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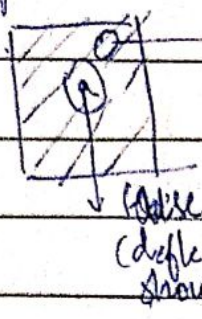
morphological image processing
operate on a binary image (eg: after thresholding)

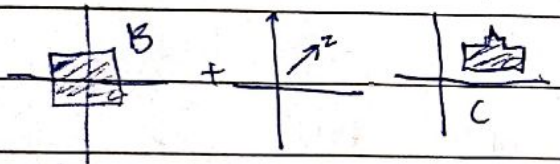


It can cause 2 separate objects which are close to appear as 1

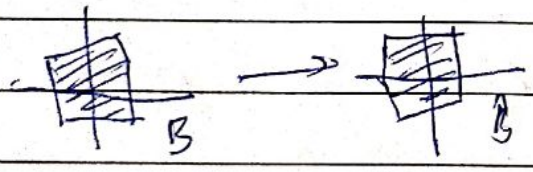
Structuring element: Small pixel template that helps produce the new image from the old one (Binary array)
Set of pixels - list of (any) coordinates.

Simple operations on set B

* B_z translation of B by vector z
$= \{c \mid c = b + z, b \in B\} = \{(x+z, y+z) \mid (x,y) \in B\}$

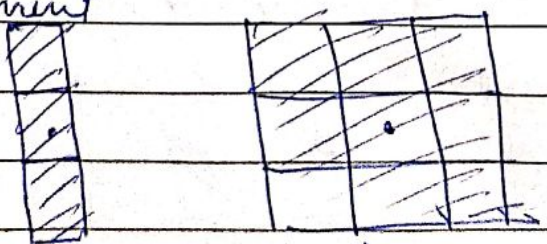


* $\hat{B}$: reflection $\{c \mid c = b, b \in B\} = \{(-x, -y) \mid (x,y) \in B\}$



Structuring element

0	1	0
1	1	1
0	1	0



Basic operations: structuring elm

* Erosion → $A \ominus B = \{z \mid B_z \subseteq A\}$
Set of points z such that str elm translated by z fully inside A.

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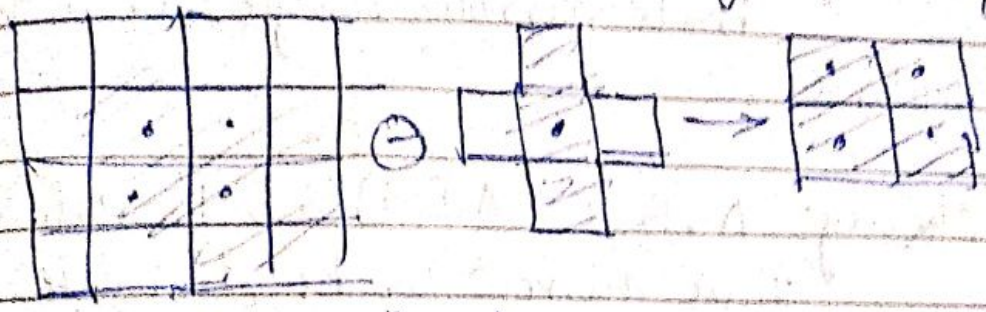
Based on the structuring element size but not larger output is the set of pixel where structuring element fits



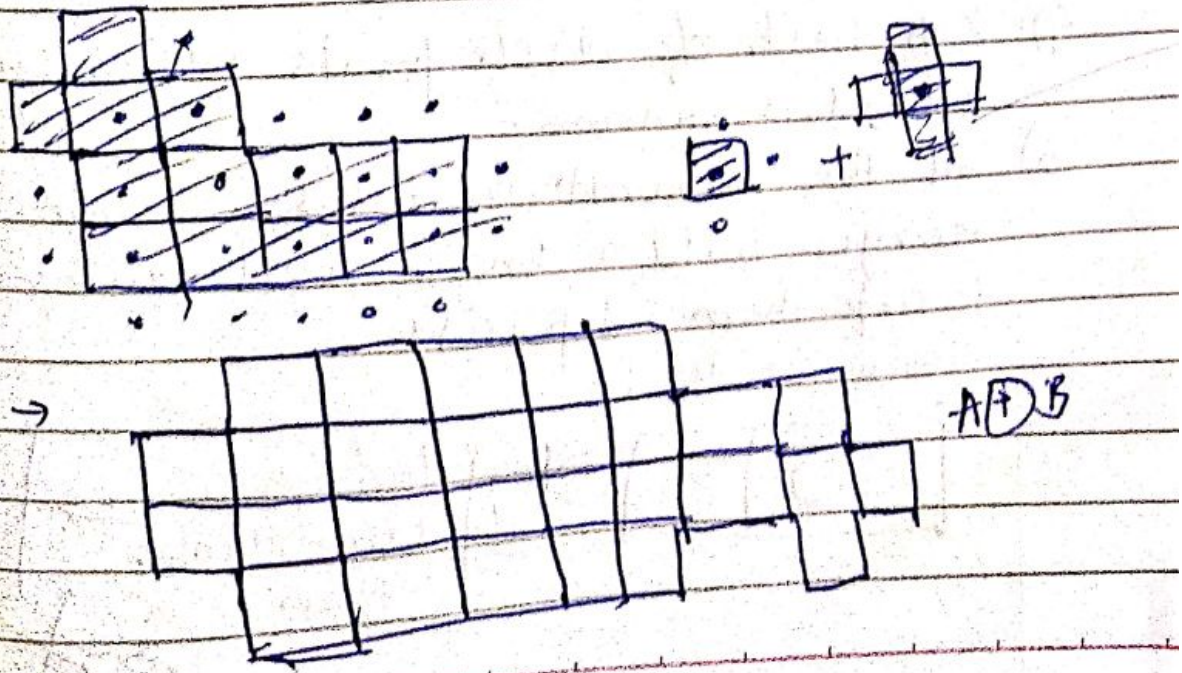
Erosion: Removes thin lines, isolated dots lines gives details
larger than struct element & peels away layer thick lines become thin

$A \ominus B \subseteq A$ [Eroded image is always a subset of original]

* DILATION: Fatten up to bridge connection

$A \oplus B = \{z \mid \hat{B}z \cap A \subseteq A\}$

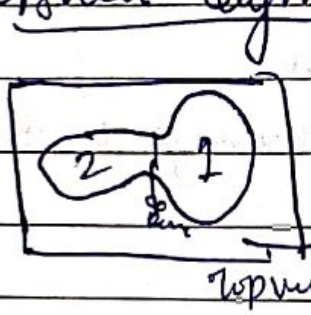
Find pixel such that shifted struct has any overlap with original set

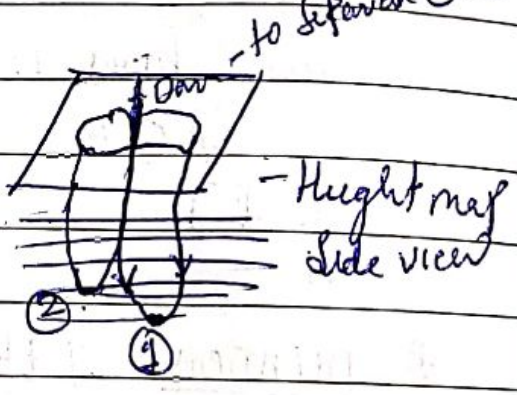


* Opening: $A \circ B = (A \ominus B) \oplus B$ [Erode then dilate]
Break narrow bridges, eliminate thin structures

Closing: $A \cdot B = (A \oplus B) \ominus B$ [dilate then Erode]
Fuse narrow breaks, eliminates small holes Boundary extraction $\beta A = A - (A \ominus B)$

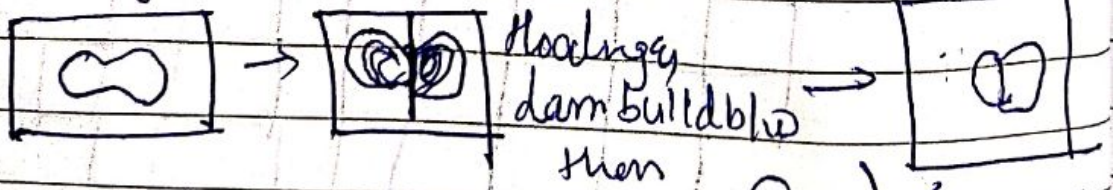
Watershed Segmentation





1) Find local minima
2) Punch a hole in each one
3) Start rising the water level from the bottom one unit at a time.
4) Keep track of which points are associated with which minima.
5) At the moment two bains are about to merge build a single pixel wide 'dam' to keep them separate

Flooding = dilation



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