1	2	3	4	5	6	7	8	9	10	11	12	13	=
10	14	12	12	13	12	13	12	9	10	12	12	6	147

CV Fall 2020 Final (Part 1) Name:_____

1. Why do we need the image header? Write two reasons, (2)

2. What are the usages of the histogram of an gray-scale image? List two usages. (2)

3. What is the meaning of the value of the histogram, hist [i]? (1)

4. What is the meaning of the value at pixel (i, j) after the threshold operation? (1)

5. What is the meaning of the value at pixel (i, j) after the connected component operation? (1)

6. What is the meaning of the value at pixel (i, j) after the distance transform operation? (1)

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

8. What is the meaning of the value at pixel (i, j) after an edge detection operation? (1)

9. What can be wrong if a wrong threshold value is apply to a grey-scale image which has a bi-modal histogram? (2)

10. What is the theory/idea of the bi-means automatic threshold selection method to select the best threshold value? (2)

11. Given a 3x3 neighbors of pixel, p (i, j) below, write the computation formula for the three image noise filters you were taught in class: (4)

a	b	c
d	(i,j)	e
f	g	h

(a) 3x3 averaging: p'(i,j) =

(b) 3x3 median-filter: p'(i,j) =

Mask

1	2	1
2	4	2
1	2	1

(c) Gaussian filter (with a given 3x3 Mask):

p'(i,j) =

12. Why 3x3 median-filter is a better choice over the 3x3 averaging filter? Explain. (2)

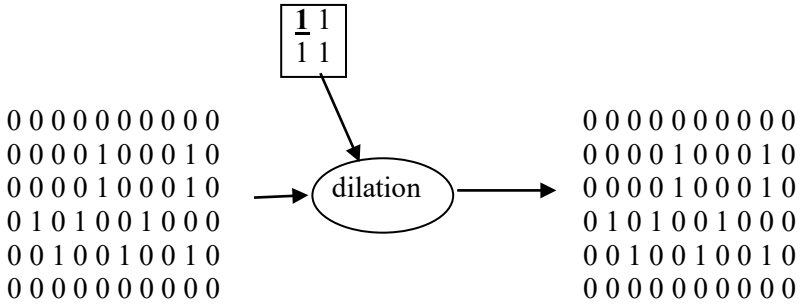
13. Why 3x3 median-filter may wipe-out object corners in a grey-scale image. (2)

14. Given the 1-D image and the structuring element (with origin **1**) below, apply 1-D morphological "erosion" and write the result after arrow →. (2)

0 0 1 1 1 1 0 1 1 1 1 0 0 1 0 1 0 0 1 **1** 1

Erosion result →

15. Given a 2-D image on the left and a structuring element (with origin **1**) on the top, apply 2-D 'dilation' operation using the structuring element; modify the image given on the right to show the result of dilation. (3)



16. What knowledge do we need to know when designing a structuring element for a morphological operation to be apply to a binary image? (2)

17. Write the algorithm steps for the 8-connected component algorithm? (5)

18. What are the purposes of the EQ-table used in the connected component algorithm? (2)

19. What is the run-length encoding for? (1)

20. How do we represent a run in the run-length encoding? (1)

21. Among the four run-length encoding methods, which method has the best compression rate? And which method has the worst compression rate? (2)

22. Among the four run-length encoding methods, which method is used in fax machine? (1)

23. What kind of image would yield the worst compression rate to use run-length encoding no matter which method to use? Illustrate an example. (2)

24. 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) =

25. 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)

26. Write the algorithm steps for the distance transform using 8-connectness. (5)

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

28. Write the definition of the medial axis (in term of disks) of an object. (2)

29. 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)

30. What is the purpose for detecting edges in the grey-scale image? List two purposes. (2)

31. the Sobel's four masks using positive and negative values? (2)

32. Given a 5 x 5 image window below, the center pixel is (i, j), compute convolution on pixel (i, j) using Sobel's horizontal mash and the gradient edge detector on (i, j) o(2) (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) =

GradientEdge (i, j) =

33. 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! (2)

34. If the input image contains 78 co-linear points at an angle of 120 degrees and the distance from the line to the origin is 70, where would the Hough transform space show? (1)

35. 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)) =

36. Write the algorithm steps of the Iso-data clustering for line-detection algorithm. No need to write the distant equation, (5)

37. What are the usage of the chain-code of a binary object? List at least two usage. (2)

38. Can we guess the size and shapes of an object from its chain-code? Explain your answer. (2)

39. How many bits (not bytes!) would be used for the chain-code of one connected component in a binary image, if the connected component has 1,000 boundary pixels? Show your calculation. (2)

40. How do we use chain-code to represent an object with holes? (2)

41. What are the purposes for detecting corners of a boundary of an object? List at least two. (2)

42. Write the algorithm steps for the K-curvature corner detector, including the equation for computing the curvature. (5)

43. Write the algorithm steps for the Maximum arc-chord corner detector, including the equation for computing the orthogonal distance from a point, p=(x, y) to the line formed by two other points: q = (x1, y1) and r = (x2, y2). (5)

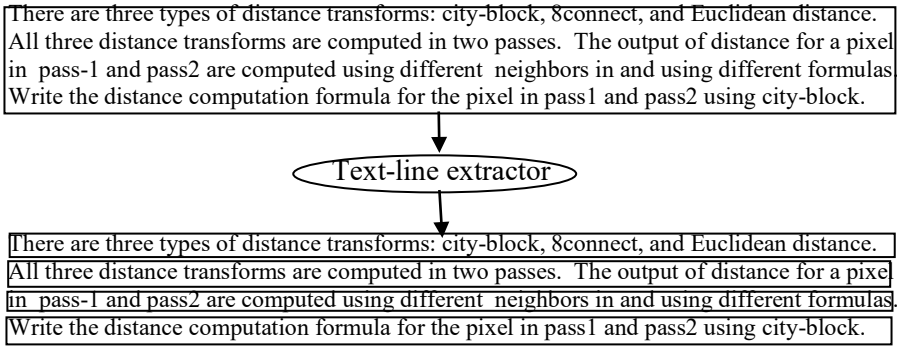
44. Compute the horizontal and vertical projection profiles of the image below. (2)

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

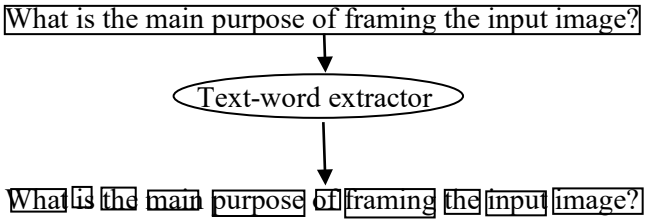
45. Just by <u>eye-balling</u> the two projection profiles (HPP, and VPP) of a document, without looking at the document image, would you be able to tell us the reading direction of the document? Explain your answer. (2)

46. Write an algorithm steps of a method that automatic detects reading direction of a document from its two projection profiles (HPP and VPP). The method outputs the reading direction. (5)

47. Given a paragraph from an English document and its bounding box (like the one shown below), write an algorithm steps, shows how to extract text-line bounding boxes for every text-line in the paragraph (shown below). You may assume the inter-text-line spacing is given. (5)



48. Given a text-line from an English document and its bounding box (like the one shown below), describe in English, or in algorithm steps, shows how to extract text-word bounding boxes within the given text-line. (shown below). You may assume the inter-word spacing is given. (5)



49. Given the two projection profiles (HPP and VPP) of a document, how to compute the smallest bounding box that enclosed the written part of the document? (2)

50. If you are asked by a customer to develop a software inspection system, what would be the first question you must ask the customer? Explain your answer. (2)

51. Given the economic consequence of inspections and the performance evaluations for inspection systems A and B below, answer the following questions:

Economic Consequence of inspection results

		(Assigned) Good	(Assigned) Bad
(True)	Good	-$20	-$120
(True)	Bad	-$500,000	-$120

Inspection A Performance

		(Assigned) Good	(Assigned) Bad
(True)	Good	100%	0%
(True)	Bad	3%	97%

Inspection B Performance

		(Assigned) Good	(Assigned) Bad
(True)	Good	95%	5%
(True)	Bad	0%	100%

a) Which inspection system, A or B, produces more false alarms? Explain your answer. (2)

b) Which inspection system, A or B, produces more miss-detections? Explain your answer. (2)

c) Which inspection system, A or B, is more accurate in its inspection result? Explain your answer. (2)

d) Given the economic consequence of inspections, which system, A or B, is preferable? Explain your answer. (2)

52. Given a set of states, $S = \{s_1, s_2, \ldots, s_n\}$ and the probabilities of the states $\{p(s_1), p(s_2), \ldots, p(s_n)\}$, what is the probability-based entropy of S? Express in entropy computation equation. (2)

53. Write the algorithm steps for building a entropy-based decision tree. (5)

54. Document image "zone" classification, using connected component bounding boxes within a zone to determine these three zone type: 1) text-zone or 2) table zone or 3) photo zone. Describe how this method works in English or algorithms steps. (5)

(b) Method 2: using entropy-based decision rules and decision tree using features of zones. Write a list of features in feature vectors for zones that would be good for document zone classification using decision tree. Write at least 5 features, and for each feature explain why it would be useful to distinguish one type of zone from the others. (6)