------1--------2--------3--------4---------5--------6--------7-----= ----------							
| 13	| 11	| 12	| 10	| 11	| 9	| 9	| 75

CV Spring 2021 Exam 2 (Part 1 - Essay Questions) Name:_____

**** This is a close book exam.**
**** If you are caught cheating of any kind on this exam, -999 will be your score for this exam.**

1. What are the purposes of finding straight lines in an image? List two usages with brief explanations. (2)

2. Given a list of N points, S = $\{(x_1, y_1), (x_2, y_2), \ldots, (x_N, y_N)\}$, write the equations for the centroid, (CX, CY) of S, the 3 second moments: XY, X^2, Y^2 of S, and the best fitted line L of S. (4)

   $CX =$ $CY =$

   $XY =$ $X^2 =$ $Y^2 =$

   The best fitted line L :

3. Write the algorithm steps for the Iso-data clustering for line-detection algorithm. No need to redefine the equation, (4)

4. What is the theory/idea behind the Iso-data clustering to detect lines in an image? (1)

5. Write **the pros and cons** of Iso-data clustering for line-detecton. (2)

6. What is Hough transform? (1)

7. Given a line, L, with angle, a, passing thru a point p(x, y), there are two ways to compute the orthogonal distance from L to the origin (0,0), by using the angle, a and (x, y). Write the two distance formula below:

   a) Use Euclidean space: (2)

   dist (a, (x, y)) =

   b) Use Polar space: (1)

   dist (a, (x, y)) =

8. Hough Transform algorithm steps. You may use dist (…) function without redefine it. (-3 if write in pseudo code). (4)

9. What is the theory/idea behind the Hough-transform algorithm that makes the algorithm to detect co-linear points in 2-D space? Be clear and precise! (1)

10. Write **the pros and cons** of Hough transform. (2)

11. Given a binary image of size N by M, what is the dimension of the Hough-transform 2D array? (1)

12. What is the meaning of the value at Hough [i, j] at Hough-transform array? (1)

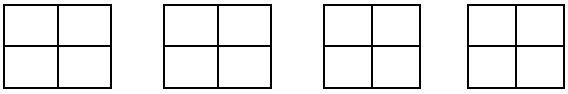
13. If the input image contains 92 co-linear points at an angle of 150 degrees and the distance from the line to the origin is 40, where would the Hough transform space show? (1)

14. Where are edges in a grey-scale image? (1)

15. Where are edges in a binary image? (1)

16. What are the usages of edge images (the results of edge detectors)? List two usages with brief explanations (2)

17. Fill-in the four masks for Robert's edge detector. (2)



18. Given a 5 x 5 image window below, the center pixel is (i, j), compute convolution on pixel (i, j) using Robert's horizontal mask and vertical mask. (2)

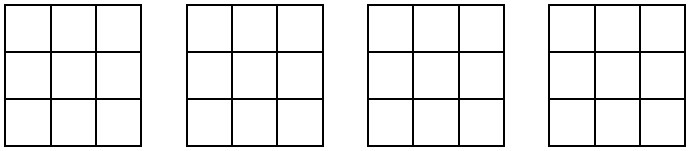
		j			
	2	3	3	2	10
	3	2	2	1	2
i	10	2	**1**	1	12
	2	12	10	10	10
	10	11	12	10	11

Horizontal (i, j) =

Vertical (i, j) =

19. What is the idea behind Robert's four masks that enable them to detect edges in a grey-scale image? (1)

20. Fill-in the four masks for the Sobel's edge detector. (2)



21. Given a 5 x 5 image window below, the center pixel is (i, j), apply convolution on pixel (i, j) with Sobel's horizontal mask and vertical diagonal mask. (2)

			j		
	2	3	3	2	10
	3	2	2	1	2
i	3	12	**10**	10	12
	2	10	10	10	10
	10	11	12	10	11

Horizontal (i, j) =

Vertical (i, j) =

22. Compute the gradient edge detector on (i, j) of the above image window. (1)

GradientEdge (i, j) =

23. Explain the purposes of having positive and negative values in all four masks used in Sobel edge detector. (1)

24. Explain the purposes of having different weights, i.e., 1 and 2, in all four masks used in Sobel edge detector. (1)

25. What is the meaning of the value of pixel (i, j) in the result of any edge detector? (1)

26. What is the distance transform of a given image? (1)

27. What is the meaning of the value of pixel (i, j) in the result of distance transform? (1)

28. What are the usages of distance transform of a binary image? List two usages with brief explanations. (2)

29. You were taught three types of digital distances-transform: City-block, 8-connect, and Euclidean. All the three distance transforms are computed in 2 passes: 1st pass and 2nd pass; and the algorithm steps for each of the two passes for all three distance transforms are identical, except each uses difference formula to compute distances. Giving the diagram below of pixel X's 3x3 neighbors, write the distance computations of two passes for all three distance transforms. (4)

a	b	c
d	X	e
f	g	h

City-block: (1) 1st pass: dist(i,j) =

2nd pass: dist(i,j) =

8-connect: (1) 1st pass: dist(i,j) =

2nd pass: dist(i,j) =

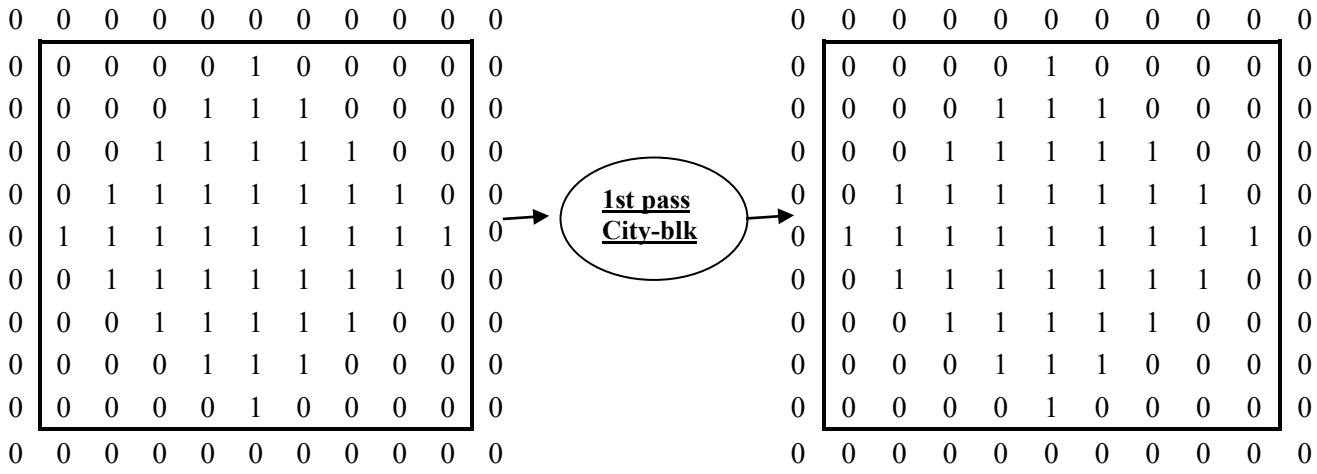
Euclidean: (2) 1st pass: dist(i,j) =

2nd pass: dist(i,j) =

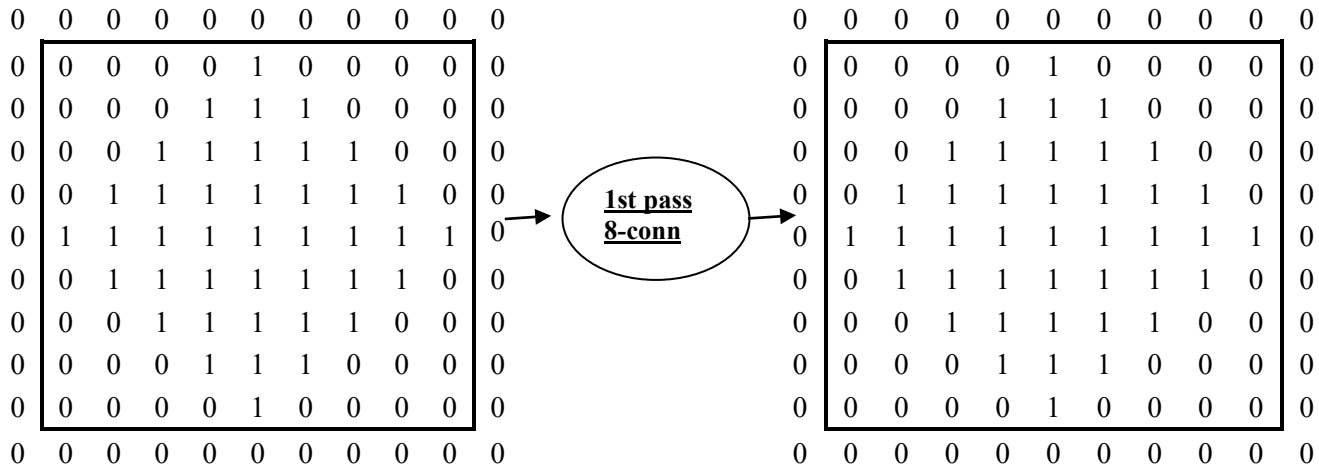
30. How can we be sure we have the correct distance transform for the pixel, X, by only look at its 3 x 3 neighbors' distance values? (1)

31. Why do we need to include the pixel, X , on the 2nd pass of distance computation, but not on the 1st pass? (1)

32. Given the image on the left below, apply the **1st pass** of the **city-block distance transform**, and modify the original image on the right to show the result. (3)



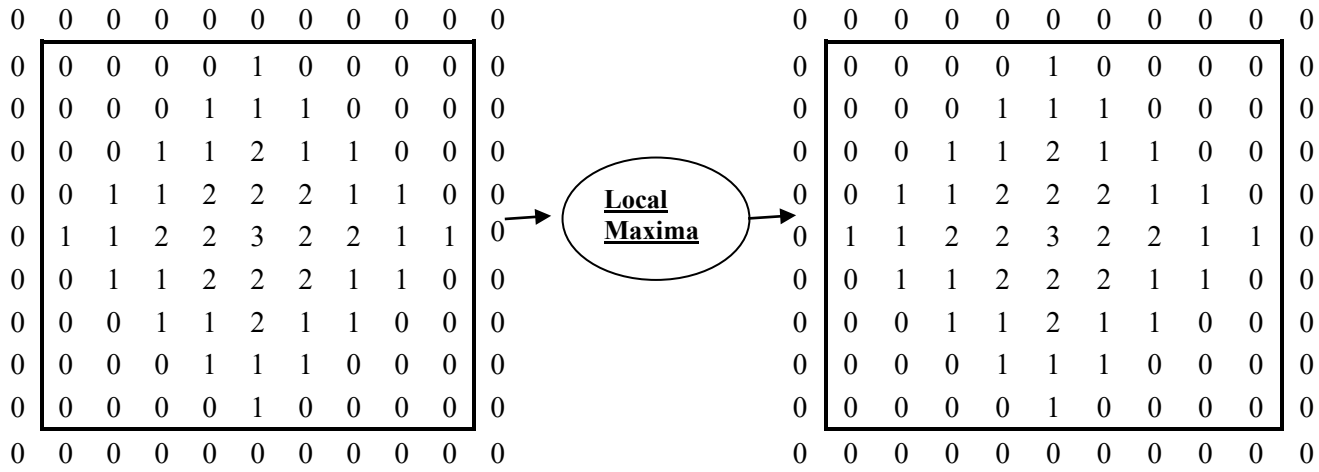
33. Given the image on the left below, apply the **1st pass** of **8-connected distance transform**, and modify the image on the right to show the result. (3)



34. Write the definition of the medial axis (in term of disks) of an object. (1)

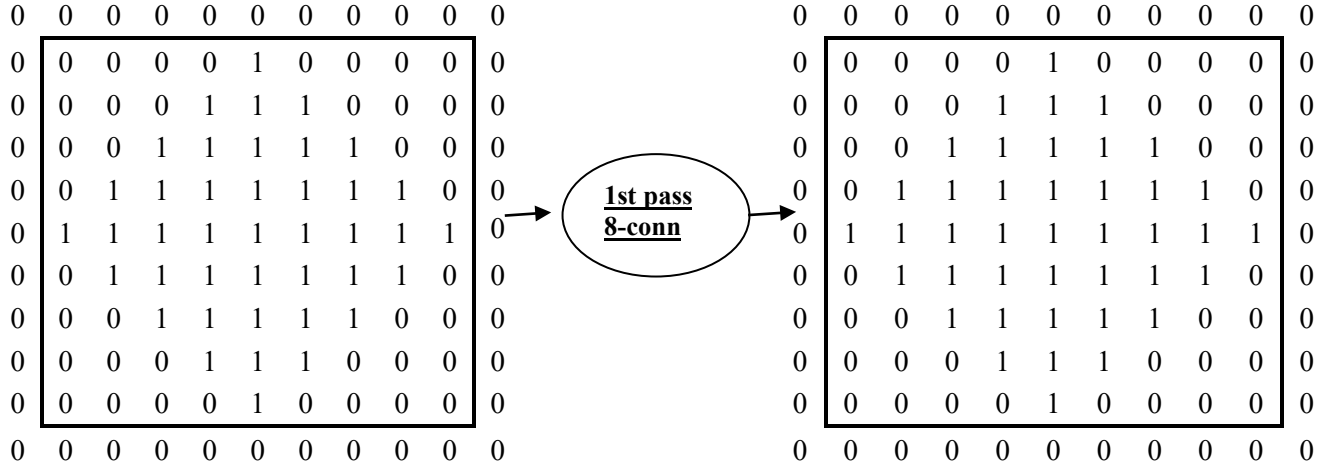
35. You were taught a method to compress a binary image using distance transform (via skeletons of objects). Write an algorithm, **in algorithm steps**, to describe the process, from taking the input binary image to produce the compress file. (-4 for not writing in algorithm steps). (5)

36. Image on the left below is the result of the **2nd pass** **8-connect distance transforem** of an image, apply the **local maxima** and modify the image on the right to show the result. (3)



37. You were taught another method using thinning to obtain the skeletons of objects in a binary image. Write the conditions for an object pixel (1's) during thinning that can be "thinned" (changed from 1 to 0), say, **thinning from the West**. (2)

38. Given the image on the left below, apply the thinning from the West. (2)



39. Can we use thinning method for binary image compression? Explain your answer for credits. **0 for yes/no answer.** (2)