

(1)

QUESTION 1

Part (A)

Roll No - 17K-3867

Digits	A	B	$\stackrel{\text{1st}}{=}$	$s_1(8,5)$	$s_2(2,4)$
1	8	5	1	0	6.08
7	4	8	7	5 \rightarrow	4.47
3	2	4	3	6.08	0
8	6	9	8	4.47	6.40
6	3	5	6	5	1.41 4.41
7	4	8	7	5	4.32

for iteration 1:

for seed 1(8,5) :

$$\begin{aligned} &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(8-4)^2 + (5-8)^2} \\ &= 0 \end{aligned}$$

for seed 2(2,4) :

$$\begin{aligned} &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(2-4)^2 + (4-8)^2} \\ &= 6.08 \end{aligned}$$

for seed 1(8,5) :

$$\begin{aligned} &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(8-4)^2 + (8-5)^2} \\ &= 4.12 \end{aligned}$$

for seed 2(2,4) :

$$\begin{aligned} &= \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \\ &= \sqrt{(2-4)^2 + (4-8)^2} \\ &= 4.47 \end{aligned}$$

for seed 1(2,4) :

$$\begin{aligned} &= \sqrt{(2-8)^2 + (5-4)^2} \\ &= 6.08 \end{aligned}$$

for seed 2(2,4) :

$$\begin{aligned} &= \sqrt{(2-2)^2 + (4-4)^2} \\ &= 0 \end{aligned}$$

$c_1 : (S/U) \rightarrow 1, 2, 8, 5$

$c_2 : (\text{letter}) \rightarrow 3, 6, 7, 7$

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$$c_1 \text{ centroid} = \left(\frac{8+6}{2}, \frac{5+9}{2} \right) = (7, 7)$$

$$c_2 \text{ centroid} = \left(\frac{2+3+4+4}{4}, \frac{4+5+8+8}{4} \right) = (3.25, 6.25)$$

2nd iteration

$$(7, 7) \quad (3.25, 6.25)$$

1 2.23 4.91

7 3.16 1.9103"

3 5.83 2.571"

8 2.23" 3.88

6 4.0411" 1.227"

7 3.116 1.09903"

$c_1 \rightarrow 1, 8$

$c_2 \rightarrow 7, 3, 6, 7$

Since c_1 & c_2 are same therefore, point of convergence has reached and these are final clusters.

QUESTION 1

(3)

(B)

	D2(1,1)	D3(4,1)
D1 (2,1)	1	2
D2 (1,1)	0	3
D3 (4,1)	3	0
D4 (1,2)	1 0.16	3.16
D5 (2,2)	1.414	2.23
D6 (4,2)	3.018	1

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$$c_1 = 1, 2, 4, 5 \quad c_2 = 3, 6$$

$$\text{centroid of } c_1 = \left(\frac{2+1+1+2}{4}, \frac{1+1+2+2}{4} \right)$$

$$c_1 = (1.5, 1.5)$$

$$\text{centroid of } c_2 = \left(\frac{4+4}{2}, \frac{1+2}{2} \right)$$

$$c_2 = (4, 1.5)$$

	(1.5, 1.5)	(4, 1.5)
D1 (2, 1)	0.707	2.06
D2 (1, 1)	0.707	3.04
D3 (4, 1)	2.54	0.5
D4 (1, 2)	0.707	3.04
D5 (2, 2)	0.707	2.06
D6 (4, 2)	2.54	0.5

$$c_1 = 1, 2, 4, 5$$

$$c_2 = 3, 6$$

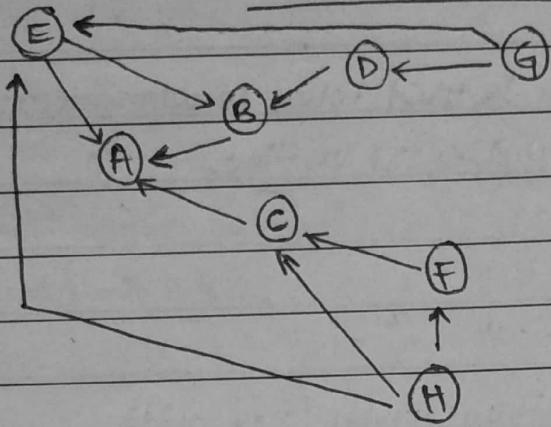
Since the clusters have not changed in 2nd iteration. ∴ These are final clusters.

Name - Ayesha Asraf
 Roll No - 17K-3867 - F
 Course - AI

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QUESTION 2 (A)



QUESTION 2 (B)

$$\rightarrow P(OS = \text{Pass} | ITC = \text{Pass})$$

$$= \frac{P(OS = \text{Pass}, ITC = \text{Pass})}{P(ITC = \text{Pass})}$$

$$= \frac{P(OS = \text{Pass} | DS) \cdot P(DS | ITC = \text{Pass}, OOP) \cdot P(OOP) \cdot P(ITC = \text{Pass})}{P(ITC = \text{Pass})}$$

$$= P(OS = \text{Pass} | DS) \cdot P(DS | ITC = \text{Pass}, OOP) \cdot P(OOP)$$

DS	OOP	$P(OS = \text{Pass} DS)$	$P(DS ITC = \text{Pass}, OOP)$	$P(OOP)$
Pass	Pass	0.3	0.2	0.4
Pass	Fail	0.3	0.3	0.6
Fail	Pass	0.8	0.8	0.4
Fail	Fail	0.8	0.7	0.6

$$= (0.5)(0.2)(0.4) + (0.3)(0.3)(0.6) + (0.8)(0.8)(0.4) + (0.8)(0.7)(0.6)$$

$$= 0.67$$

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QUESTION 3 (A)

Constraint satisfaction problem is used when constraints are predefined, gives effective result & solve problem in less time.

Examples :

① Sudoku

Variables = arbitrary number ($n \times n$ grid)

Domain = $\{1 - 9\}$

Constraints \Rightarrow

- ① In each row, all unique digits
- ② In each col, all unique digits
- ③ In each 3×3 box, all unique digits.

② Cryptarithmetic

Variables = $\{F, O, U, R\}$

Domain = $\{0 - 9\}$

constraint = Two alphabets cannot have same value.

③ N-Queen Prob

Variables = Q_1, Q_2, \dots, Q_n

Domain = $\{x, y\}$

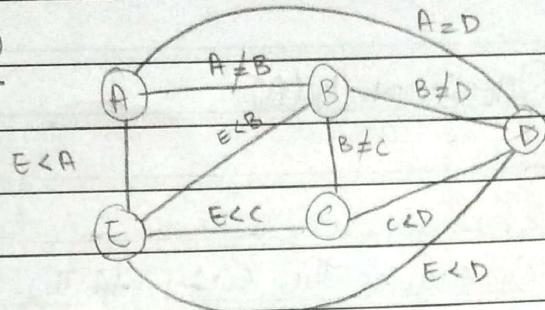
constraint = no two queen at such a position that they attack each other.

Name - Ayesha Asraf
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QUESTION 3(B)



$$A = \{1, 2, 3, 4\}$$

$$B = \{1, 2, 3, 4\}$$

$$C = \{1, 2, 3, 4\}$$

$$D = \{1, 2, 3, 4\}$$

$$E = \{1, 2, 3, 4\}$$

$$\begin{array}{cccccccccc} & ① & ② & ③ & ④ & ⑤ & ⑥ & ⑦ & ⑧ & ⑨ \\ A-B & | & B-A & | & B-D & | & D-B & | & B-C & | & C-B & | & B-E & | & E-B & | & A-D & | \\ \text{⑩} & D-A & | & D-C & | & C-D & | & C-E & | & E-C & | & A-E & | & E-A & | & E-D & | & D-E & | \end{array}$$

$$\begin{array}{cccccccccc} \text{add} & \rightarrow & B-E & | & A-D & | & B-D & | & B-C & | & D-C & | & C-B & | & D-A & | & B-A & | & D-B & | & E-B & | \\ & ⑪ & ⑫ & ⑬ & ⑭ & ⑮ & ⑯ & ⑰ & ⑱ & ⑲ & ⑳ & ⑳ & ⑳ & ⑳ & ⑳ & ⑳ & ⑳ & ⑳ & ⑳ & ⑳ & ⑳ \end{array}$$

$$\textcircled{1} \quad \textcircled{A} \longrightarrow \textcircled{B} \Rightarrow A \neq B.$$

$$\{1, 2, 3, 4\} \neq \{1, 2, 4\} \rightarrow \text{same}$$

$$\textcircled{2} \quad \textcircled{B} \longrightarrow \textcircled{A} \Rightarrow B \neq A$$

$$\{1, 2, 4\} \neq \{1, 2, 3, 4\} \rightarrow \text{same}$$

$$\textcircled{3} \quad \textcircled{B} \longrightarrow \textcircled{D} \Rightarrow B \neq D$$

$$\{1, 2, 4\} \neq \{1, 2, 3, 4\} \rightarrow \text{same}$$

$$\textcircled{4} \quad \textcircled{D} \longrightarrow \textcircled{B}$$

$$\{1, 2, 3, 4\} \neq \{1, 2, 4\}$$

$$\textcircled{5} \quad \textcircled{B} \longrightarrow \textcircled{C}$$

$$\{1, 2, 3, 4\} \neq \{1, 3, 4\}$$

$$\textcircled{6} \quad \textcircled{C} \longrightarrow \textcircled{B}$$

$$\{1, 3, 4\} \neq \{1, 2, 3, 4\} \rightarrow \text{same}$$

$$\textcircled{7} \quad \textcircled{B} \longrightarrow \textcircled{E} \quad E < B$$

$$\{1, 2, 4\} \quad \{1, 2, 3, 4\} \longrightarrow \text{same}$$

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$$\textcircled{8} \textcircled{E} \textcircled{B} \rightarrow E < B$$

→ new added in queue

$$\{1, 2, 3, 4\}$$

$$\{1, 2, 3, 4\} \quad \dots | B - E | \dots$$

$$\textcircled{9} \textcircled{A} \textcircled{D} \rightarrow A = D$$

$$\{1, 2, 3, 4\} = \{1, 2, 3, 4\} \rightarrow \text{same}$$

$$\textcircled{10} \textcircled{D} \textcircled{A}$$

$$\{1, 2, 3, 4\} = \{1, 2, 3, 4\} \rightarrow \text{same}$$

$$\textcircled{11} \textcircled{D} \textcircled{C} \quad C < D$$

add to queue

$$\{1, 2, 3, 4\} > \{1, 3, 4\} \rightarrow \text{shrinked}$$

$$|A - D| B - D$$

$$\textcircled{12} \textcircled{C} \textcircled{D}$$

$$\{1, 3, 4\} < \{2, 3, 4\} \rightarrow \text{shrinked}$$

$$|B - C| D - C |A - D|$$

$$\textcircled{13} \textcircled{C} \textcircled{E} \quad E < C$$

$$\{1, 3\} < \{1, 2, 3\} \rightarrow \text{same}$$

$$\textcircled{14} \textcircled{E} \textcircled{C}$$

$$\{1, 2, 3\} < \{1, 3\} \rightarrow \text{shrinked}$$

$$|C - B|$$

$$\textcircled{15} \textcircled{A} \textcircled{E} \quad E < A$$

$$\{1, 2, 3, 4\} > \{1, 2\} \rightarrow \text{shrinked}$$

$$|D - A| B - A$$

$$\textcircled{16} \textcircled{E} \textcircled{A} \quad E < A$$

$$\{1, 2\} < \{2, 3, 4\} \rightarrow \text{same}$$

$$\textcircled{17} \textcircled{E} \textcircled{D} \quad E < D$$

$$\{1, 2\} < \{2, 3, 4\} \rightarrow \text{same}$$

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(8) $D \rightarrow E$

$$\{2, 3, 4\} > \{1, 2\} \rightarrow \text{same}$$

(9) $B \rightarrow E$ $E < B$

$$\{2, 4\} > \{1, 2\} \rightarrow \text{shifted} \quad |E - B|$$

(10) $A \rightarrow D$

$$\{2, 3, 4\} \quad \{2, 3, 4\} \rightarrow \text{same}$$

(11) $B \rightarrow D$ $B \neq D$

$$\{2, 4\} \quad \{2, 3, 4\} \rightarrow \text{same}$$

(12) $E \rightarrow C$ $B \neq C$

$$\{2, 4\} \quad \{1, 3\} \rightarrow \text{same}$$

(13) $D \rightarrow C$ $C < D$

$$\{2, 3, 4\} > \{1, 3\} \rightarrow \text{same}$$

(14) $C \rightarrow B$ $B \neq C$

$$\{1, 3\} \quad \{2, 4\}$$

{Final values:}

$$\rightarrow A = \{2, 3, 4\}$$

$$\rightarrow B = \{2, 4\}$$

$$\rightarrow C = \{1, 3\}$$

$$\rightarrow D = \{2, 3, 4\}$$

$$\rightarrow E = \{1, 2\}$$

(15) $B \rightarrow A$ $A \neq B$

$$\{2, 4\} \quad \{2, 3, 4\}$$

(16) $D \rightarrow B$ $B \neq D$

$$\{2, 3, 4\} \quad \{2, 4\}$$

(17) $E \rightarrow B$ $E < B$

$$\{1, 2\} \quad \{2, 4\}$$

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Name - Ayesha Ausaf

Roll No - 17K-3867 - F

Course - AI

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QUESTION 4 (A)

Machine Learning

Application of AI which enables the system to have the ability to learn and improve automatically (without explicit programming). It learns by the data which is given.

Types

- Supervised learning
- Unsupervised learning
- Reinforcement learning

Classification

- ① Supervised learning
- ② Predefined labels given
- ③ Categorizes on the basis of training data

Clustering

- ① Unsupervised learning
- ② Labels are not predefined.
- ③ Learns from the observation.

QUESTION 4(B)

Entropy of label

Covid 19.	Allergy	Cold
3	3	4

$$\begin{aligned} \text{entropy} &= -\frac{3}{10} \log_2 \left(\frac{3}{10} \right) - \frac{3}{10} \log_2 \left(\frac{3}{10} \right) - \frac{4}{10} \log_2 \left(\frac{4}{10} \right) \\ &= 0.5210 + 0.5210 + 0.5287 \end{aligned}$$

$$\text{entropy} = 1.5707$$

$$IG(\text{headache}) = 1.5707 - \left[\frac{5}{10} \times 1.521 + \frac{5}{10} \times 1.52 \right]$$

Yes	No
5	5
[2, 1, 2]	[1, 2, 2]

$$\begin{aligned} \text{Yes} \rightarrow e &= -\frac{2}{5} \log_2 \left(\frac{2}{5} \right) - \frac{1}{5} \log_2 \left(\frac{1}{5} \right) - \frac{2}{5} \log_2 \left(\frac{2}{5} \right) \\ &= 1.521 \end{aligned}$$

$$\begin{aligned} \text{No} \rightarrow e &= -\frac{1}{5} \log_2 \left(\frac{1}{5} \right) - \frac{2}{5} \log_2 \left(\frac{2}{5} \right) - \frac{2}{5} \log_2 \left(\frac{2}{5} \right) \\ &= 1.521 \end{aligned}$$

$$IG(\text{headache}) = 0.0497$$

$$IG(\text{cough}) = 1.5707 - \left[\frac{5}{10} (0.71) + \frac{5}{10} (0.96) \right]$$

Yes	No
5	5
[2, 3, 0]	

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$$-\frac{1}{5} \log_2 \left(\frac{1}{5} \right) - \frac{4}{5} \left(\log_2 \left(\frac{4}{5} \right) \right) ; -\frac{2}{5} \log_2 \frac{2}{5} - \frac{3}{5} \log_2 \frac{3}{5}$$

$$\approx 0.46 + 0.25 = 0.71$$

$$\approx 0.96$$

$$IG(\text{cough}) = 0.7357$$

$$IG(\text{fever}) = 1.5707 - \left[0 + \frac{1}{10} (0.98) \right]$$

Yes

3

$$[3, 0, 0] <_{\geq 0}$$

No

7

$$[0, 3, 4]$$

$$e = -\frac{3}{7} \log_2 \left(\frac{3}{7} \right) - \frac{4}{7} \log_2 \left(\frac{4}{7} \right)$$

$$\approx 0.98$$

$$IG(\text{fever}) = 0.8847$$

$$IG(\text{fw}) = 1.5707 - \left[\frac{8}{10} (1.405) \right]$$

Yes

8

$$[1, 3, 4]$$

No

2

$$[2, 0, 0] <_{\geq 0}$$

$$-\frac{1}{8} \log_2 \left(\frac{1}{8} \right) - \frac{3}{8} \log_2 \left(\frac{3}{8} \right) - \frac{4}{8} \log_2 \left(\frac{4}{8} \right)$$

$$\approx 0.375 + 0.530 + 0.5$$

$$e = 1.405$$

$$IG(\text{fw}) = 0.4467$$

$$IG(\text{pain in body}) = 1.5707 - \left[\frac{5}{10} (1.521) - \frac{5}{10} (1.521) \right]$$

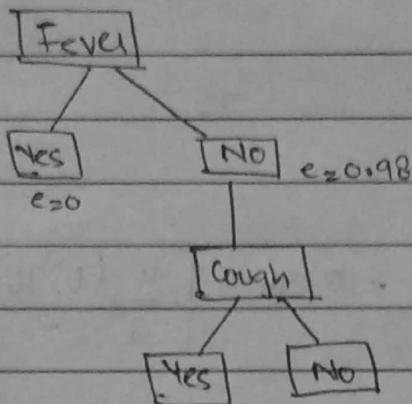
Yes

No

5

5

[1, 2, 2]

[2, 1, 2] $e=1.521$ For No:

$$\text{for entropy of parent} = 0.98$$

$$IG(\text{headache}) = 0.98 - \left[\frac{3}{7} (0.917) + \frac{4}{7} (0.76) \right]$$

Yes

No

3

4

[0, 1, 2]

[0, 2, 2]

$$e = -\frac{1}{3} \log_2 \left(\frac{1}{3} \right) - \frac{2}{3} \log_2 \left(\frac{2}{3} \right)$$

$$e = 0.917$$

$$e = \frac{2}{3} \log_2 \left(\frac{2}{3} \right) - \frac{2}{3} \log_2 \left(\frac{2}{3} \right)$$

$$e = 0.76$$

$$IG(\text{headache}) = 0.152$$

$$IG(\text{cough}) = 0.98 (0)$$

Yes

No

4

3

[0, 0, 4]

[0, 3, 0]

$$IG(\text{wough}) = 0.98$$

$$IG(\text{flu}) = 0.98 - \left[\frac{4}{7} (0.98) \right]$$

Yes	No
7	0
(0, 3, 4)	

$$0.98$$

$$IG(\text{flu}) = 0$$

$$IG(\text{pain in body}) = 0.98 - \left[\frac{4}{7} (0.76) - \frac{3}{7} (0.917) \right]$$

Yes	No
4	3
[0, 2, 2]	[0, 1, 2]
$\epsilon = 0.76$	$\epsilon = 0.917$

$$IG(\text{pain in body}) = 0.938$$

QUESTION 5 (A)

Minimax algo explores the game using depth first search. It computes the decision from current state.

We can use BFS for 2 player game as it can figure out all possible moves from starting position & by using assessment function it can figure out approximately how good of a situation will be after each sequence of move.

