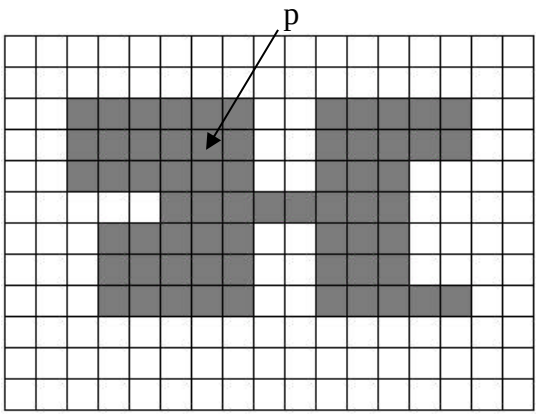
CS5680/CS6680 – Fall Semester 2017
Final Take-Home Exam
Due by 1:30 p.m. of December 12, 2017 in class
Total Points: 50 points

General Instructions:

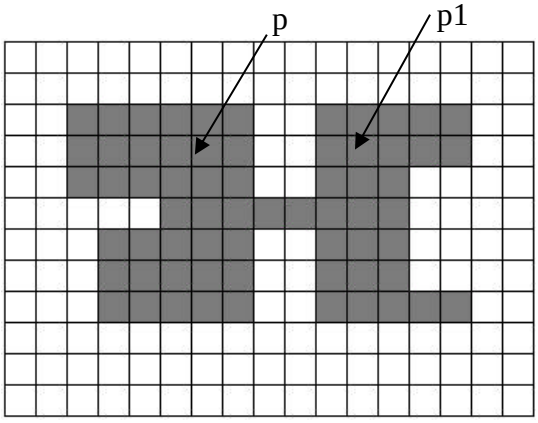
This is a hand-written, individual exam. Please ensure to have enough detail for each solution. You need to go through each step by your own computation. However, you may use Matlab functions to find the eigenvalue, eigenvector, inverse of a matrix, etc. Do not cheat and refer to the cheating policy on the syllabus.

Problem 1 [Total: 10 points]: (Medium-Level Image Processing)

1.1. Starting with the point p on image A (white pixels indicate a value of 0 and dark pixels indicate a value of 1), show the results after computing $(p \oplus 3B) \cap A$, where $3B = B \oplus B \oplus B$ and B is a 3×3 square structuring element. **[2 points]**

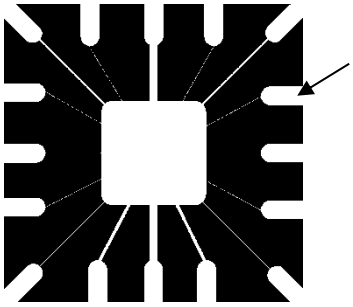


1.2. What is the geodetic distance between p and p1? Geodetic distance is the minimum n such as $(p \oplus nB) \cap A$ contains p1. **[2 points]**



1.3. Given the original image shown below, **write down one morphological solution** to keep all 16 rounded thick sticks on the border (one sample rounded thick stick is pointed by the arrow) and remove the other components in the image. Make sure that you clearly indicate your structuring element(s) and their

origin(s) and **use the structuring elements with the minimum size** to solve the problem. There is no need to write Matlab code. **[6 points]**



Problem 2 [Total: 10 points]: (Advanced Image Processing)

2.1. Seeded Region Growing [5 points] [Ch5.DIPSegmentation.pdf slides 68-73]

a. For the given data with the two atomic regions shaded, go through the calculations to show the **next step** in the process. That is, determine which pixel will be picked out for merging into either of the two shaded regions and which pixels, if applicable, will be determined as boundary pixels to segment the two regions. (Use 8-connected neighborhood for your calculation).

b. Instead of using the two seeds as shown in the figure below, two different seeds are chosen for the seeded region growing algorithm. One seed is located at the upper right corner and the other seed is located at the lower left corner. Discuss the difference(s) between the segmentation results obtained by the seeded region growing algorithm using these two sets of seeds.

3	2	2	1	1	1	1	1
6	5	2	2	1	1	1	1
7	7	7	7	7	1	1	1
7	7	6	7	6	7	1	1
8	7	7	8	6	7	1	1
8	8	7	3	2	1	1	1
8	8	8	4	2	1	2	1
8	8	8	5	1	1	1	1

Seed2

Seed1

2.2. Watershed Segmentation [5 points] [Ch5.DIPSegmentation.pdf slides 75-99]

a. Identify the minimums in the given data, which contains the gradient of an 8×8 image. Explain why they are minimums.

b. Determine the watershed line, which falls on the boundaries between catchment basins of the minimums found in a. (Use 8-connected neighborhood for your calculation).

8	8	7	8	9	9	9	9
8	8	3	3	9	9	9	9
8	8	9	9	9	9	9	9
8	7	6	8	9	9	9	9
7	6	6	7	7	9	1	1
7	2	2	7	6	5	1	1
7	6	6	7	11	12	5	5
7	7	6	7	11	11	7	5

Problem 3 [Total 30 points]: (Pattern Recognition)
For all the sub-problems, you may treat the original data set as the training data set.

3.1. **[10 points]** Apply **the K-means algorithm [Ch7.2.PRDistanceFunctions.pdf slides 27-40]** to the data set {(0, 0)', (0, 1)', (5, 4)', (5, 5)', (4, 5)', (1, 0)'} to cluster the samples (i.e., patterns) into **two** appropriate pattern classes. Here, the initial cluster centers are selected as the first two samples of the above data set, e.g., {(0, 0)'} and {(0, 1)'}.

3.2. **[10 points]** Apply the **Hierarchical Clustering algorithm [Ch7.2.PRDistanceFunctions.pdf slides 41, 42]** on the same data set described in 3.1 to cluster the samples into **two** appropriate pattern classes. Make sure that the single link clustering is used in step 3.

3.3. **[8 points]** Apply the **minimum-distance classification technique [Ch7.2.PRDistanceFunctions.pdf slides 11-16]** to find the decision boundary to separate the two pattern classes obtained from the problem 3.1. Sketch its decision boundary and decide which class an unknown pattern (2, 2) belongs to.

3.4. **[2 points]** For each of the two pattern classes obtained from the problem 3.1 and decide which class an unknown pattern (2, 2) belongs to using the 1NN (1 nearest neighbor) classifier, which assigns the unknown pattern to the class of its closest neighbor in the feature space.