IT416: Computer Vision

End Semester Examination 2021-22

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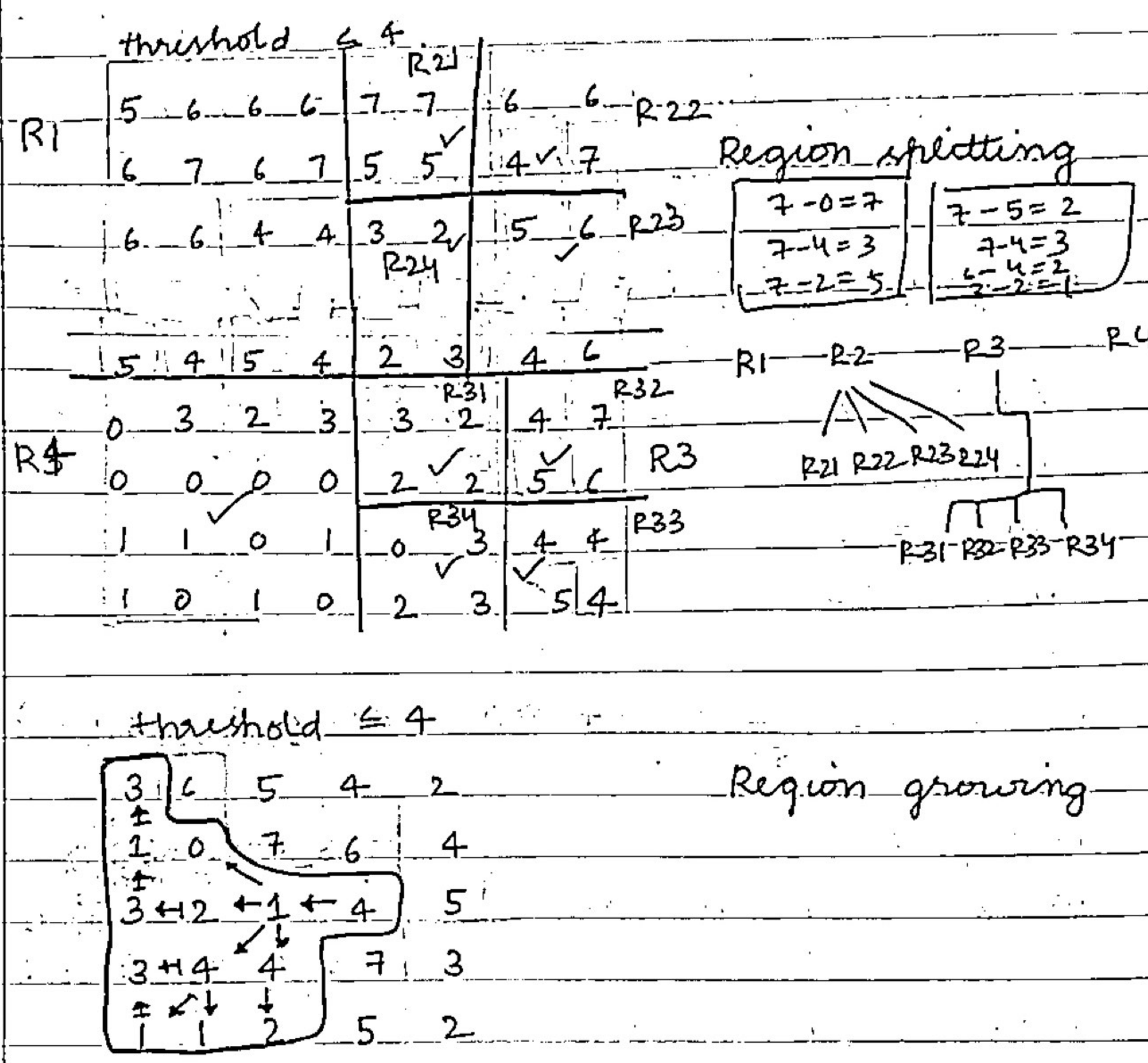
Q1.



Region growing

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Q.2.

2	1	2	1
4	5	5	6
3	2	1	4
6	2	1	6

(i) pixel value	frequency (ni)
0	0
1	4
2	4
3	1
4	2
5	2
6	3
7	0

$$l = \frac{(l_{max} - l_{min})(m - m_{min})}{m_{max} - m_{min}} + l_{min}$$

m = gray level, $l = \frac{(7-0)(m-1)}{6-1} + 0$

$l_{min} = 0$ $\quad l = \frac{7(m-1)}{5}$

$l_{max} = 7$

$m_{min} = 1$

$m_{max} = 6$

$m = 0, \; l = \frac{-7}{5} = -1.4 \approx 0$ $\quad m = 4, \; l = \frac{21}{5} = 4.2 \approx 4$

$m = 1, \; l = 0$ $\quad m = 5, \; l = \frac{28}{5} = 5.6 \approx 6$

$m = 2, \; l = \frac{7}{5} = 1.4 \approx 1$ $\quad m = 6, \; l = \frac{35}{5} = 7 \approx 7$

$m = 3, \; l = \frac{14}{5} = 2.8 \approx 3$ $\quad m = 7, \; l = \frac{42}{5} = 8.2 \approx 7$

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i	0	1	2	3	4	5	6	7
n_i	4	4	0	1	2	0	2	3

Q-3

① Equalise histogram (i)

Gray level	n_k	$P(r_k) = \frac{n_k}{n}$ (PDF)	S_k (CDF)	$S_k \times 7$	histogram equalisation	new
0	80	0.20	0.20	1.4	1	80
1	100	0.25	0.45	3.15	3	100
2	90	0.23	0.68	4.76	5	90
3	60	0.15	0.83	5.81	6	60+30 = 90
4	30	0.07	0.9	6.30	6	
5	20	0.05	0.95	6.65	7	30+10 = 30
6	10	0.02	0.97	6.79	7	
7	0	0	0.97	6.79	7	

$n = 390$

② Equalize histogram (ii)

Gray level	n_k	$p(r_k) = \frac{n_k}{n}$ (PDF)	S_k (CDF)	$S_k \times 7$	histogram equalisation
0	0	0	0	0	0
1	0	0	0	0	0
2	0	0	0	0	0
3	60	0.15	0.15	1.05	1
4	80	0.20	0.35	2.45	2
5	100	0.25	0.6	4.2	4
6	80	0.20	0.8	5.6	6
7	70	0.12	0.97	6.79	7

$n = 390$

③ mapping step

(i) Take first and last column of histogram (ii)

(ii) Take the last two columns of histogram (i)

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(ii)

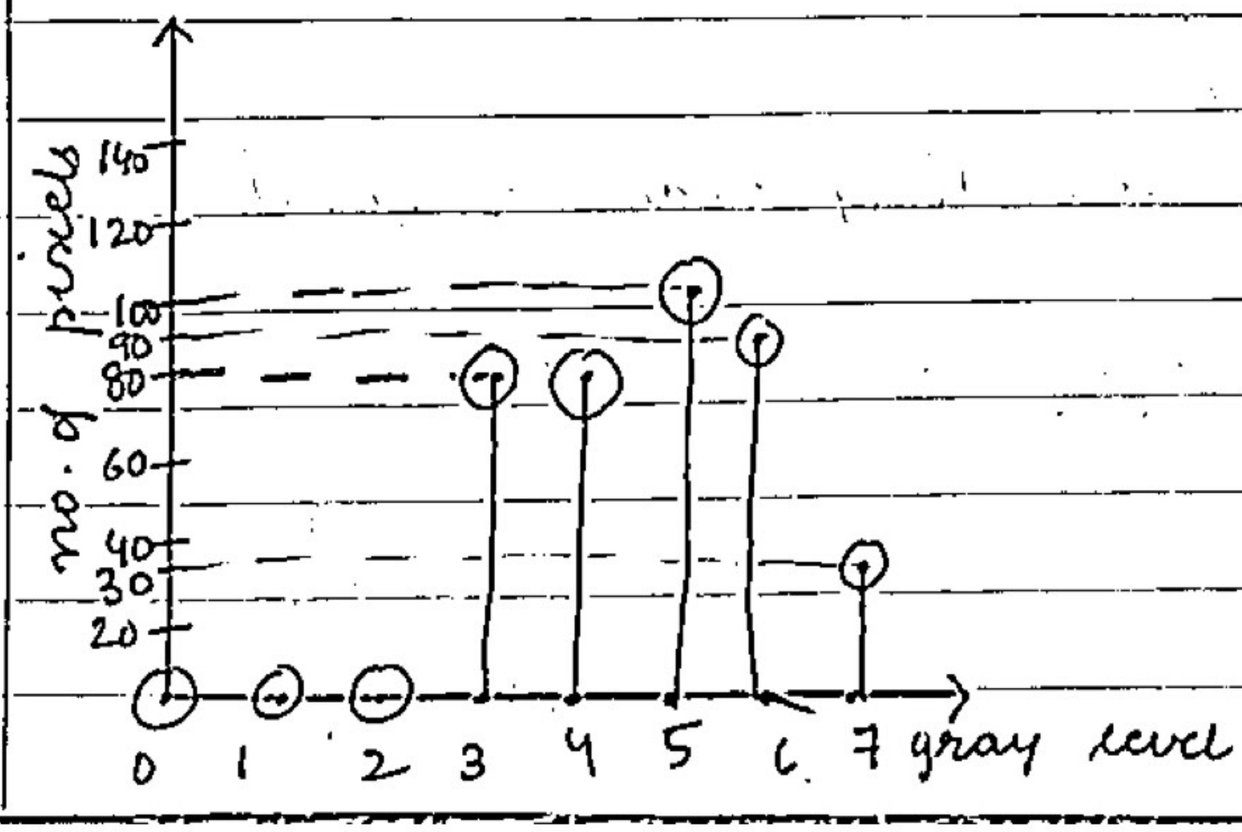
gray level	histogram equalisation level
0	0
1	0
2	0
3	1
4	2
5	4
6	6
7	7

(i)

histogram equalisation level	new n_k
1	80
3	100
5	90
6	90
6	
7	
7	30
7	

gray level	0	1	2	3	4	5	6	7
no. of pixels	0	0	0	80	80	100	90	30

the final histogram will be.



Q 4. $f(3)$

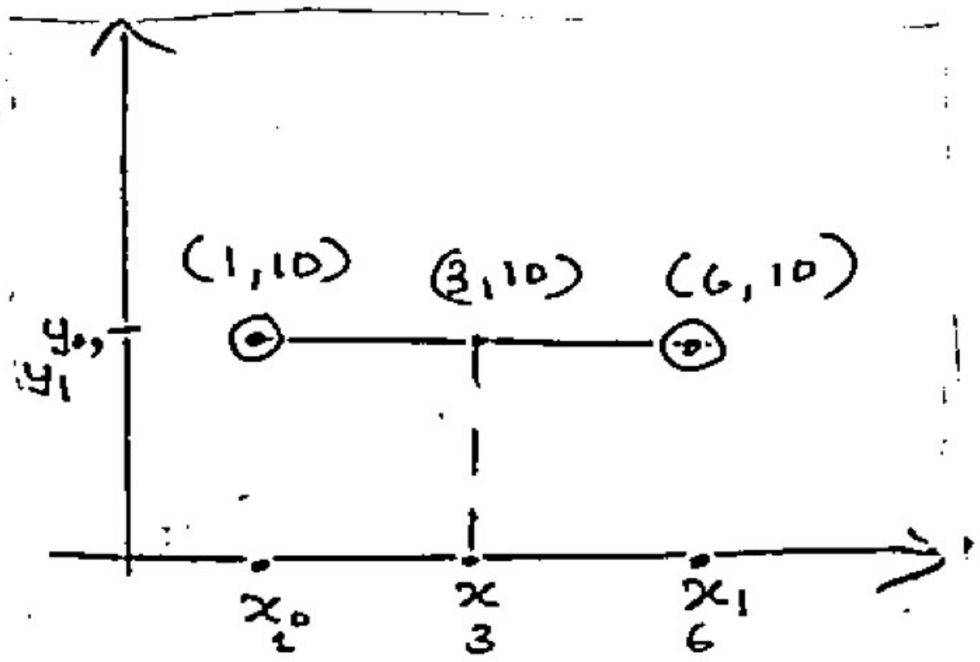
$f(1) = 10$

$f(6) = 10$

$x_0 = 1$, $y_0 = 10$

$x_1 = 6$, $y_1 = 10$

$x = 3$, $y = ?$



$$y = y_0 + \frac{y_1 - y_0}{x_1 - x_0}(x - x_0)$$

$$= 10 + \frac{10 - 10}{6 - 1}(3 - 1) = 10$$

Q5.

7	7	4
6	4	3
1	0	7

3×3

(a) Mean filter

$= \frac{1}{9}[7+7+4+6+4+3+1+0+7]$

$= \frac{39}{9} = 4.33 \approx 4$

(c) Weighted average filter

Structuring element

1	1	1
1	2	1
1	1	1

3×3

$= \frac{1}{9}[7\times1 + 7\times1 + 4\times1 + 6\times1 + 4\times2 + 3\times1 + 1\times1 + 0\times1 + 1\times7]$

$= \frac{43}{9} = 4.77 \approx 5$

(b) Median filter

→ arrange in ascending order to find median

$= 0, 1, 3, 4, 4, 6, 7, 7, 7$

$= 4$

(d) Min filter

0, 1, 3, 4, 4, 6, 7, 7, 7

= 0 (take minimum of all values.

(e) Max filter

0, 1, 3, 4, 4, 6, 7, 7, 7

= 7 (take maximum of all values)

Q6)

x_1	1	2	2	3	4	5
x_2	1	1	3	2	3	5

Step 1 : Choose random 2 cluster centers

Say, $v_1 = (2,1)$ and $v_2 = (2,3)$

Step 2 : Find the distance between the cluster centers and each data points

Data Point	Distance from (2,1)	Distance from (2,3)	Assigned cluster center
$d_1(1,1)$	$\sqrt{1^2+1^2} \approx 1$	2.24	V1
$d_2(2,1)$	0	2	V1
$d_3(2,3)$	2	0	V2
$d_4(3,2)$	1.41	1.41	V1
$d_5(4,3)$	2.83	2	V2
$d_6(5,5)$	5	3.61	V2

Step 3 :-

List data points in each cluster :-

Cluster 1 : V_1 { d_1, d_2, d_4 }

Cluster 2 : V_2 : d_3, d_5, d_6 }

Step 4 : Recalculate the cluster centers

$$V_1 = \frac{1}{3}[(1,1) + (2,1) + (3,2)]$$

$$= (2, 1.33)$$

$$V_2 = \frac{1}{3}[(2,3) + (4,3) + (5,5)]$$

$$= \frac{1}{3}(11, 11)$$

$$= (3.67, 3.67)$$

Step 5 :- Repeat step 2, 3 and 4 till results converge i.e cluster elements do not change

Data point	Distance from V_1 (2, 1.33)	Distance from V_2 (3.67, 3.67)	Assigned Cluster center
d_1 (1,1)	1.05	3.78	V_1
d_2 (2,1)	0.33	3.15	V_1
d_3 (2,3)	1.67	1.8	V_1
d_4 (3,2)	1.20	1.8	V_1
d_5 (4,3)	2.61	0.75	V_2
d_6 (5,5)	4.74	1.88	V_2

Cluster 1 : V_1 { d1, d2, d3, d4 }

Cluster 2 : V_2 = { d5, d6 }

Recalculate as in step 4

$$V_1 = \frac{1}{4}[d1 + d2 + d3 + d4]$$

$$= \frac{1}{4}[(1,1) + (2,1) + (2,3) + (3,2)] \quad = (2, 1.75)$$

$$V_2 = \frac{1}{2}[d5, d6]$$

$$= \frac{1}{2}[(4,3) + 5,5)]$$

$$= (4.5, 4)$$

Since, cluster elements differ from previous cluster elements, we need to recalculate and assign to clusters.

Data points	Distance from V_1 (2, 1.75)	Distance from V_2 (4.5, 4)	Assigned cluster center
d1 (1,1)	$\sqrt{1^2+0.75^2} = 1.25$	4.61	V_1
d2 (2,1)	$\sqrt{0+0.75^2} = 0.75$	3.9	V_1
d3 (2,3)	$\sqrt{1.25^2} = 1.25$	2.69	V_1
d4 (3,2)	1.03	2.5	V_1
d5 (4,3)	2.36	1.12	V_2
d6 (5,5)	4.42	1.12	V_2

New clusters

Cluster 1 : $V_1 : \{d1, d2, d3, d4\}$

Cluster 2 : $V_2 : \{d5, d6\}$

There is no change in cluster elements compared to previous iteration.

Therefore, no more iterations are required.

So, final clusters are:

cluster 1: $V_1 \{d1, d2, d3, d4\} = \{(1,1), (2,1), (2,3), (3,2)\}$

cluster 2: $V_2 : \{d5, d6\} = \{(4,3), (5,5)\}$