KULLIYAH OF INFORMATION AND COMMUNICATION TECHNOLOGY

SEMESTER 2 2020/2021

CSCI 2304 (SECTION 1)

INTELLIGENT SYSTEMS

ASSIGNMENT 3

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QUESTION 1

1) k = 3, Centroid = C1(4,9) , C2(2,5), C3(1,2)

a) Distance (D) = $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

Distance E01(4,9) to **C1(4,9)**

= $\sqrt{(4-4)^2 + (9-9)^2}$

= 0

Distance E01(4,9) to **C2(2,5)**

= $\sqrt{(4-2)^2 + (9-5)^2}$

= 4.47

Distance E01(4,9) to **C3(1,2)**

= $\sqrt{(4-1)^2 + (9-2)^2}$

= 7.62

Distance E02(8,4) to **C1(4,9)**

$= \sqrt{(8-4)^2 + (4-9)^2}$

= 6.40

Distance E02(8,4) to **C2(2,5)**

$= \sqrt{(8-2)^2 + (4-5)^2}$

= 6.08

Distance E02(8,4) to **C3(1,2)**

$= \sqrt{(8-1)^2 + (4-2)^2}$

= 7.28

Distance E03(2,5) to **C1(4,9)**

$= \sqrt{(2-4)^2 + (5-9)^2}$

= 4.47

Distance E03(2,5) to **C2(2,5)**

$\sqrt{(2-2)^2 + (5-5)^2}$

= 0

Distance E03(2,5) to **C3(1,2)**

$= \sqrt{(2-1)^2 + (5-2)^2}$

= 3.16

Distance E04(5,8) to **C1(4,9)**

$= \sqrt{(5-4)^2 + (8-9)^2}$

= 1.41

Distance E04(5,8) to **C2(2,5)**

$= \sqrt{(5-2)^2 + (8-5)^2}$

= 4.24

Distance E04(5,8) to **C3(1,2)**

$= \sqrt{(5-1)^2 + (8-2)^2}$

= 7.21

Distance E05(1,2) to **C1(4,9)**

$= \sqrt{(1-4)^2 + (2-9)^2}$

= 7.62

Distance E05(1,2) to **C2(2,5)**

$= \sqrt{(1-2)^2 + (2-5)^2}$
= 3.16

Distance E05(1,2) to **C3(1,2)**

$= \sqrt{(1-1)^2 + (2-2)^2}$
= 0

Distance E06(7,5) to **C1(4,9)**

$= \sqrt{(7-4)^2 + (5-9)^2}$
$= 5$

Distance E06(7,5) to **C2(2,5)**

$= \sqrt{(7-2)^2 + (5-5)^2}$
$= 5$

Distance E06(7,5) to **C3(1,2)**

$= \sqrt{(7-1)^2 + (5-2)^2}$
$= 6.71$

Iteration 0	C1(4,9)	C2(2,5)	C3(1,2)	CLUSTER
E01(4,9)	0	4.47	7.62	C1
E02(8,4)	6.40	6.08	7.28	C2
E03(2,5)	4.47	0	3.16	C2
E04(5,8)	1.41	4.24	7.21	C1
E05(1,2)	7.62	3.16	0	C3
E06(7,5)	5	5	6.71	C2

b) The 3 clusters:

- Cluster 1 there is E01(4,9), E04(5,8)
- Cluster 2 there is E02(8,4), E03(2,5) and E06(7,5)
- Cluster 3 there is E05(1,2)

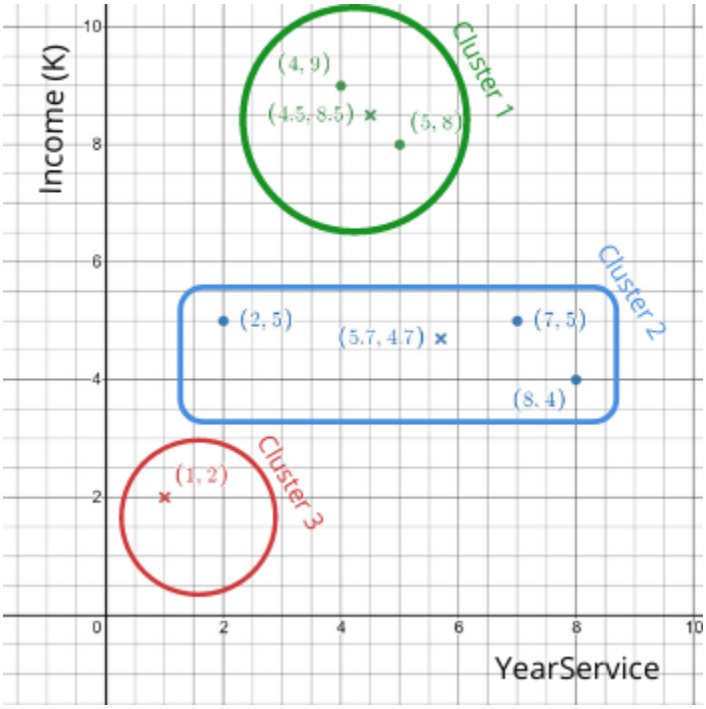
c) Centroids of the new clusters:

- (Cluster 1) C1 – E01(4,9), E04(5,8)
  $= \left(\frac{4+5}{2}, \frac{9+8}{2}\right) = (4.5\ , 8.5)$

- (Cluster 2) C2 – E02(8,4), E03(2,5) and E06(7,5)
  $= \left(\frac{8+2+7}{3}, \frac{4+5+5}{3}\right) = (5.7\ , 4.7)$

- (Cluster 3) C3 – E05(1,2) = (1,2)

d) Draw a 10 by 10 graph with all the 6 points and show the clusters after the first epoch and the new centroids.



e) How many more iterations are needed to converge? Draw the result for each epoch.

The number of iterations needed to achieve convergence is 2 iterations.

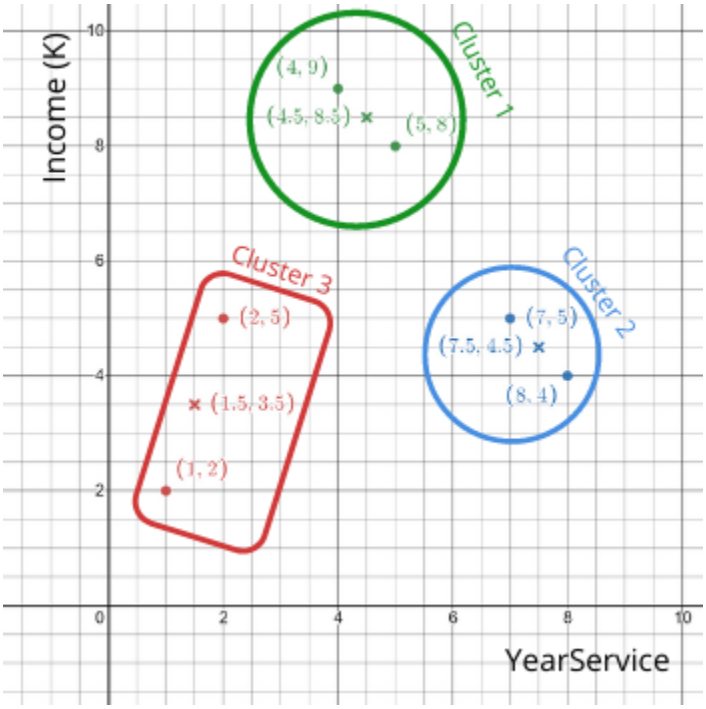
Note: E06 at Iteration 0 belong to 2 clusters which are Cluster 1 & 2. However, the number of iterations needed to achieve convergence is lesser when E06 is appointed to Cluster 2. Thus, E06 is assigned to Cluster 2.

Iteration 1	C1(4,9)	C2(2,5)	C3(1,2)	CLUSTER
E01(4,9)	0.71	4.62	7.62	C1
E02(8,4)	5.70	2.40	7.28	C2
E03(2,5)	4.30	3.71	3.16	C3
E04(5,8)	0.71	3.37	7.21	C1
E05(1,2)	7.38	5.42	0	C3
E06(7,5)	4.30	1.33	6.70	C2

The 3 clusters for Iteration 1:

- Cluster 1 there is E01(4,9), E04(5,8)
- Cluster 2 there is E02(8,4), E06(7,5)
- Cluster 3 there is E03(2,5), E05(1,2)

With centroids $C1(4.5\ ,8.5), C2(7.5\ ,4.5), C3(1.5, 3.5)$



Iteration 2	C1(4,9)	C2(2,5)	C3(1,2)	CLUSTER
E01(4,9)	0.71	5.70	6.04	C1
E02(8,4)	5.70	0.71	6.52	C2
E03(2,5)	4.30	5.52	1.58	C3
E04(5,8)	0.71	4.30	5.70	C1
E05(1,2)	7.38	6.96	1.58	C3
E06(7,5)	4.30	0.71	5.70	C2

The 3 clusters for Iteration 2:

- Cluster 1 there is E01(4,9), E04(5,8)
- Cluster 2 there is E02(8,4), E06(7,5)
- Cluster 3 there is E03(2,5), E05(1,2)

With centroids $C1(4.5\ ,8.5), C2(7.5, 4.5), C3(1.5,3.5)$

QUESTION 2

2) $= f(x) = \left(-\frac{x^2}{8}\right) + 4x$

Chromosome Number	Initial Population	x Value	Fitness Value $f(x)$	Selection Probability
1	0 1 0 1 1	11	28.875	12.145
2	0 1 0 0 1	9	25.875	10.883
3	0 0 1 1 1	7	21.875	9.2
4	0 1 1 1 0	14	31.5	**13.249**
5	0 1 1 0 0	12	30	12.618
6	1 1 1 1 0	30	7.5	3.155
7	1 0 1 1 0	22	27.5	11.567
8	1 1 0 0 1	25	21.875	9.2
9	0 0 0 1 1	3	10.875	4.574
10	1 0 0 0 1	17	31.875	**13.407**
Total			**237.75**	

Table 2: Initial Population

a) **Fitness Value**

Chromosome 1 = $\left(-\frac{11^2}{8}\right) + 4(11) = -15.125 + 44 = \mathbf{28.875}$

Chromosome 2 = $\left(-\frac{9^2}{8}\right) + 4(9) = -10.125 + 36 = \mathbf{25.875}$

Chromosome 3 = $\left(-\frac{7^2}{8}\right) + 4(7) = -6.125 + 28 = \mathbf{21.875}$

Chromosome 4 = $\left(-\frac{14^2}{8}\right) + 4(14) = -24.5 + 56 = \mathbf{31.5}$

Chromosome 5 = $\left(-\frac{12^2}{8}\right) + 4(12) = -18 + 48 = \mathbf{30}$

Chromosome 6 = $\left(-\frac{30^2}{8}\right) + 4(30) = -112.5 + 120 = \mathbf{7.5}$

Chromosome 7 = $\left(-\frac{22^2}{8}\right) + 4(22) = -60.5 + 88 = \mathbf{27.5}$

Chromosome 8 = $\left(-\frac{25^2}{8}\right) + 4(25) = -78.125 + 100 = \mathbf{21.875}$

Chromosome 9 = $\left(-\frac{3^2}{8}\right) + 4(3) = -1.125 + 12 = \mathbf{10.875}$

Chromosome 10 = $\left(-\frac{17^2}{8}\right) + 4(17) = -36.125 + 68 = \mathbf{31.875}$

b) **Fitness Ratio**

Chromosome 1 = $\frac{28.875}{237.75} * 100\% = \mathbf{12.145}$

Chromosome 2 = $\frac{25.875}{237.75} * 100\% = \mathbf{10.883}$

Chromosome 3 = $\frac{21.875}{237.75} * 100\% = \mathbf{9.2}$

Chromosome 4 = $\frac{31.5}{237.75} * 100\% = \mathbf{13.249}$

Chromosome 5 = $\frac{30}{237.75} * 100\% = \mathbf{12.618}$

Chromosome 6 = $\frac{7.5}{237.75} * 100\% = \mathbf{3.155}$

Chromosome 7 = $\frac{27.5}{237.75} * 100\% = \mathbf{11.567}$

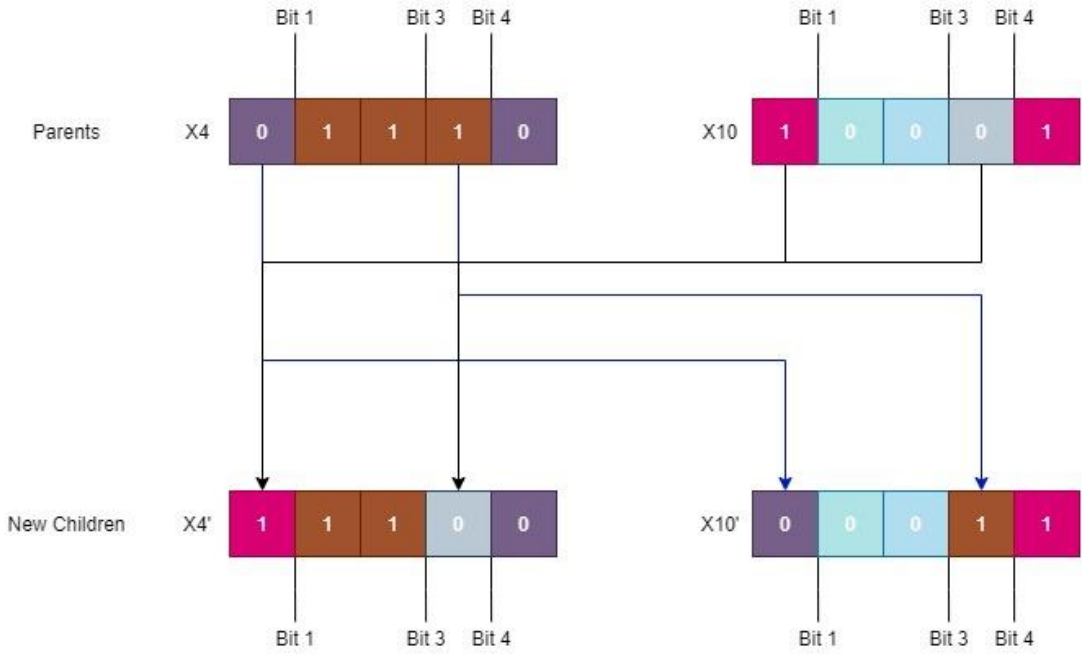
Chromosome 8 = $\frac{21.875}{237.75} * 100\% = \mathbf{9.2}$

Chromosome 9 = $\frac{10.875}{237.75} * 100\% = \mathbf{4.574}$

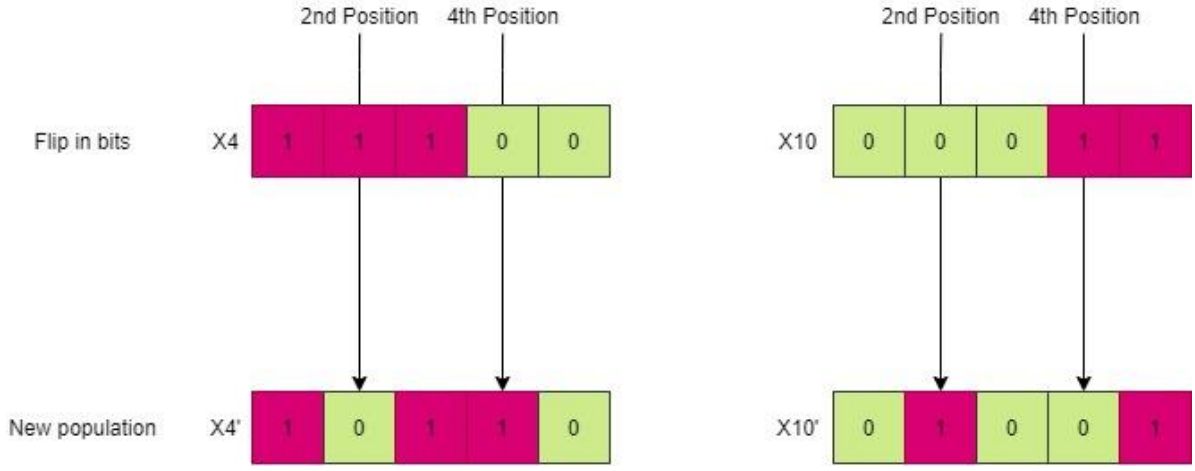
Chromosome 10 = $\frac{31.875}{237.75} * 100\% = \mathbf{13.407}$

The two best chromosomes based on their fitness of fit are chromosomes 4 and 10.

b)


Bit 1
Bit 3
Bit 4
Parents
X4
0 1 1 1 0
X10
1 0 0 0 1
New Children
X4'
1 1 1 0 0
X10'
0 0 0 1 1

c)


2nd Position
4th Position
Flip in bits
X4
1 1 1 0 0
X10
0 0 0 1 1
New population
X4'
1 0 1 1 0
X10'
0 1 0 0 1