Medical Image Analysis

Week 2: Assignment Key and Solution

Answer key:

Q. No.	Ans. Key
1	a
2	c
3	b
4	d
5	c
6	a
7	b
8	c
9	c
10	b

Q. No.	Ans. Key
11	d
12	d
13	c
14	b
15	d
16	d
17	c
18	b
19	-
20	d

Solutions to selected questions:

Q1. First, calculate LBP for continuously 45° rotation.

LBP1 (0° rotation of the given matrix) = {00111100} = 60

LBP2 (45° rotation of the given matrix) = {01111000} = 120

Calculate up to LBP_8 = 30

Finally, $LBP_{ri} = \min_k \{LBP_k\} = 15$

For more detail refer Lec. 2.1 Slide No. 11.

Q2. Calculate the co-occurrence matrix of the given matrix as discussed in Lec 2.1 Slide No. 11.

	0	**1**	**2**	**3**
0	0	0	2	0
1	0	0	1	1
2	1	2	0	0
3	2	0	0	0

Operator: NE 1px

Q3. Calculate the co-occurrence matrix of the given matrix as discussed in Lec. 2.1 Slide No.11

	0	**1**	**2**	**3**
0	0	0	2	0
1	0	0	1	1
2	1	2	0	0
3	2	0	0	0

Operator: NE 1px

Then, calculate probability as shown in below:

	0	**1**	**2**	**3**
0	0	0	2/9	0
1	0	0	1/9	1/9
2	1/9	2/9	0	0
3	2/9	0	0	0

Probability

Now, calculate the Entropy as discussed in lecture Lec. 2.1 Slide No. 11.

$$Entropy = \sum_{a,b} P_{\varphi,d}(a,b)\log(P_{\varphi,d}(a,b))$$

Q4. Calculate the co-occurrence matrix of the given matrix as discussed in lecture Lec. 2.1 Slide No.11.

	0	**1**	**2**	**3**
0	0	0	2	0
1	0	0	1	1
2	1	2	0	0
3	2	0	0	0

Operator: NE 1px

Then, calculate probability as shown in below:

	0	**1**	**2**	**3**
0	0	0	2/9	0
1	0	0	1/9	1/9
2	1/9	2/9	0	0
3	2/9	0	0	0

Probability

Now, calculate the Energy as discussed in lecture Lec. 2.1 Slide No. 11.

$$Energy = \sum_{a,b} P^2_{\varphi,d}(a,b)$$

Q5. Euclidean distance between pixels $\boldsymbol{x}$and $\boldsymbol{y}$ is given as,

$d(\boldsymbol{x},\boldsymbol{y}) = \sqrt{(x_R - y_R)^2 + (x_G - y_G)^2 + (x_B - y_B)^2}$

$$\therefore d(A,S) = 10, d(B,S) = 9.54, d(C,S) = 6.16, d(D,S) = 7.14$$

Q6. Initial centroids, C_o = (1,1,2) and C_1=(2,3,1). Distance of pixels from centroids:

Pixel	**C_o=(1,1,2)**	**C_1=(2,3,1)**
(1,1,2)	0	2.45
(3,6,1)	5.47	3.16
(2,3,1)	2.45	0
(5,4,7)	7.07	6.78

Cluster 1: {(1,1,2)} and cluster 2: {(2,3,1),(3,6,1),(5,4,7)}. Updated centroids are, C_o=(1,1,2) and C_1=(3.34,4.34,3).

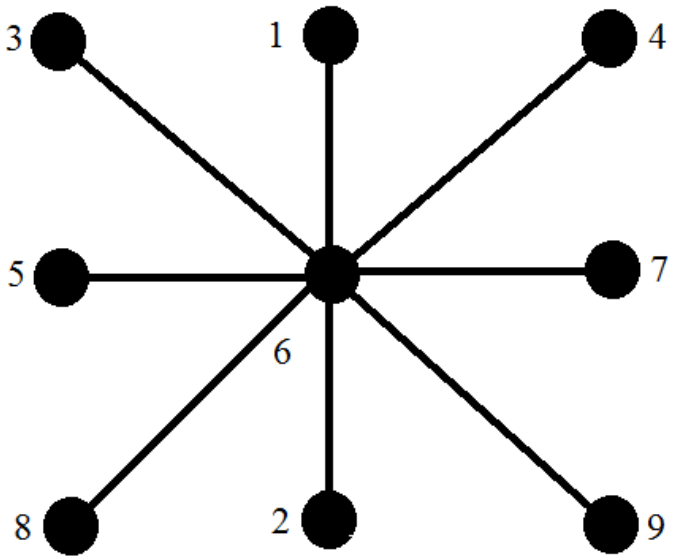
Q7.

Pixel	**Distance**	
	ω_1	**ω_2**
A	58.29	301.73
B	116.73	172.26
C	242.5	64.77
D	29.58	267.84

A - ω_1, B - ω_1, C - ω_2, D - ω_1,

Q8. Refer Lec. 2.2 Slide no. 3

Q9. First, convert the RGB image into graph shown in figure below where the node numbers are taken from notation matrix.



Graphical representation of the image

Now, calculate the edge weights connected to the node no: 6 with the help of the equation below where the β value changes with the direction of the edge (vertical, horizontal and diagonal) given in the question.

$$W_{i,j} = e^{-\beta \|c_i - c_j\|}$$

For more detail see Lec. 2.3 Slide No. 5.

Q10. Calculate degree as discussed in Lec. 2.3 Slide No. 6.

$$d_p = \sum_q W_{pq}$$

Q11. Calculate the values of $L_{44}, L_{3,5}$ as discussed Lec. 2.3 Slide No. 6.

$$L_{pq} = \begin{cases} d_p, \text{if } p = q \\ -W_{pq}, \text{if } v_p, v_p \text{ adjacent} \\ 0, \text{otherwise} \end{cases}$$

Q12. I is a 3×3 matrix, so L is a 9×9 matrix and there are 2 marked node in the matrix so, L_M is 2×2 matrix and L_U is 7×7.

Hence, B^T is 7×2 and X is 7×2 (Calculate using the equation given in the question.)

For more detail refer Lec. 2.3 Slide No. 7.

Q13. Refer Lec. 2.4 Slide No. 4 and 6.

$$\mathbf{r}(s_1) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, \mathbf{r}(s_2) = \begin{bmatrix} 2 \\ 2 \end{bmatrix}, \mathbf{r}(s_3) = \begin{bmatrix} 3 \\ 3 \end{bmatrix}$$

$$\text{Elasticity} = \left\|\frac{\partial \mathbf{r}(s_3)}{\partial s}\right\| = \left\|\frac{\mathbf{r}(s_3) - \mathbf{r}(s_2)}{\|\mathbf{r}(s_3) - \mathbf{r}(s_2)\|}\right\| = \left\|\frac{\begin{bmatrix}3\\3\end{bmatrix} - \begin{bmatrix}2\\2\end{bmatrix}}{\sqrt{2}}\right\| = 1$$

Q14. Refer Lec. 2.4 Slide No. 4 and 6.

Follow down steps from **Q13.** Replace the elasticity equation with stiffness equation

Q15. Refer Lec. 2.4 Slide No. 4. (Use W1 = W2 = 1)

Q16. Refer Lec. 2.4 Slide No. 4.

Q17. Refer Lec. 2.5 Slide no. 11

Q18. Sensitivity = $\frac{TP}{TP+FN}$ = 0.77

Precision = $\frac{TP}{TP+FP}$ = 0.83

Q19. Marks to all

Q20. Refer Lec. 2.5 Slide no. 12