CSE 473/573 Spring 2010 March 2, 2010

Midterm Exam

Instructions: Answer all questions in the bluebook provided. closed book, notes. No electronic devices allowed.

1. Let M be a 3x3 mask M whose values are all -1 except the center pixel whose value is +8. The origin of the mask is its center pixel.

(a) Find the 6x6 output when M is applied to the 6x6 image shown below. Note: some of the values in the output will be negative.

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

(b) Suppose we apply M to a binary image, then we threshold the output so that only pixels +8 or higher are marked as foreground pixels. What image features in the original binary image does this procedure detect?

(c) Repeat (b) in the case where we change the threshold from +8 to +3. What image features in the original binary image are detected?

2. Let X be an 8x8 binary image which contains exactly 23 foreground pixels.

(a) How many nodes are there in the T-Pyramid for X?

(b) What is the minimum number of inner boundary pixels in any 8x8 image which contains exactly 23 foreground pixels? Use 8-connectivity to define adjacency between foreground and background pixels. Justify your answer.

(c) What is the maximum number of nodes in the quadtree for any 8x8 image with exactly 23 foreground pixels? Show how the 23 foreground pixels can be distributed so that the quadtree has this maximum number of nodes.

3. Define the limit of an image X as follows: given an image X, pick an operator Ω, where Ω is one of the four operators dilation, erosion, opening, or closing. Next pick a structuring element B. Then Y is the limit of X using Ω and B if Y is the result of applying Ω using stucturing element B to the image X infinitely often:

$$Y = X \Omega B \Omega B \Omega B \Omega B \ldots$$

An image X is shown in the upper left figure below. For each of the remaining 5 figures, specify an operator Ω_i and structuring element B_i for which Y_i is the limit of X using Ω_i and B_i. If you don't think there is Ω_i and B_i for which Y_i is the limit of X using any Ω_i or B_i, explain why not.

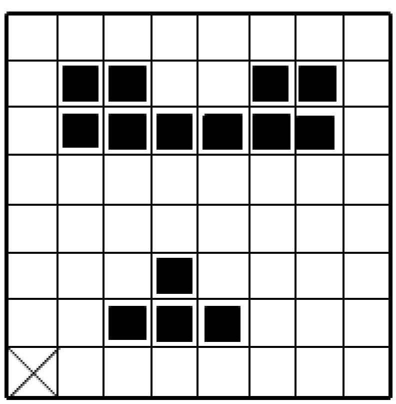
(a) Specify Ω_1 and B_1 so that Y_1 is the limit of X using Ω_1 and B_1.

(b) Specify Ω_2 and B_2 so that Y_2 is the limit of X using Ω_2 and B_2.

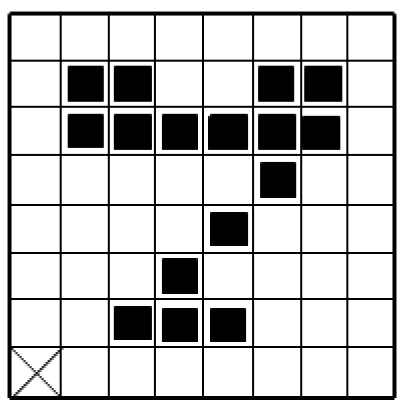
(c) Specify Ω_3 and B_3 so that Y_3 is the limit of X using Ω_3 and B_3.

(d) Specify Ω_4 and B_4 so that Y_4 is the limit of X using Ω_4 and B_4.

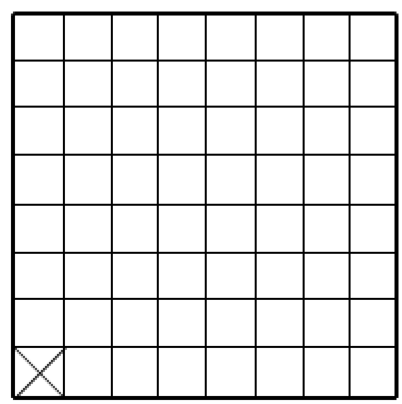
(e) Specify Ω_5 and B_5 so that Y_5 is the limit of X using Ω_5 and B_5.



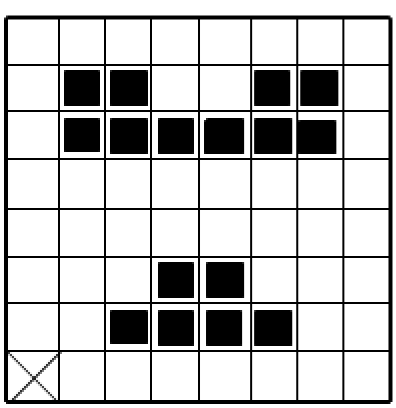
X



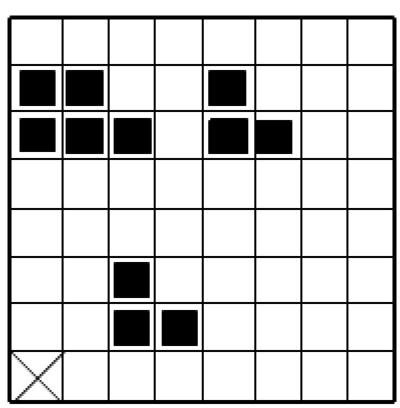
Y_1



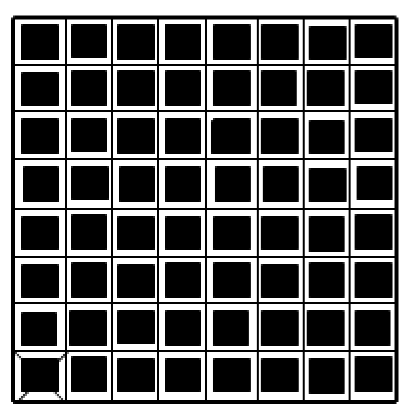
Y_2



Y_3



Y_4



Y_5=ZxZ, ie. the entire image plane is black