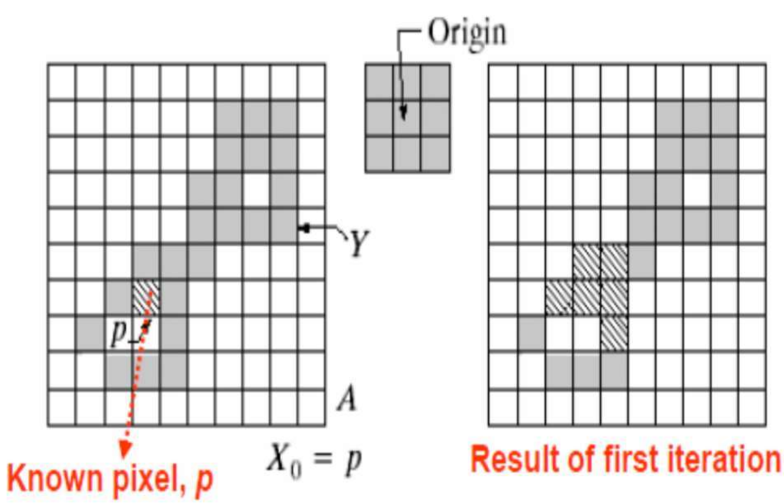
Connected Components

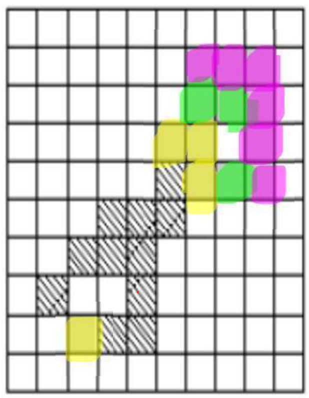
$$X_k = (X_{k-1} \oplus B) \bigcap A \qquad \begin{array}{c} k = 1,2,3,... \\ \textit{terminates when } X_k = X_{k-1} \end{array}$$

- X_0=1 corresponds to one of the pixels on the component Y. Note that one of the pixel locations on the component must be known.
- Consecutive dilations and their intersection with A, yields all elements of component Y.

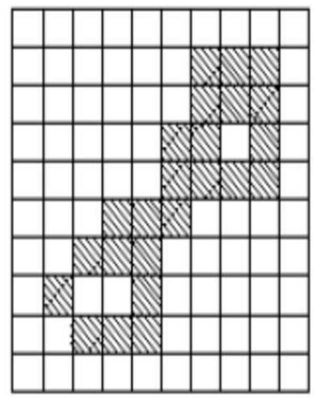
Connected Components



Connected Components



Result of second iteration

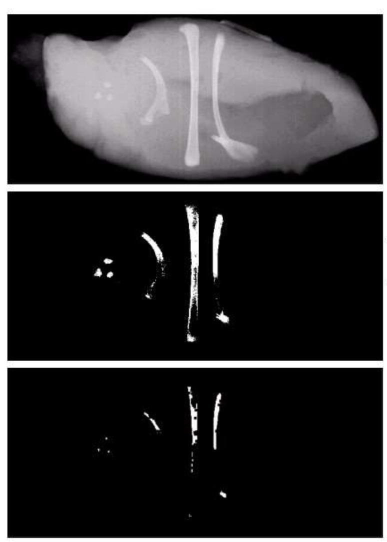


Result of last iteration

Connected components

- a
  b
  c d

  FIGURE 9.18 (a) X-ray image of chicken filet with bone
- fragments. (b) Thresholded image. (c) Image eroded with a 5 × 5 structuring element of 1's. (d) Number of pixels in the connected components of (c). (Image courtesy of NTB Elektronische Geraete GmbH, Diepholz, Germany, www.ntbxray.com.)



Connected component	No. of pixels in connected comp
01	11
02	9
03	9
04	39
05	133
06	1
07	1
08	743
09	7
10	11
11	11
12	9
13	9
14	674
15	85

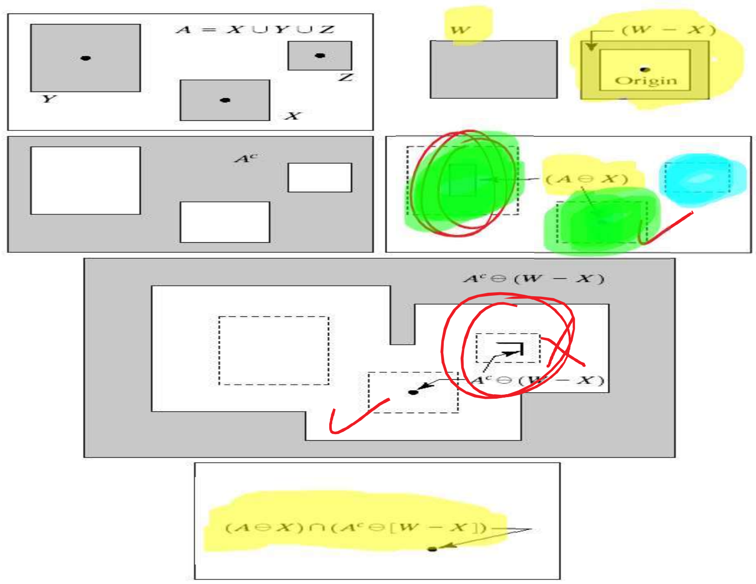
Hit or Miss Transformation

Used to extract pixels with specific neighbourhood configurations from an image

- Set A has subsets X, Y, Z
- W is a window enclosing X
- W-X is the local background of X
- Erode A by X
- Erode A^C by W-X

Hit or Miss Transform

A



Hit or Miss Transform

Hit - or - Miss transform is given as

$$A \circledast B = (A \ominus X) \cap \left[A^c \ominus (W - X) \right]$$

where A = *Set in which we want to find the location of object* X

B = *Set composed of* X *and its background* W

$B = (\underline{X, \omega - X})$

Hit or Miss Transform

We can also write Hit - or - Miss transform as

$$A \circledast B = (A \ominus B_1) \cap (A^c \ominus B_2)$$

where $B_1 = Object$ *and* $B_2 = background$

Hit or Miss Transform

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

A

0	0	0
0	1	0
0	1	0

B_1

0	1	0
0	0	0
0	0	0

B_2

Hit or Miss Transform

STEP 1: Erode A by B_1

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

A

0	0	0
0	1	0
0	1	0

B_1

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

A_{Pad}

Hit or Miss Transform

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

A_{Pad}

0	0	0
0	1	0
0	1	0

B_1

0						

$A \ominus B_1$

Hit or Miss Transform

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

A_{Pad}

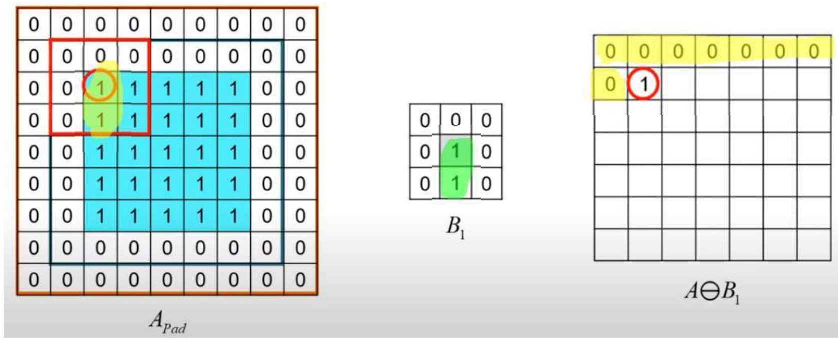
0	0	0
0	1	0
0	1	0

B_1

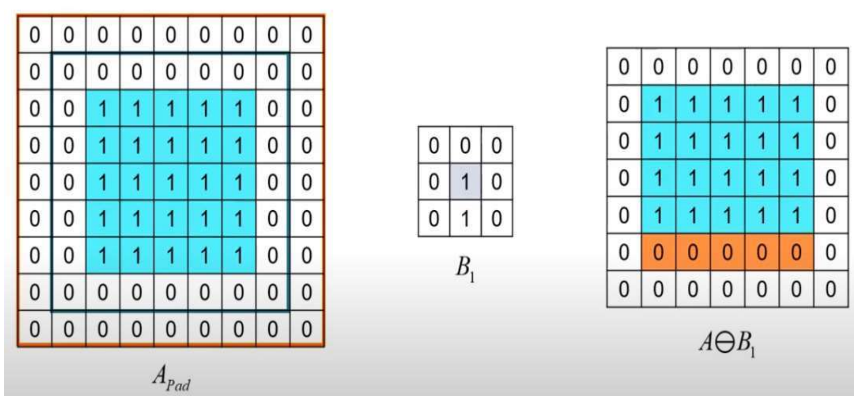
0	0	0	0	0	0	0

$A \ominus B_1$

Hit or Miss Transform



Hit or Miss Transform



Hit or Miss Transform

We can also write Hit - or - Miss transform as

$$A \circledast B = (A \ominus B_1) \cap (A^c \ominus B_2)$$

where $B_1 = Object$ and $B_2 = background$

Hit or Miss Transform

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

A^c

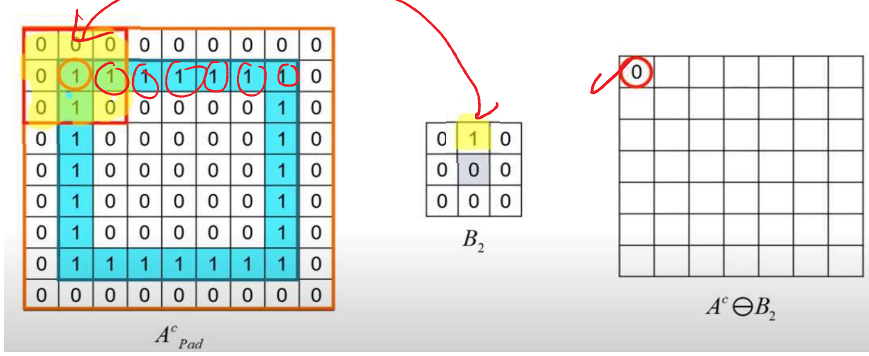
0	1	0
0	0	0
0	0	0

B_2

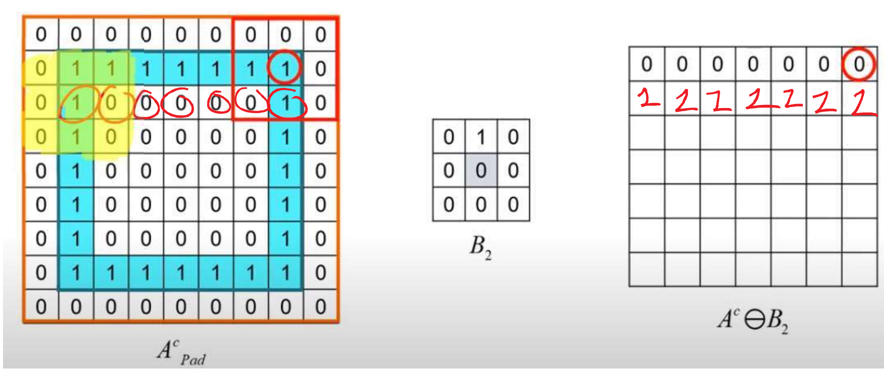
0	0	0	0	0	0	0	0	0
0	1	1	1	1	1	1	1	0
0	1	0	0	0	0	0	1	0
0	1	0	0	0	0	0	1	0
0	1	0	0	0	0	0	1	0
0	1	0	0	0	0	0	1	0
0	1	0	0	0	0	0	1	0
0	1	1	1	1	1	1	1	0
0	0	0	0	0	0	0	0	0

A^c_{Pad}

Hit or Miss Transform



Hit or Miss Transform



Hit or Miss Transform

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

$A^c{}_{Pad}$

0	1	0
0	0	0
0	0	0

B_2

0	0	0	0	0	0	0
1						

$A^c \ominus B_2$

Hit or Miss Transform

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

$A^c{}_{Pad}$

0	1	0
0	0	0
0	0	0

B_2

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

$A^c \ominus B_2$

Hit or Miss Transform

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

$A \ominus B_1$

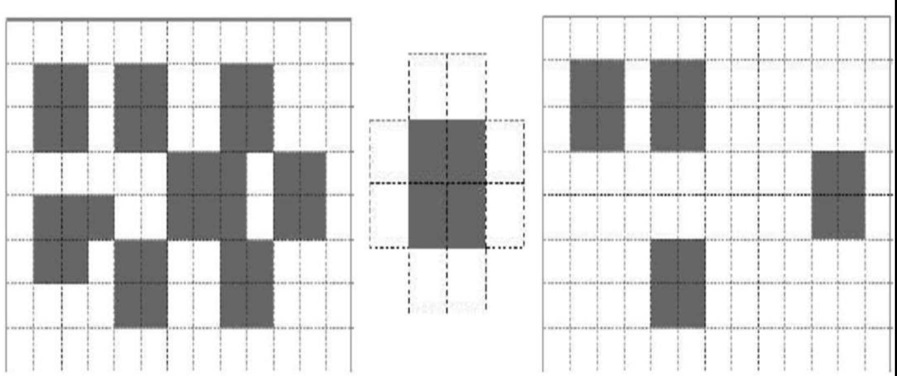
0	0	0	0	0	0	0
1	1	1	1	1	1	1
1	0	0	0	0	0	1
1	0	0	0	0	0	1
1	0	0	0	0	0	1
1	0	0	0	0	0	1
1	0	0	0	0	0	1

$A^c \ominus B_2$

0	0	0	0	0	0	0
0	1	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

$A \circledast B$
$= (A \ominus B_1) \cap (A^c \ominus B_2)$

Hit or Miss Transform



Hit or Miss Transform

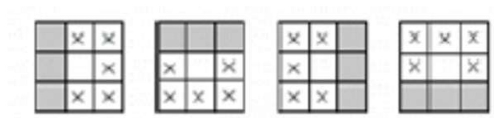
- A background is necessary to detect disjoint sets
- When we only aim to detect certain patterns within a set, a background is not required, and simple erosion is sufficient

Convex Hull

$$X_k^i = (X_{k-1} \circledast B^i) \cup A, \; i = 1, 2, 3, 4, \; k = 1, 2, \ldots, \; X_0^i = A$$

Now let $D^i = X^i_{\text{conv}}$, where "conv" indicates convergence in the sense that $X_k^i = X_{k-1}^i$. Then the convex hull of A is

$$C(A) = \cup_{i=1}^{4} D^i$$



B^1 B^2 B^3 B^4