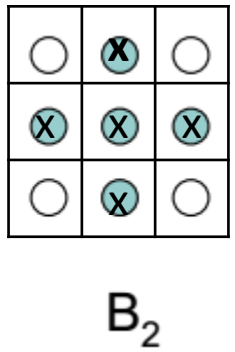
$$\hat{B} = \{w \mid w = -b, b \in B\}$$



形态学滤波器 Morphological filtering

结构元 Structuring Element B

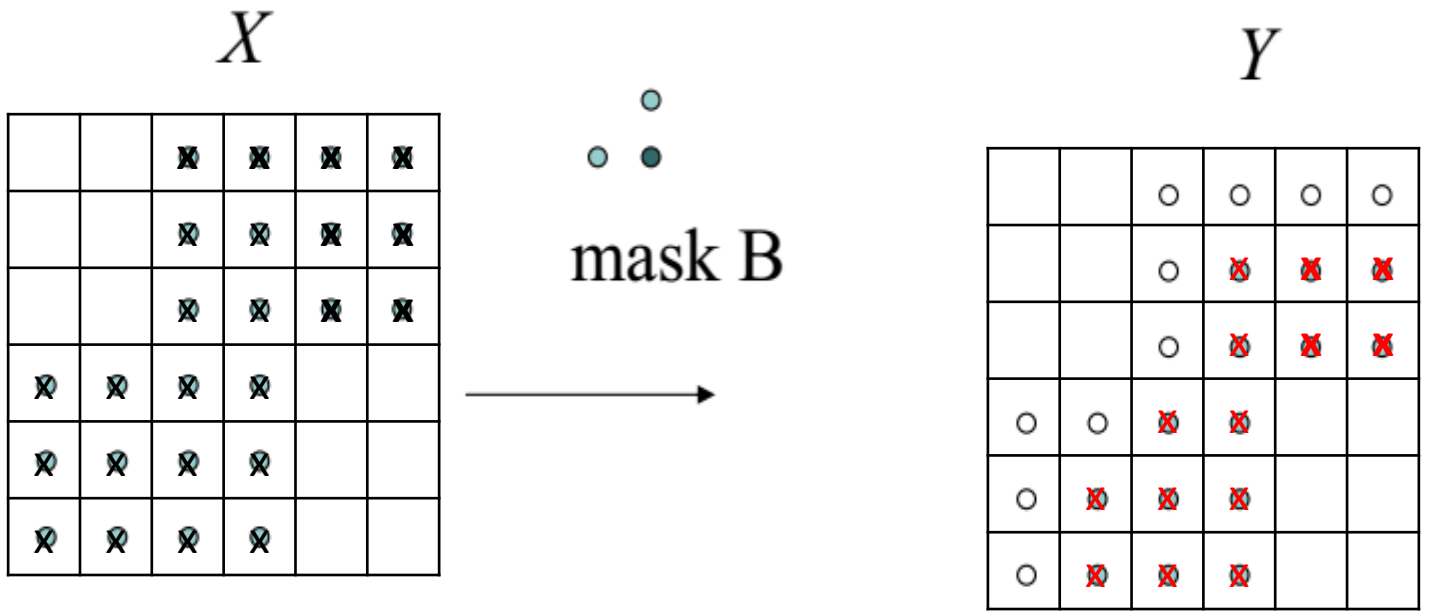




腐蚀 Erosion

$$Y = X \ominus B = \{x : B_x \subset X\}$$

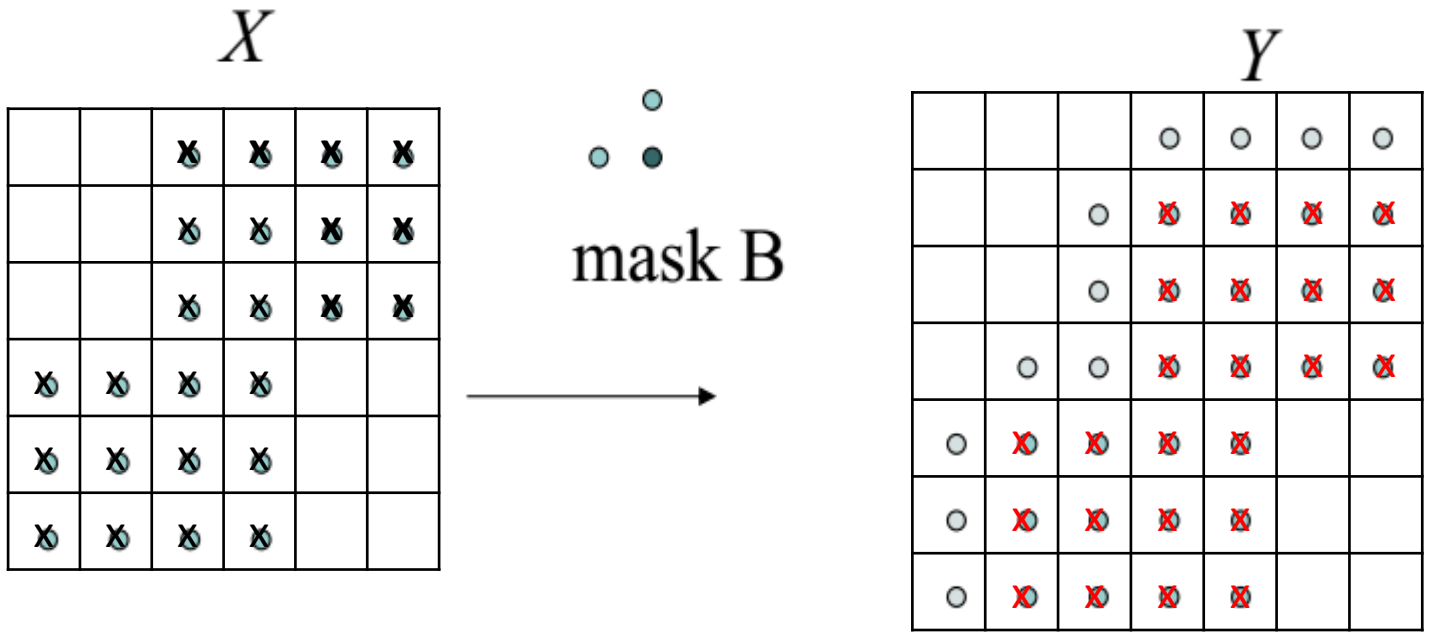
min(X, B)



扩张 Dilation

$$Y = X \oplus B = \{z \mid (\hat{B})_z \cap X \neq \phi\}$$

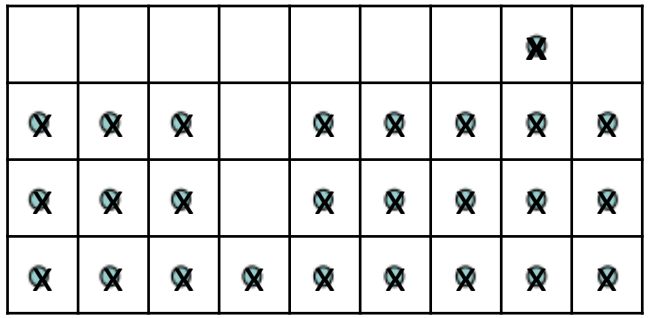
$\max(X, \hat{B})$



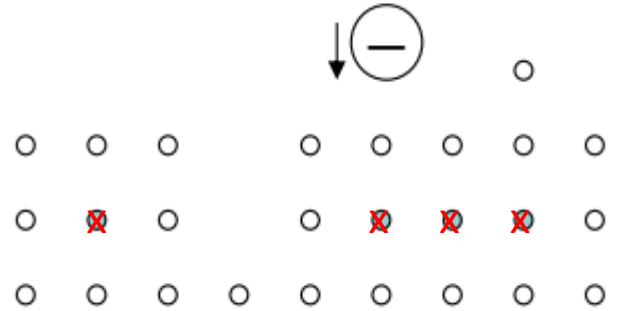
开运算 Opening Operator

$$X \circ B = (X \ominus B) \oplus B$$

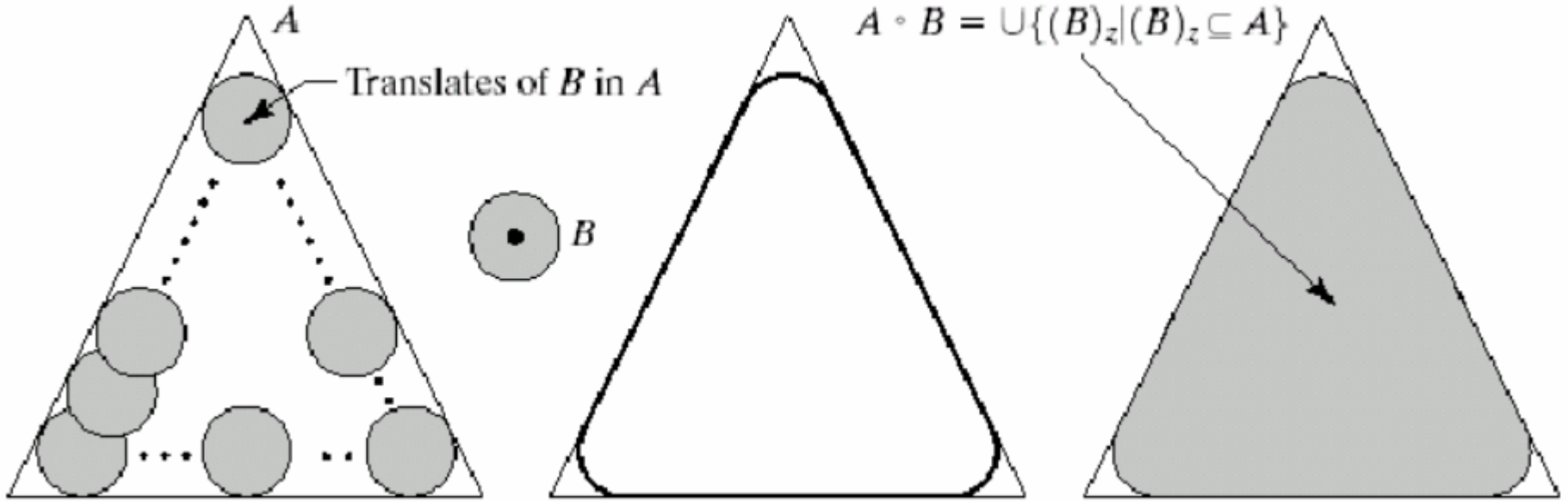
X



B



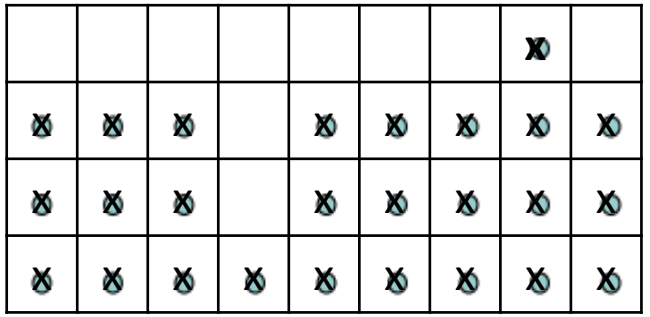
$X \circ B$


A
Translates of B in A
B
$A \circ B = \cup\{(B)_z | (B)_z \subseteq A\}$

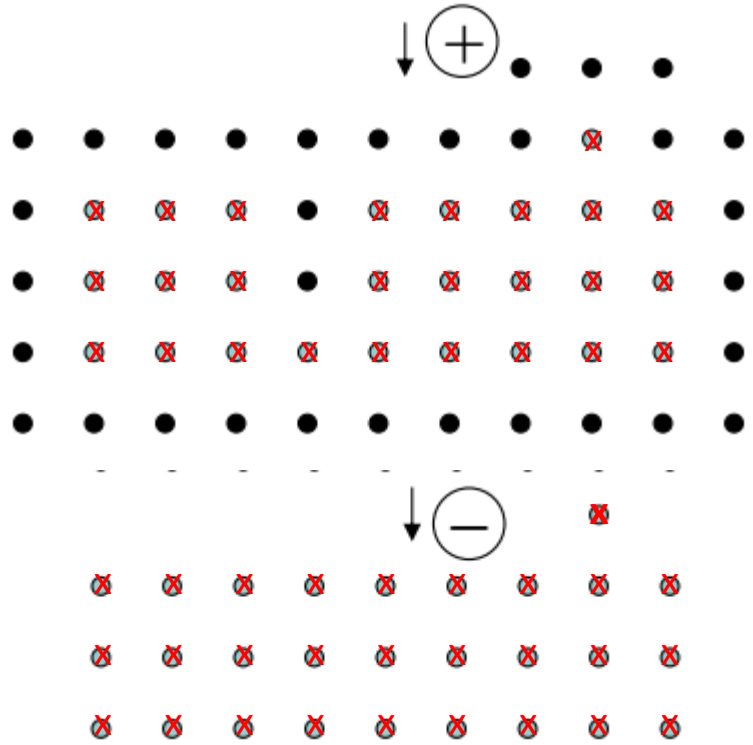
闭运算 Closing Operator

$$X \bullet B = (X \oplus B) \ominus B$$

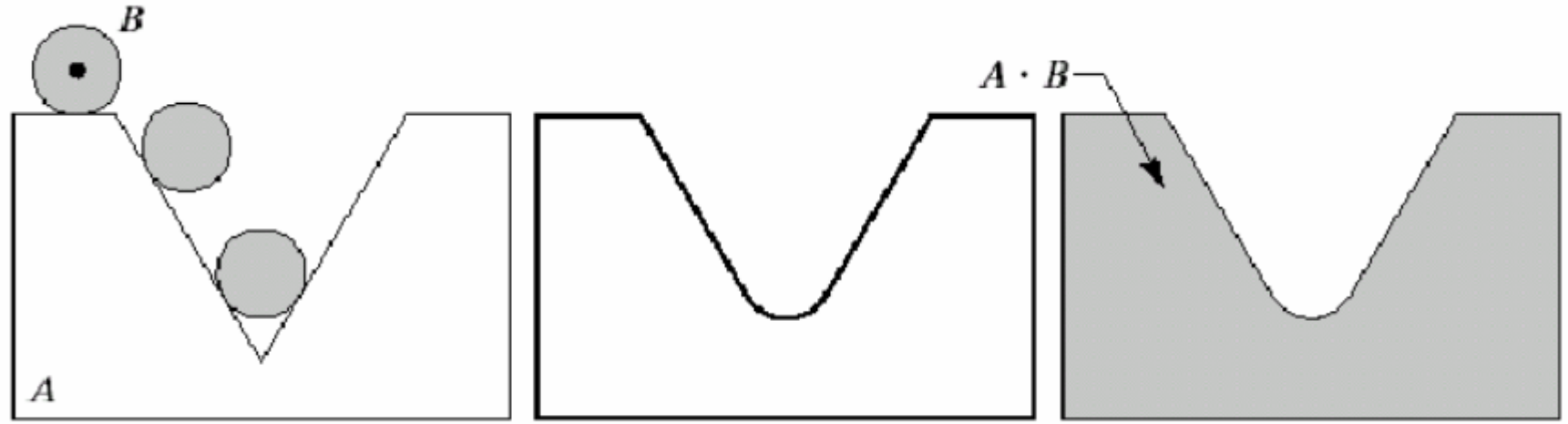
X



B

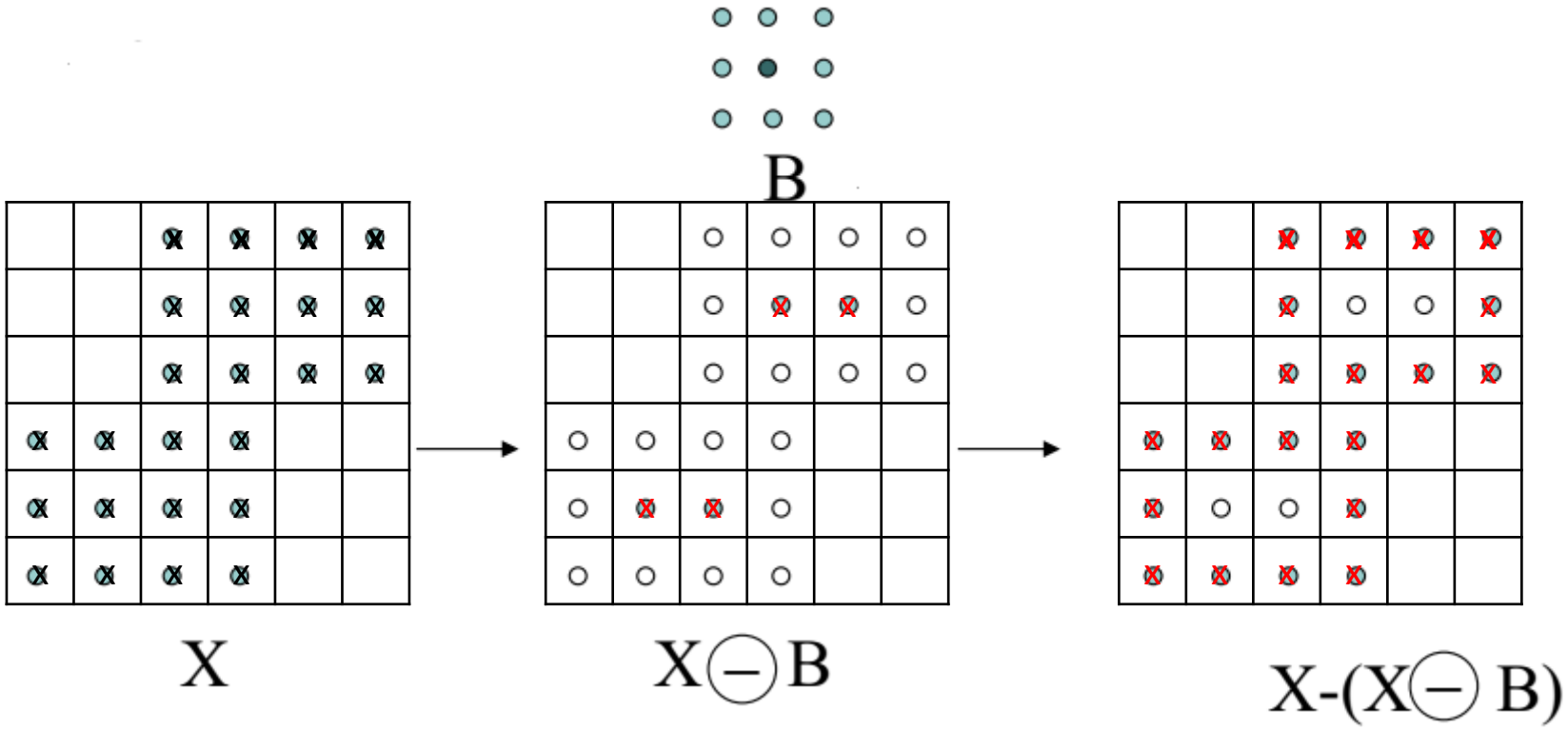


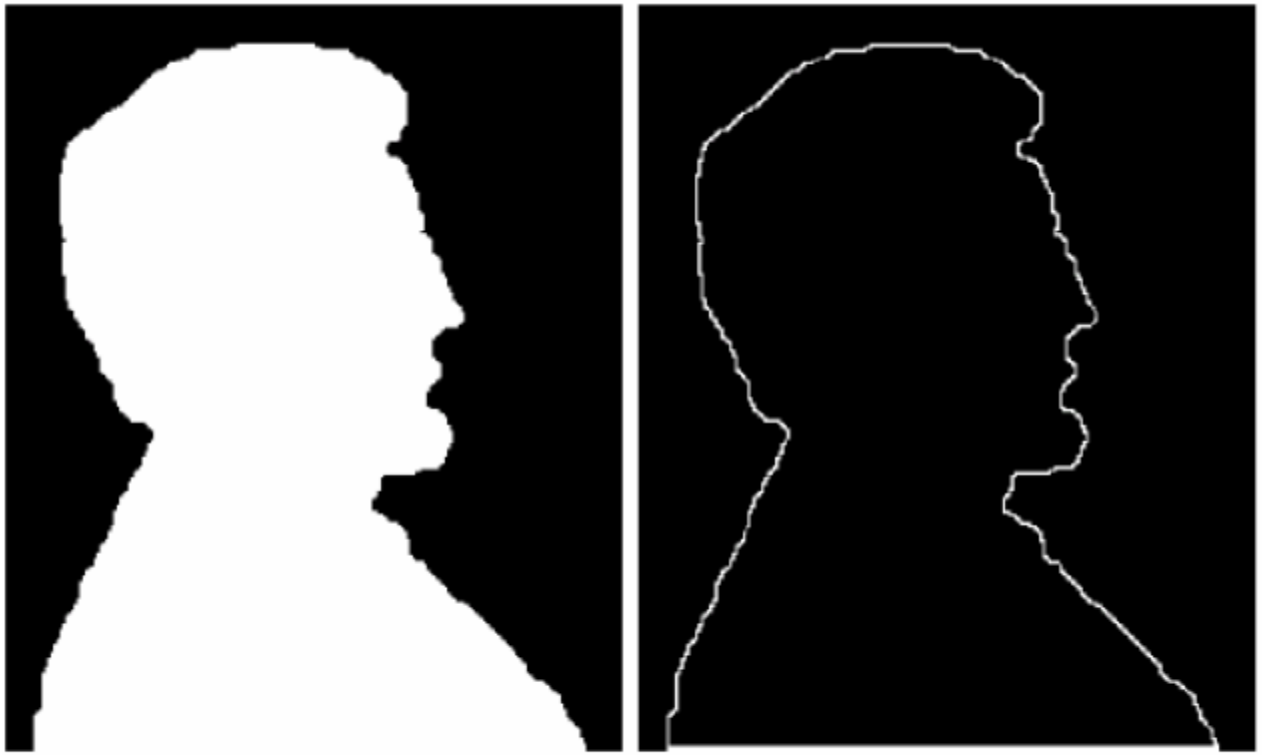
$X \bullet B$


B
A
A · B

边界提取 Boundary Extraction Operator

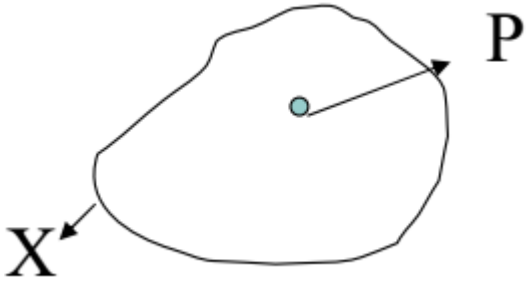
$$\partial X = X - (X \ominus B)$$





X ∂X

区域填充 Region Filling Operator

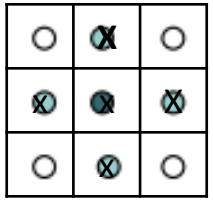


Iterations:

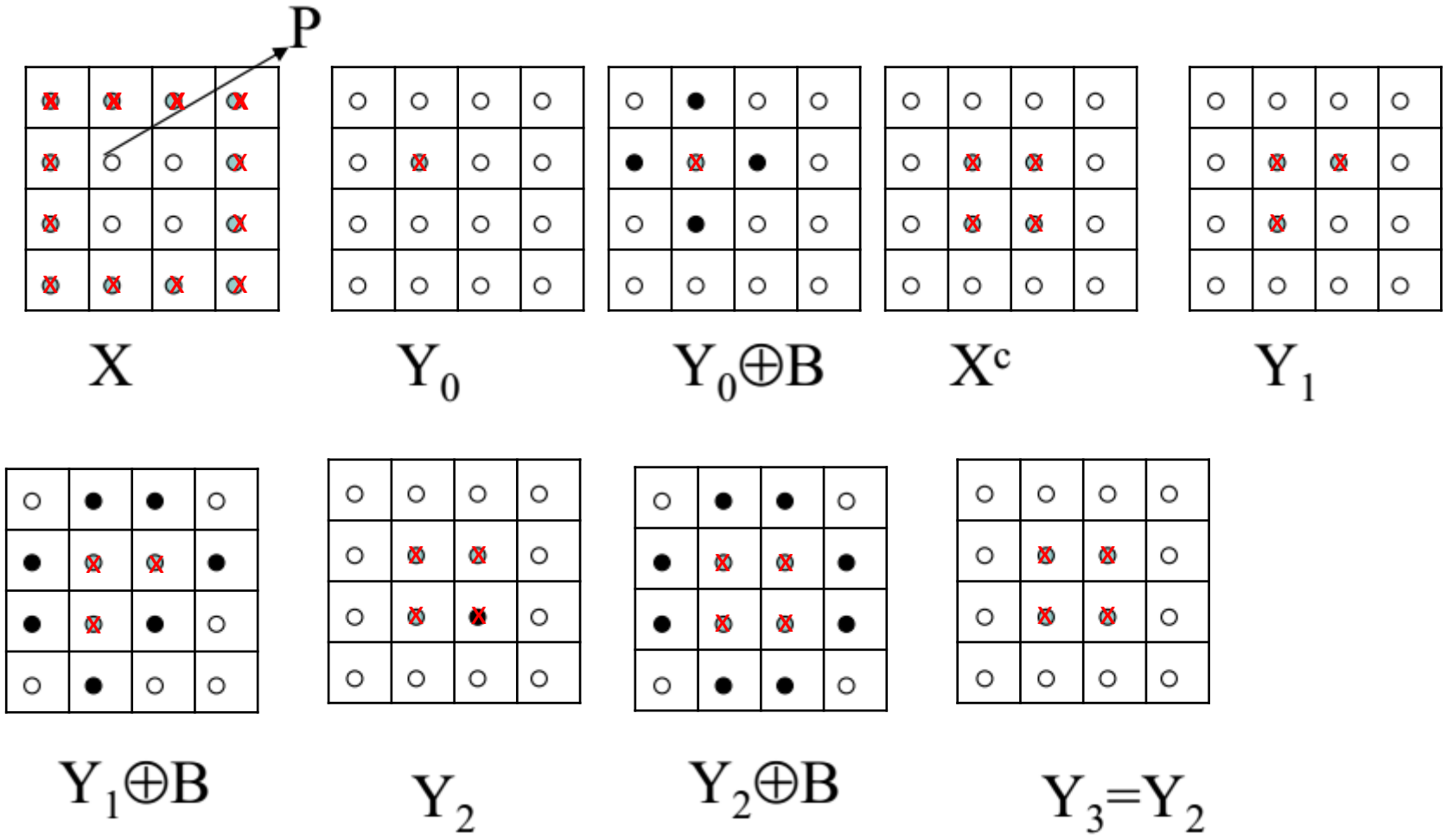
$Y_0=P$

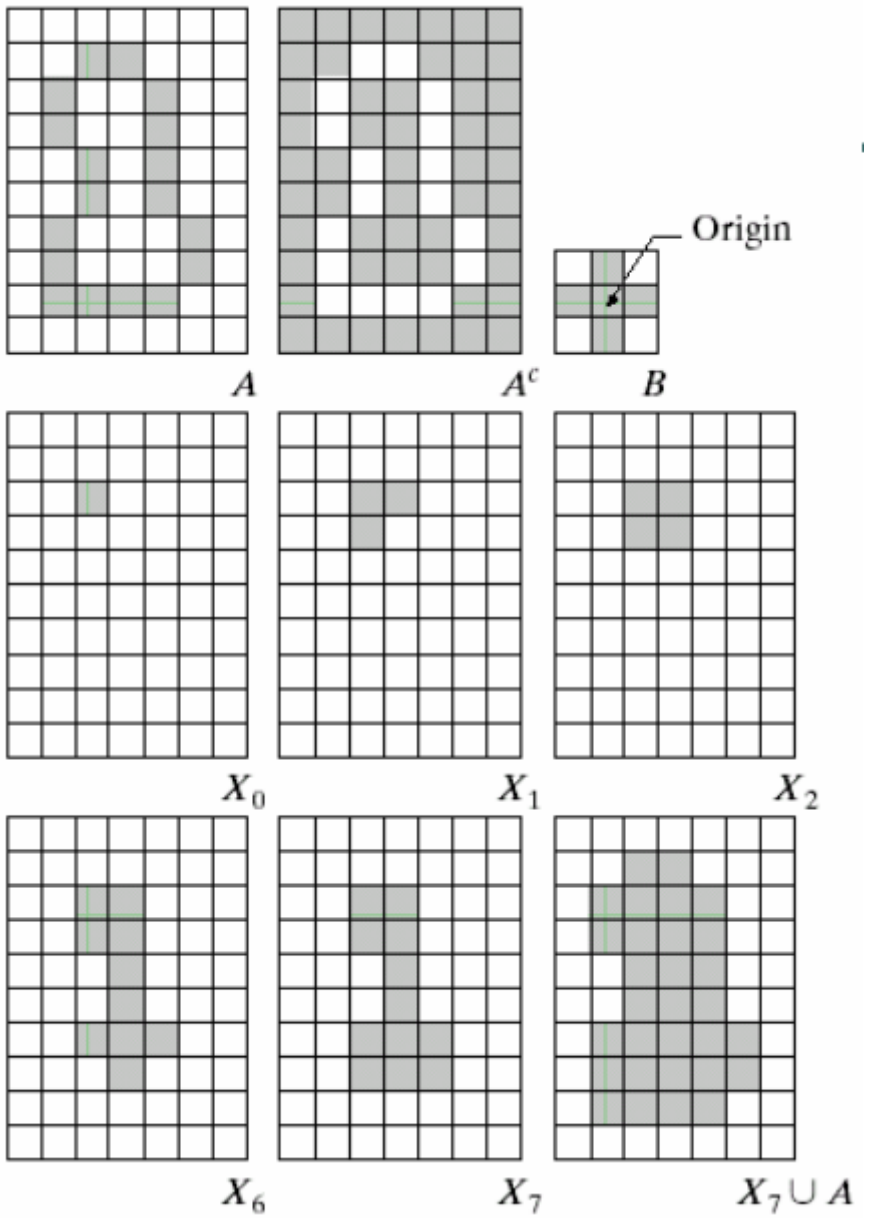
$Y_k=(Y_{k-1}\oplus B)\cap X^c$, $k=1,2,3\ldots$

Terminate when $Y_k=Y_{k-1}$,output $Y_k\cup X$



B


P
X
Y_0
$Y_0 \oplus B$
X^c
Y_1
$Y_1 \oplus B$
Y_2
$Y_2 \oplus B$
$Y_3 = Y_2$


Origin
A
A^c
B
X_0
X_1
X_2
X_6
X_7
$X_7 \cup A$

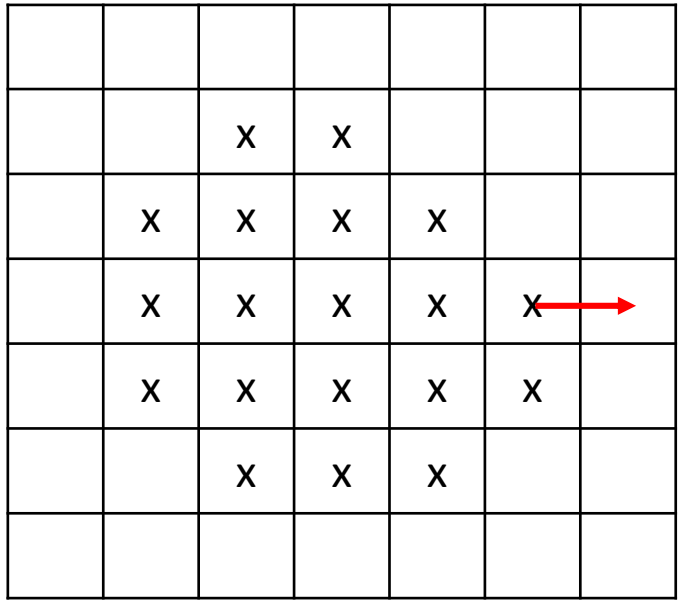
链码与边界跟踪

Chain-code & contour tracing

方向编码

（链码 Chain Code）

3	2	1
4	P	0
5	6	7



3，3，4，5，6，6，7，0，0，1，2

初始化：最“东面”边界点，方向：0

依次判断初始方向右、前、左是否存在前景点

是：　设置前进方向并前进到下一边界点

修改初始方向为小于等于前进方向的偶数编号

否：　初始方向+2

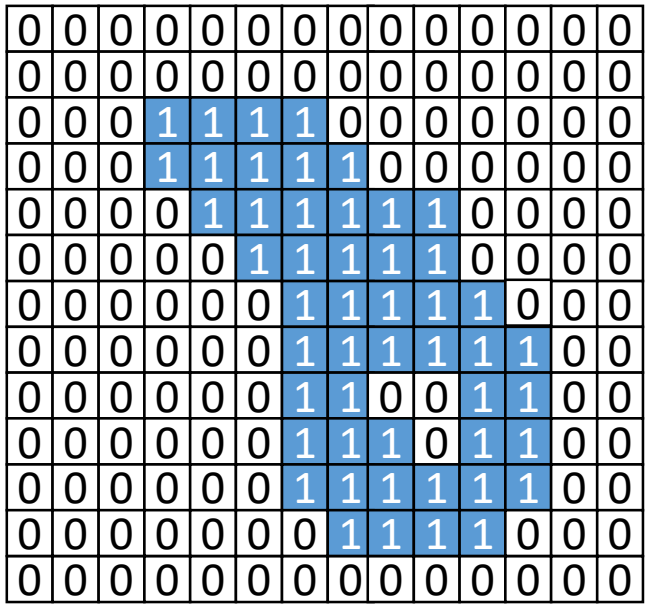
结束条件：　回到起始点

同一点连续修改初始方向4次

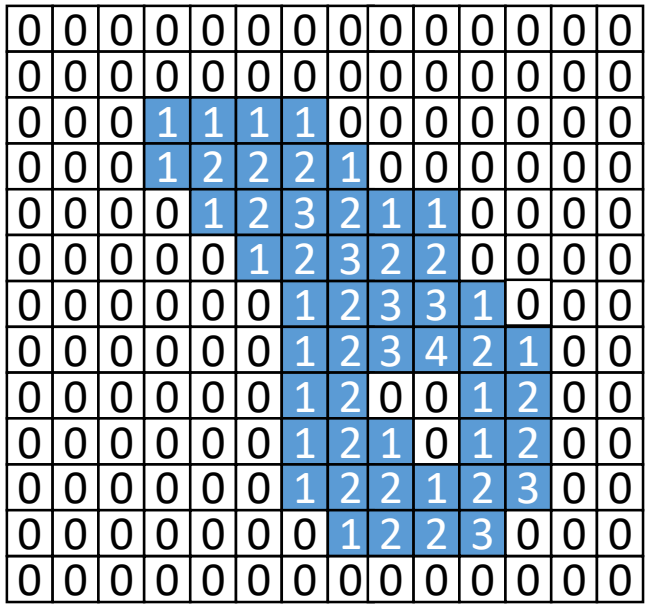
距离图与距离变换
Distance Map & Distance Transform

逆向扫描 Backward scanning

$$d_4(i,j) = \min\{d_4(i+1,j)+1, d_4(i,j+1)+1, d_4(i,j)\}$$



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	1	1	1	1	0	0	0	0	0	0	0
0	0	0	1	1	1	1	1	0	0	0	0	0	0
0	0	0	0	1	1	1	1	1	1	0	0	0	0
0	0	0	0	0	1	1	1	1	1	0	0	0	0
0	0	0	0	0	0	1	1	1	1	1	0	0	0
0	0	0	0	0	0	1	1	1	1	1	1	0	0
0	0	0	0	0	0	1	1	0	0	1	1	0	0
0	0	0	0	0	0	1	1	1	0	1	1	0	0
0	0	0	0	0	0	1	1	1	1	1	1	0	0
0	0	0	0	0	0	0	1	1	1	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	0	0	0	0	0
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0	0	0	1	2	2	2	1	0	0	0	0	0	0
0	0	0	0	1	2	3	2	1	1	0	0	0	0
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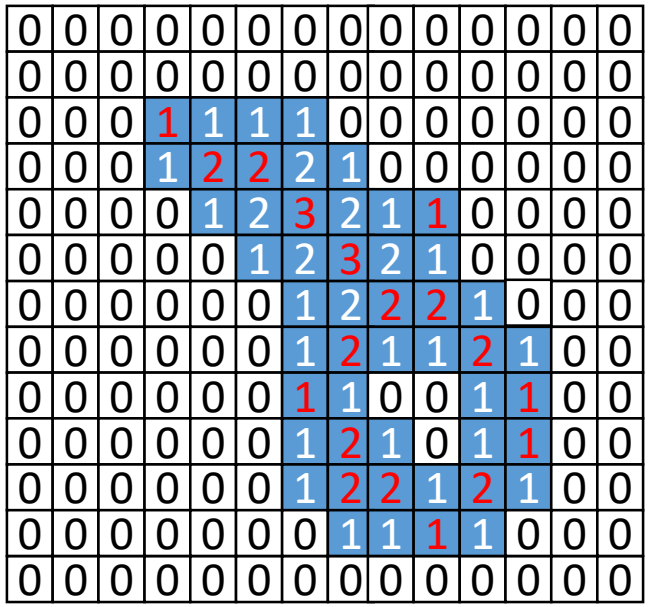
0	0	0	0	0	0	1	2	1	0	1	2	0	0
0	0	0	0	0	0	1	2	2	1	2	3	0	0
0	0	0	0	0	0	0	1	2	2	3	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0



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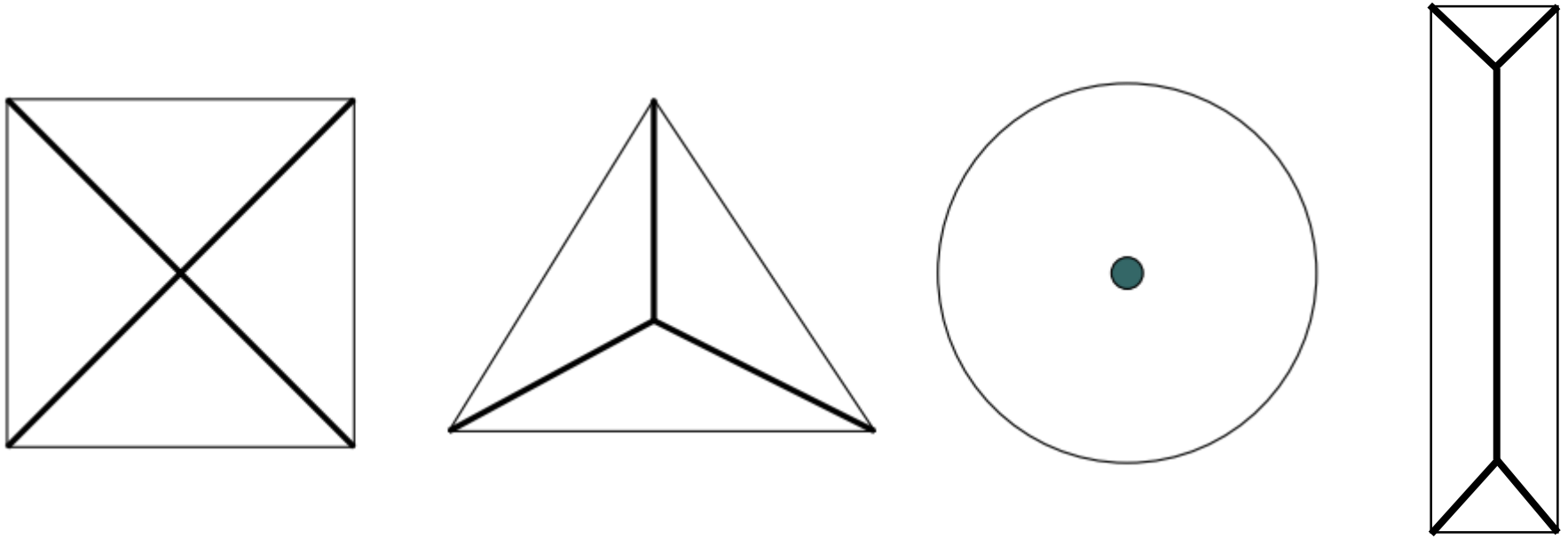
0	0	0	0	0	0	0	1	1	1	1	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0

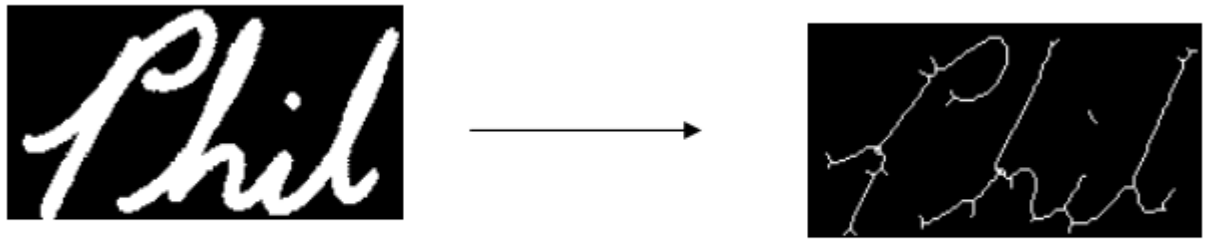
正向扫描 Forward scanning, for d(I,j) = 1

$$d_4(i,j) = \min\{d(i-1,j), d(i,j-1)\} + 1$$

中心轴线（骨架）

Medial Axis (Skeleton)





original skeleton