

CS4640 week 9 Mathematical Morphology

Morph: change shape!

clean up or get fundamental information

binary images

basic operations: dilation & erosion

binary images: 0: background
1: foreground

object: connected pixels

operation makes some $0 \rightarrow 1$
some $1 \rightarrow 0$

structuring element (se) rectangular binary array

center: true center if odd dimension $\frac{n+1}{2}$ n odd
else $\frac{n}{2}$ n even

Dilation background pixels

- * remain background if all 1's in se correspond to background
- * else change to foreground

erosion foreground pixels

- * remain foreground if all 1's in se correspond to foreground
- * else change to background

strel : obtain structuring element

se = strel('shape', 'parameters'); (book)
 se = strel(<shape>, <parameters>); (we)
 ↑ not a string

using strel is more efficient

se = strel('line', 40, 45);
 pp = imerode(frankg, ^{<150}se);

se = strel('disk', 2, 0);
 pp = imerode(frankg, ^{<150}se);


CS4640 → combu(frankg, pp); ← !

→ strel returns strel object

consider letters that touch

seh = ones(2, 1);

pp1 = imerode(frankb, seh)

frankb 3222, 104


3213, 94
 3234, 124



look at bwmorph(im, '...

⋮ dilate
 ⋮ erode
 ⋮ skew
 ⋮ thin
 ⋮

particle or object sizing

- * count total # objects (connected comps)
- * repeatedly erode until no change (not like book)
- * no objects (book)

try it on franklin

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opening

- * remove small objects
- * smooth contours

$$A \circ B = \underbrace{(A \ominus B)}_{\text{erode}} \oplus B$$

then dilate

closing

- * remove small holes
- * join narrow isthmuses

$$A \bullet B = \underbrace{(A \oplus B)}_{\text{dilate}} \ominus B$$

then erode

try on im 45

- * can help merge noise into big component
- * can then use to clean up characters

Boundary Extraction

$$A_p = A - (A \ominus B)$$

Connected Components

Algorithm 1 (scan line)

3	2	1
4	X	0
5	6	7

 $\forall r = 1 : M$ $\forall c = 1 : N$ if $aim(r,c) = 1$ if neighbors 1, 2, 3, 4 all 0assign label at r,c to new labelelse if only one of 1, 2, 3, 4 is labeledassign its label to r,c else if more than one of 1, 2, 3, 4 is labeledassign one of the labels to r,c +

declare that label set equivalent

endendend

Connected Components (M & M's)

on input: A image

x_0 arbitrary foreground pixel

X_k set of connected pixels at k^{th} iteration

B structuring element

$k=0$

while not done

$k=k+1;$

$$X_k = (X_{k-1} \oplus B) \cap A$$

if $X_k == X_{k-1}$

done is true

end

end

repeat until

$$\sum X_k == A$$

Region Filling

on input: H : representation of hole pixels
(no path from them to image border)

B : structuring element

x_0 : pixel in H

$k = 0$

while not done

$k = k + 1$

$$x_k = (x_{k-1} \oplus B) \cap \bar{A}$$

if $x_k = x_{k-1}$

done is true

end

end

repeat until

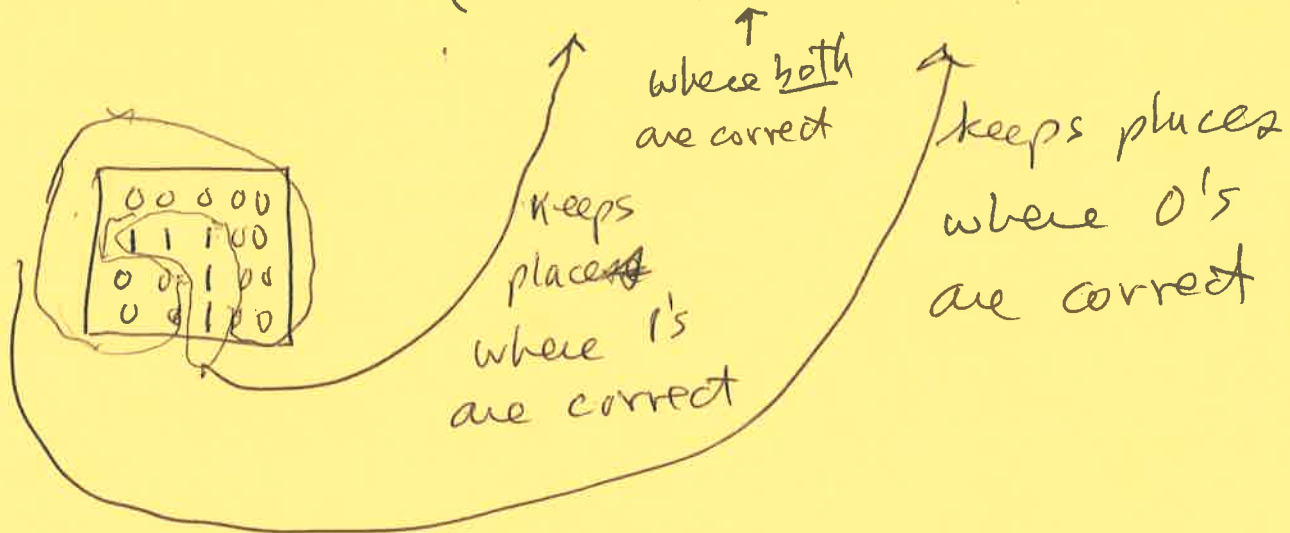
$$\sum x_k = H$$

To find H , apply the above to a background pixel on the border (row = 1 or M , col = 1 or N)
to find x_k , then set $H = \overline{A \cup x_k}$.

Hit or Miss Transform

Detects patterns in image : structure, shape

$$A \otimes B = (A \ominus B) \cap (\bar{A} \ominus \bar{B})$$

Generalized

$$A \otimes B = (A \ominus B_1) \cap (\bar{A} \ominus B_2)$$

$$B = (B_1, B_2)$$

Don't care

1 hit

-1 miss

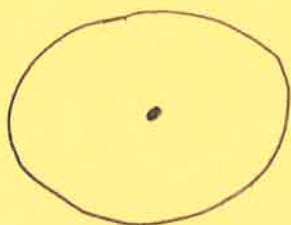
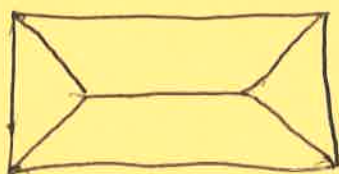
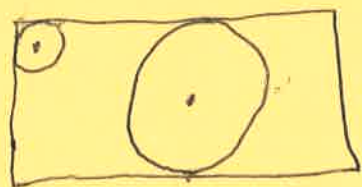
0 don't care

see CS464U - week 9

Thinning

$$\text{thin}(A, B) = A \cap \overline{A \otimes B}$$

Skeletonization - Medial Axis Transform



wherever a circle fits inside shape and touches 2 or more points on boundary, is part of the skeleton

should be
is not in digital image
why not?

but this is what
bwmorph(im, 'skel', Inf)
returns

Think about how to do
this correctly.

opening by reconstruction

opening operation removes small objects

but the dilation operation

→ does not restore existing objects exactly

consider images:

A : marker : obtained by erosion (or opening)

M : mask: original image

B : ones $(3, 3)$

$A_1 \leftarrow A$

iterate: $A_{n+1} = (A_n \oplus B) \cap M$

until $A_{n+1} = A_n$