Final Assignment

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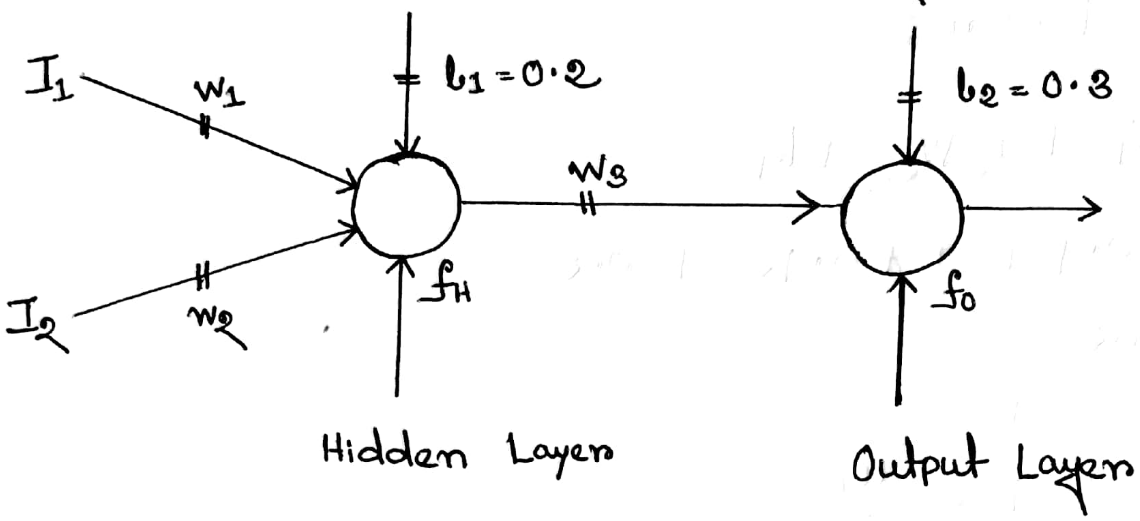
ID: 012193040

Question — 01

Answer :

Given Neural Network Architecture :



My Student ID is = 012 193 040.

Last two digits are : 40.

Therefore,

$$w_1 = \frac{40}{100} = 0.4$$

$$w_2 = \frac{40+2}{100} = 0.42$$

$$w_3 = \frac{40+5}{100} = 0.45$$

Learning rate, $\eta = 40/100 = 0.4$

Momentum Co-efficient, $\mu = 0.55$

Threshold $= 0.4$

Training Model :

Using Pattern 1 $(I_1 = 0,\ I_2 = 1,\ d_1 = 1)$:

Forward Pass :

For Hidden Layer :

$$U_1 = I_1 W_1 + I_2 W_2 + b_1$$

$$= 0 * 0.4 + 1 * 0.42 + 0.2$$

$$= 0.62$$

$$f_H = \frac{1}{1 + e^{-u_1}}$$

$$= \frac{1}{1 + e^{-0.62}}$$

$$= 0.6502$$

For Output Layer :

$$U_1 = f_H W_3 + b_2$$

$$= 0.6502 * 0.45 + 0.3$$

$$= 0.5926$$

$$f_o = \frac{1}{1 + e^{-u_1}}$$

$$= \frac{1}{1 + e^{-0.5926}}$$

$$= 0.6439$$

Back Propagation :

δ-calculation :

For Output Layer :

$$\delta_0 = f_0' (d_1 - f_0)$$

$$= f_0 (1 - f_0)(d_1 - f_0)$$

$$= 0.6439 * (1 - 0.6439)(1 - 0.6439)$$

$$= 0.0816$$

For Hidden Layer :

$$\delta_H = f_H' (\delta_0 * W_3)$$

$$= f_H (1 - f_H)(\delta_0 * W_3)$$

$$= 0.6502 * (1 - 0.6502) * (0.0816 * 0.45)$$

$$= 0.00835$$

Weight Update :

$$\Delta W_3 = \mu * \eta * \delta_0 * f_H$$

$$= 0.55 * 0.4 * 0.0816 * 0.6502$$

$$= 0.0117$$

$$W_3 = W_3 + \Delta W_3$$

$$= 0.45 + 0.0117$$

$$= 0.4617$$

$\Delta w_1 = \mu * \eta * \delta_H * I_1$

$= 0.55 * 0.4 * 0.00835 * 0$

$= 0$

$w_1 = w_1 + \Delta w_1$

$= 0.4 + 0$

$= 0.4$

$\Delta w_2 = \mu * \eta * \delta_H * I_2$

$= 0.55 * 0.4 * 0.00835 * 1$

$= 0.001837$

$w_2 = w_2 + \Delta w_2$

$= 0.42 + 0.00184$

$= 0.4218$

$\Delta b_2 = \mu * \eta * \delta_0 * 1$

$= 0.55 * 0.4 * 0.0816 * 1$

$= 0.0179$

$b_2 = b_2 + \Delta b_2$

$= 0.3 + 0.0179$

$= 0.3179$

$\Delta b_1 = \mu * \eta * \delta_H * 1$

$= 0.55 * 0.4 * 0.00835 * 1$

$= 0.0018$

$b_1 = b_1 + \Delta b_1$

$= 0.2 + 0.0018$

$= 0.2018$

Updated weights are :

$w_3 = 0.4617$; $w_1 = 0.4$; $w_2 = 0.4218$

$b_2 = 0.3179$; $b_1 = 0.2018$

Using Pattern 2 ($I_1 = 1, I_2 = 1, d_2 = 1$) :

Forward Pass :

For Hidden Layer :

$$U_2 = I_1 W_1 + I_2 W_2 + b_1$$

$$= 1 * 0.4 + 1 * 0.4218 + 0.2018$$

$$= 1.0236$$

$$f_H = \frac{1}{1 + e^{-u_2}}$$

$$= \frac{1}{1 + e^{-1.0236}}$$

$$= 0.7357$$

For Output Layer :

$$U_2 = (f_H * W_3) + b_2$$

$$= (0.7357 * 0.4617) + 0.3179$$

$$= 0.6576$$

$$f_0 = \frac{1}{1 + e^{-u_2}}$$

$$= \frac{1}{1 + e^{-0.6576}}$$

$$= 0.6587$$

Back Propagation :

δ-Calculation :

For Output Layer :

$$\delta_0 = f_0' (d_2 - f_0)$$
$$= f_0 (1 - f_0)(d_2 - f_0)$$
$$= 0.6587 (1 - 0.6587)(1 - 0.6587)$$
$$= 0.0767$$

For Hidden Layer :

$$\delta_H = f_H (\delta_0 * W_3)$$
$$= f_H (1 - f_H)(\delta_0 * W_3)$$
$$= 0.7357 (1 - 0.7357)(0.0767 * 0.4617)$$
$$= 0.0069$$

Weight Update :

$$\Delta W_3 = \mu * \eta * \delta_0 * f_H$$
$$= 0.55 * 0.4 * 0.0767 * 0.7357$$
$$= 0.0124$$

$$W_3 = W_3 + \Delta W_3$$
$$= 0.4617 + 0.0124$$
$$= 0.4741$$

$$\Delta W_1 = \mu * \eta * \delta_H * I_1$$
$$= 0.55 * 0.4 * 0.0069 * 1$$
$$= 0.0015$$

$$W_1 = W_1 + \Delta W_1$$
$$= 0.4 + 0.0015$$
$$= 0.4015$$

$\Delta w_2 = \mu * \eta * \delta_H * I_2$

$= 0.55 * 0.4 * 0.0069 * 1$

$= 0.0015$

$w_2 = w_2 + \Delta w_2$

$= 0.4218 + 0.0015$

$= 0.4233$

$\Delta b_2 = \mu * \eta * \delta_0 * 1$

$= 0.55 * 0.4 * 0.0767 * 1$

$= 0.0169$

$b_2 = b_2 + \Delta b_2$

$= 0.3179 + 0.0169$

$= 0.3348$

$\Delta b_1 = \mu * \eta * \delta_H * 1$

$= 0.55 * 0.4 * 0.0069 * 1$

$= 0.0015$

$b_1 = b_1 + \Delta b_1$

$= 0.2018 + 0.0015$

$= 0.2033$

Updated weights are :

$w_3 = 0.4741$; $w_1 = 0.4015$; $w_2 = 0.4233$

$b_2 = 0.3348$, $b_1 = 0.2033$

One epoch completed.

Testing the Model:

$I_1 = 1$, $I_2 = 0$, Output = ?

Forward Pass:

For Hidden Layer:

$$u = I_1 W_1 + I_2 W_2 + b_1$$

$$= 1 * 0.4015 + 0.04218 + 0.2033$$

$$= 0.6048$$

$$f_H = \frac{1}{1+e^{-u}}$$

$$= \frac{1}{1+e^{-0.6048}}$$

$$= 0.6467$$

For Output Layer:

$$u = f_H W_3 + b_2$$

$$= 0.6467 * 0.4741 + 0.3348$$

$$= 0.6414$$

$$f_0 = \frac{1}{1+e^{-u}}$$

$$= \frac{1}{1+e^{-0.6414}}$$

$$= 0.6551$$

Given Threshold $= 0.4$

Since, $f_0 (= 0.6551) >= 0.4$

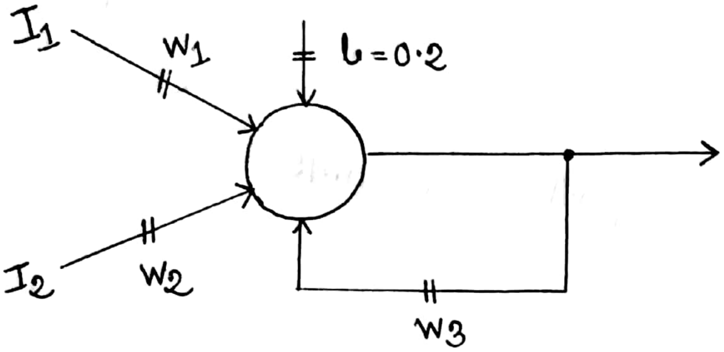
Output $= \underline{1}$

So, neuron fires.

Question - 02

Answer :

Given Neural Network Architecture :



My Student ID = 012193040.

Last two digits are : 40

Therefore,

$w_1 = 40/100 = 0.4$

$w_2 = (40+2)/100 = 0.42$

$w_3 = (40+5)/100 = 0.45$

Learning rate, $\eta = 40/100 = 0.4$

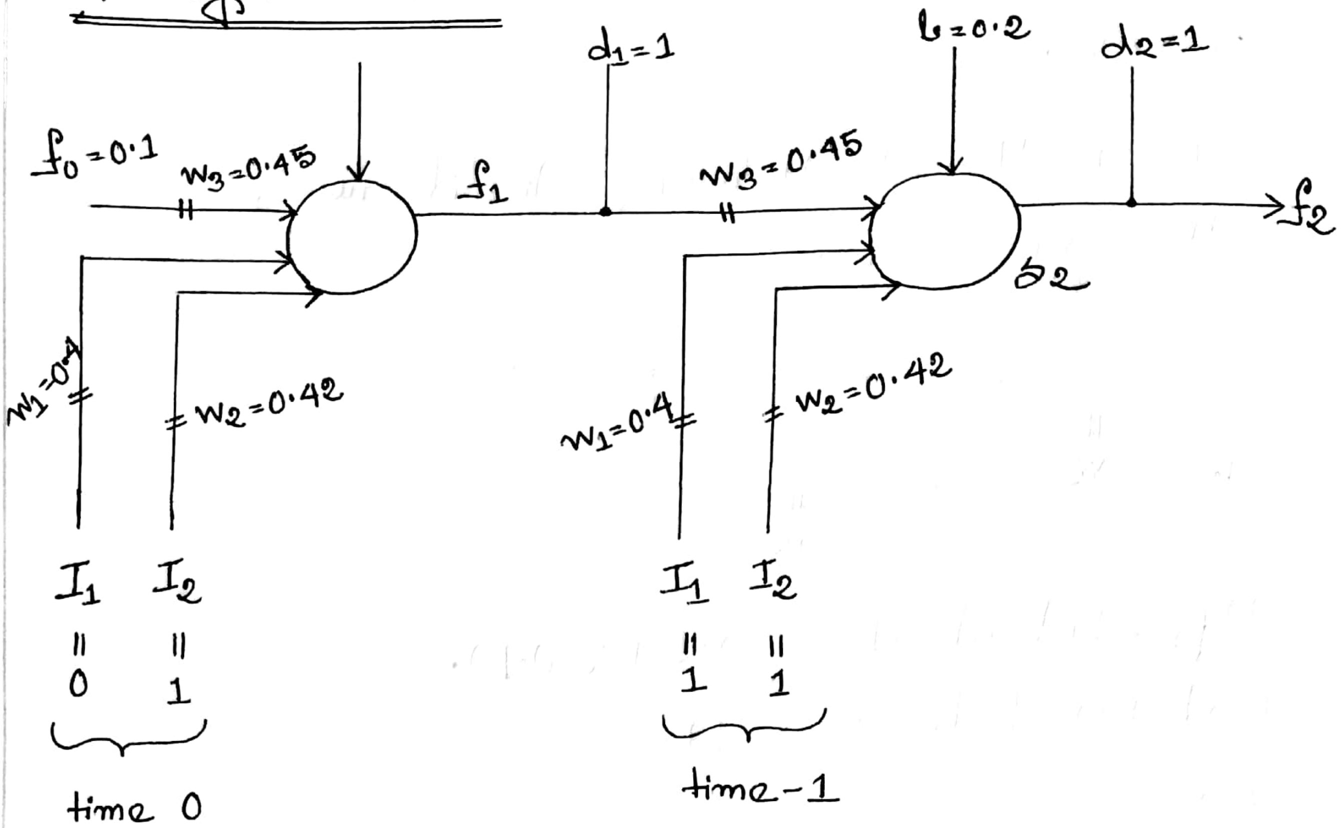
Momentum Coefficient, $\mu = 0.55$

Bias, $b = 0.2$

Initial Output, $f_0 = 0.1$

Threshold $= 0.4$

Training Model :



Forward Pass :

For N1 :

$$u_1 = f_0 w_3 + I_1 w_1 + I_2 w_2 + b$$

$$= 0.1 * 0.45 + 0 * 0.4 + 1 * 0.42 + 0.2$$

$$= 0.665$$

$$f_1 = \frac{1}{1 + e^{-u_1}}$$

$$= \frac{1}{1 + e^{-0.665}}$$

$$= 0.6604$$

For N_2 :

$$u_2 = f_1 W_3 + I_1 W_1 + I_2 W_2 + b$$

$$= 0.6604 * 0.45 + 1 * 0.4 + 1 * 0.42 + 0.2$$

$$= 1.3172$$

$$f_2 = \frac{1}{1+e^{-u_2}}$$

$$= \frac{1}{1+e^{-1.3172}}$$

$$= 0.7887$$

Back propagation through time :

For N_2 :

$$\delta_2 = f_2' (d_2 - f_2)$$

$$= f_2(1-f_2)(d_2-f_2)$$

$$= 0.7887 * (1-0.7887)(1-0.7887)$$

$$= 0.0352$$

For N_1 :

$$\delta_1 = f_1'(d_1 - f_1 + \delta_2 W_3)$$

$$= f_1(1-f_1)(d_1 - f_1 + \delta_2 W_3)$$

$$= 0.6604(1-0.6604)(1-0.6604 + 0.0352 * 0.45)$$

$$= 0.0797$$

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Weight Update :

For N_2 :

$\Delta w_3 = \mu * \eta * \delta_2 * f_1$

$= 0.55 * 0.4 * 0.0352 * 0.6604$

$= 0.0051$

$w_3 = w_3 + \Delta w_3$

$= 0.45 + 0.0051$

$= 0.4551$

$\Delta w_1 = \mu * \eta * \delta_2 * I_1$

$= 0.55 * 0.4 * 0.0352 * 1$

$= 0.0077$

$w_1 = w_1 + \Delta w_1$

$= 0.4 + 0.0077$

$= 0.4077$

$\Delta w_2 = \mu * \eta * \delta_2 * I_2$

$= 0.55 * 0.4 * 0.0352 * 1$

$= 0.0077$

$w_2 = w_2 + \Delta w_2$

$= 0.42 + 0.0077$

$= 0.4277$

$\Delta b = \mu * \eta * \delta_2 * 1$

$= 0.55 * 0.4 * 0.0352 * 1$

$= 0.0077$

$b = b + \Delta b$

$= 0.2 + 0.0077$

$= 0.2077$

Updated weights are :

$w_3 = 0.4551$, $w_1 = 0.4077$, $w_2 = 0.4277$,

$b = 0.2077$

For N_1:

$$\Delta w_3 = \mu * \eta * \delta_1 * f_0$$
$$= 0.55 * 0.4 * 0.0797 * 0.1$$
$$= 0.00175$$

$$w_3 = w_3 + \Delta w_3$$
$$= 0.4551 + 0.00175$$
$$= 0.4568$$

$$\Delta w_1 = \mu * \eta * \delta_1 * I_1$$
$$= 0.55 * 0.4 * 0.0797 * 0$$
$$= 0$$

$$w_1 = w_1 + \Delta w_1$$
$$= 0.4077 + 0$$
$$= 0.4077$$

$$\Delta w_2 = \mu * \eta * \delta_1 * I_2$$
$$= 0.55 * 0.4 * 0.0797 * 1$$
$$= 0.0175$$

$$w_2 = w_2 + \Delta w_2$$
$$= 0.4277 + 0.0175$$
$$= 0.4452$$

$$\Delta b = \mu * \eta * \delta_1 * 1$$
$$= 0.55 * 0.4 * 0.0797 * 1$$
$$= 0.0175$$

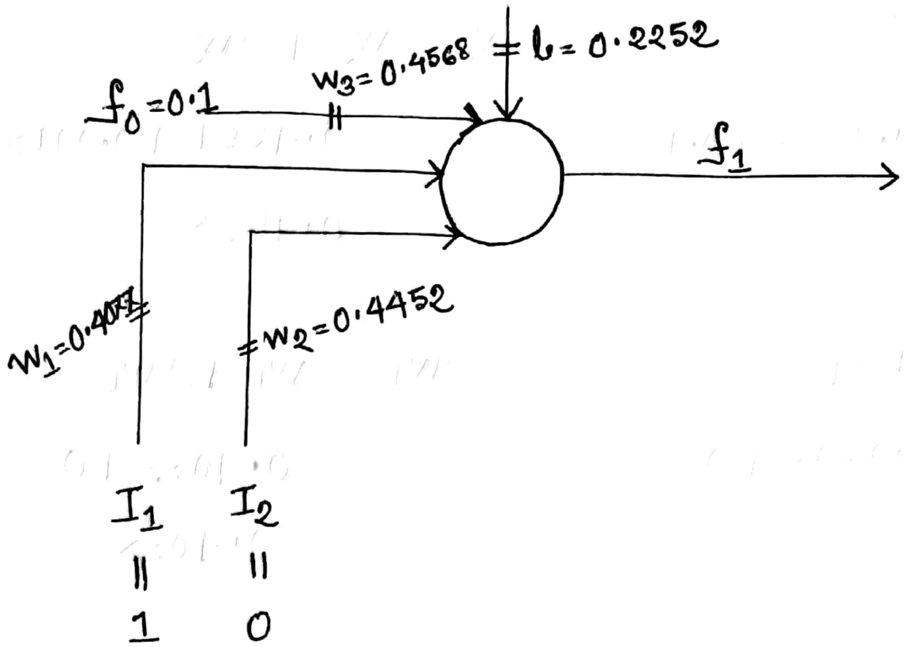
$$b = b + \Delta b$$
$$= 0.2077 + 0.0175$$
$$= 0.2252$$

Updated weights are:

$w_3 = 0.4568$, $w_1 = 0.4077$, $w_2 = 0.4452$, $b = 0.2252$

One epoch completed.

Testing the Model :



Forward Pass :

$$u = f_0 W_3 + I_1 W_1 + I_2 W_2 + b$$

$$= 0.1 * 0.4568 + 1 * 0.4077 + 0 * 0.4452 + 0.2252$$

$$= 0.6786$$

$$f = \frac{1}{1+e^{-u}} = \frac{1}{1+e^{-0.6786}}$$

$$= 0.6634$$

Given threshold $= 0.4$

Since, $f\ (= 0.6634) \geq 0.4$

Output $= 1$

So, neuron fires.

Question – 03

Answer :

Given function, $f(x) = x^3$

My Student ID : 012 193 040

X-value pool : 12, 21, 19, 30, 40

Step 0: Selecting initial population at random

String no.	initial population	x-values (DV)	$f(x)=x^3$	PSelect $f_i/\Sigma f_i$	Expected count, $f_i/\bar{f}$	Actual Count (Roulett wheel)
1	001100	12	1728	$\frac{1728}{108848} = 0.0159$	$\frac{1728}{21769.6} = 0.079$	2
2	010101	21	9261	$\frac{9261}{108848} = 0.0851$	$\frac{9261}{21769.6} = 0.425$	1
3	010011	19	6859	$\frac{6859}{108848} = 0.063$	$\frac{6859}{21769.6} = 0.315$	1
4	011110	30	27000	$\frac{27000}{108848} = 0.2481$	$\frac{27000}{21769.6} = 1.24$	1
5	101000	40	64000	$\frac{64000}{108848} = 0.588$	$\frac{64000}{21769.6} = 2.94$	0

Sum = 108848

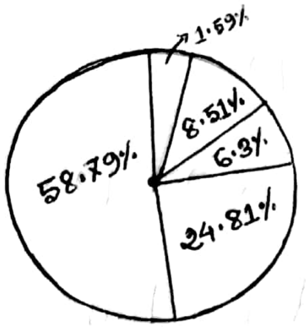
Avg. = 21769.6

Min = 1728

Iteration – 1 :

Step – 1 : Selection :

Selecting mating pool by spinning Roulette Wheel 5 times :



	PSelect	
001100	0·0159	2
010101	0·0851	1
010011	0·0630	1
011110	0·2481	1
101000	0·5879	0

Step – 2 : Crossover :

String no	Mating Pool after reproduction	Mate (randomly selected)	Crossover site (random)	New Population	x-value	$f(x) = x^3$
1	0011|00	3	4	001101	13	2197
2	00|1100	4	2	000011	3	27
3	0101|01	1	4	010100	20	8000
4	01|0011	2	2	011100	28	21952
5	011110	Unmated	—	011110	30	27000

Step-3 : Mutation :

String no.	Population after Crossover	Mutation Point	Population after mutation	X-value	$f(x) = x^3$
1	001101	6	001100	12	1728
2	000011	5	000001	1	1
3	010100	4	010000	16	4096
4	011100	3	010100	20	8000
5	011110	2	010110	22	10648

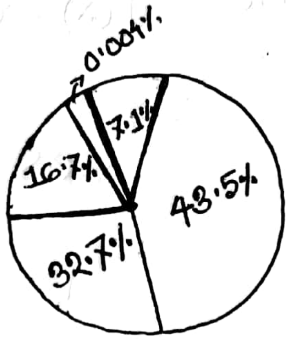
Step-4 : Compute fitness :

String no.	Population after mutation	X-values (DV)	$f(x) = x^3$	P-select $f_i / \Sigma f$	Expected count, $f_i / \bar{f}$	Actual Count (Roulette Wheel)
1	001100	12	1728	$\frac{1728}{24473} = 0.071$	$\frac{1728}{4894.6} = 0.353$	1
2	000001	1	1	$\frac{1}{24473} = 0.00004$	$\frac{1}{4894.6} = 0.0002$	2
3	010000	16	4096	$\frac{4096}{24473} = 0.167$	$\frac{4096}{4894.6} = 0.837$	1
4	010100	20	8000	$\frac{8000}{24473} = 0.327$	$\frac{8000}{4894.6} = 1.634$	1
5	010110	22	10648	$\frac{10648}{24473} = 0.435$	$\frac{10648}{4894.6} = 2.175$	0

- Sum $(f(x))$ = 24,473
- Avg $(f(x))$ = 4894.6
- Min $(f(x))$ = 1

Iteration - 2 :

Step - 1 : Selection :



	PSelect	
001100	0.071	1
000001	0.00004	2
010000	0.167	1
010100	0.327	1
010110	0.435	0

Step - 2 : Crossover :

String no	Mating pool after reproduction	Mate (randomly selected)	Crossover site (random)	New Population	x - value	$f(x) = x^3$
1.	001|100	2	3	001001	9	729
2	000|001	1	3	000100	4	64
3	0000|01	4	4	000000	0	0
4	0100|00	3	4	010001	17	4913
5	010110	Unmated	—	010110	22	10648

Step-3 : Mutation :

String no.	Population after Crossover	Mutation Point	Population after Mutation	x-value	$f(x)=x^3$
1	001001	3	000001	1	1
2	000100	4	000000	0	0
3	000000	5	000010	2	8
4	010001	6	010000	16	4096
5	010110	2	000110	6	216

Step-4 : Compute fitness :

String no.	Population after mutation	x-value (DV)	$f(x)=x^3$	P select $f_i/\Sigma f_i$	Expected count $f_i/\bar{f}$
1	000001	1	1	$\frac{1}{4321}=0.00023$	$\frac{1}{864.2}=0.0011$
2	000000	0	0	$\frac{0}{4321}=0$	$\frac{0}{864.2}=0$
3	000010	2	8	$\frac{8}{4321}=0.0018$	$\frac{8}{864.2}=0.0092$
4	010000	16	4096	$\frac{4096}{4321}=0.9479$	$\frac{4096}{864.2}=4.739$
5	000110	6	216	$\frac{216}{4321}=0.0499$	$\frac{216}{864.2}=0.2499$

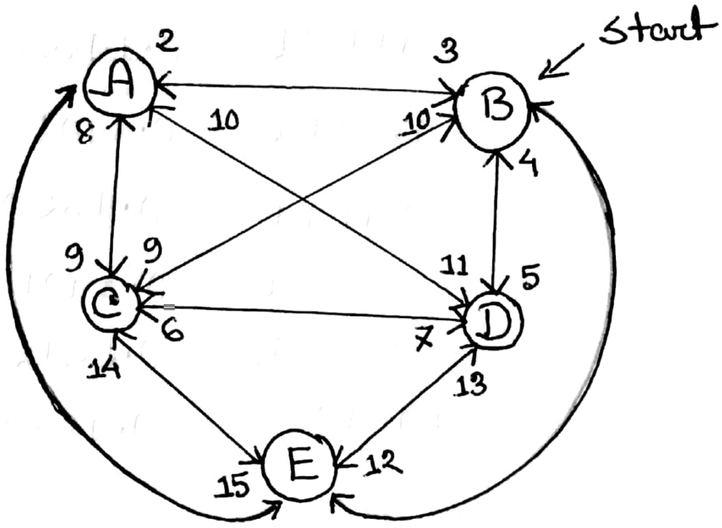
- Sum $(f(x)) = 4321$
- Avg $(f(x)) = 864.2$
- Min $(f(x)) = 0$

Two iteration completed. Minium Value is zero which can not be decreased more. Therefore

$$f(x) = 0 \; ; \; x = 0$$

Answer to the Question no. 4

Given Travelling Map,



Step 0 : Selecting initial population at random

String no.	Initial Population	Fitness (tour cost)	Pselect	Expected Count	Fitness order	Actual count
1	BADECB	2+11+12+17+3 = 45	0·1433	0·8599	3	1
2	BAECDB	2+16+14+7+4 = 43	0·1369	0·8217	4	2
3	BCAEDB	9+8+16+13+4 = 50	0·1592	0·9554	4	1
4	BDACEB	5+10+9+15+19 = 68	0·1592	0·9554	1	0
5	BCEDAB	9+15+13+10+3 = 50	0·2166	1·2994	4	1
6	BDACEB	5+10+9+15+19 = 58	0·1847	1·1083	2	1
		Sum = 315 Avg = 52·333 Min = 43				

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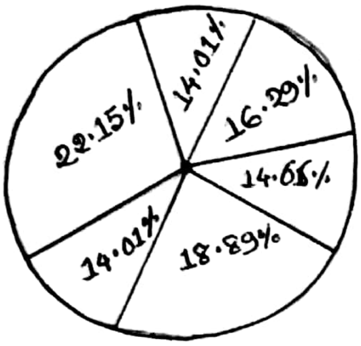
Iteration - 1 :

Step - 1 : Selection :



	Pselect		
BADECB	0.1466		1
BAECDB	0.1401		2
BCAEDB	0.1629	⇒	1
BDACEB	0.1401		0
BCEDAB	0.2215		1
BDACEB	0.1889		1

Step - 2 : Cross over :

String no.	Mating Pool after reproduction	Mate (randomly selected)	Crossover site (random)	New Population
1	B|A|DECB	3	2	BCDEAB
2	B|A|ECD*B	6	2	BDECAB
3	B|C|AEDB	1	2	BACEDB
4	BA|E|C✓DB	5	4	BCEDAB
5	BE✓|C|DAB	4	3	BECDAB
6	B|D|A*CEB	2	2	BADCEB

Step 3 : Compute Fitness :

String no.	Population after mutation	Fitness (tour cost)	PSelect	Expected count	Fitness order	Actual count
1	BCDEAB	9+7+12+17+3=48	0.1667	1	3	1
2	BDECAB	5+12+14+8+3=42	0.1458	0.875	1	2
3	BACEDB	2+9+15+13+4=43	0.1493	0.8958	2	1
4	BCEDAB	9+15+13+10+3=50	0.1736	1.0417	4	1
5	BECDAB	18+14+7+10+3=52	0.1806	1.0833	5	1
6	BADCEB	2+11+6+15+19=53	0.1840	1.1042	6	0

Sum = 288

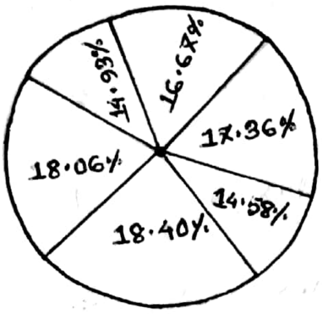
Avg = 48

Min = 42

After 1 iteration minimum tour cost is 42.

Iteration – 02

Step-1 : Selection :



	PSelect	
BCDEAB	0.1667	1
BDECAB	0.1458	2
BACEDB	0.1493	1
BCEDAB	0.1736	1
BECDAB	0.1806	1
BADCEB	0.1840	0

Step-2 : Crossover :

<table>
<tr><th>String no.</th><th>Mating pool after reproduction</th><th>Mate (randomly selected)</th><th>Crossover (random)</th><th>New Population</th></tr>
<tr><td>1</td><td>B|C|DEA*B</td><td>3</td><td>2</td><td>BADECB</td></tr>
<tr><td>2</td><td>BDE|C|AB</td><td>4</td><td>4</td><td>BCEDAB</td></tr>
<tr><td>3</td><td>B|A|C*EDB</td><td>1</td><td>2</td><td>BCAEDB</td></tr>
<tr><td>4</td><td>BCE|D|AB</td><td>2</td><td>4</td><td>BDECAB</td></tr>
<tr><td>5</td><td>BE✓|C|DAB</td><td>6</td><td>3</td><td>BCEDAB</td></tr>
<tr><td>6</td><td>BD|E|C✓AB</td><td>5</td><td>3</td><td>BDCEAB</td></tr>
</table>

Step-3 : Compute Fitness :

string no.	Population after mutation	Fitness (tour cost)	PSelect	Expected count	Fitness order
1	BADECB	2+11+12+14+10 =49	0·1707	1·0244	3
2	BCEDAB	9+15+13+10+3=50	0·1742	1·0453	4
3	BCAEDB	9+8+16+13+4=50	0·1742	1·0453	4
4	BDECAB	5+12+14+8+3=42	0·1463	0·8781	1
5	BCEDAB	9+15+13+10+3=50	0·1742	1·0453	4
6	BDCEAB	5+6+15+17+3=46	0·1602	0·9617	2

Sum = 287

Avg = 47·833

Min = 42

2 iteration completed. After 2 iteration, the minimum tour cost is 42. So, minimum cost has not been changed.

Therefore, 42 is the minimum tour cost.

And the tour map is : B-D-E-C-A-B.

Answer to the Question no. 5

Step 0 : Selecting initial population at random

String no	Initial Population	No. of 1 count, f_i	Fitness, $f_i / \Sigma f_i$	Expected count $f_i / \bar{f_i}$	Actual count (Roulette wheel)
1	01101	3	$3/12 = 0.25$	$3/3 = 1$	1
2	01100	2	$2/12 = 0.1667$	$2/3 = 0.6667$	0
3	10110	3	$3/12 = 0.25$	$3/3 = 1$	1
4	01111	4	$4/12 = 0.3333$	$4/3 = 1.3333$	2

Total = 12
Avg = 3
Max = 4

Iteration - 1 :

Step - 1 : Selection :

	Fitness		
01101	0.25	⇒	1
01100	0.1667		0
10110	0.25		1
01111	0.3333		2

Scanned with CamScanner

Step-2 : Crossover :

String no	Mating Pool after reproduction	Mate (randomly selected)	Crossover site (random)	New Population	No. of 1 counts
1	011/01	3	3	01111	4
2	1011/0	4	4	10111	4
3	011/11	1	3	01101	3
4	0111/1	2	4	01110	3

Step-3 : Mutation

String no	Population after Crossover	Mutation Point	Population after mutation	No. of 1 counts
1	01111	5	01110	3
2	10111	3	10011	3
3	01101	1	11101	4
4	01110	2	00110	2

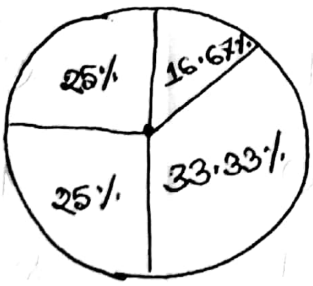
Step-4 : Compute fitness :

String no.	Population after mutation	No. of 1 counts f_i	Fitness, $f_i/\sum f_i$	Expected count, $f_i/\bar{f_i}$	Actual count (Roulette Wheel)
1	01110	3	$3/12 = 0.25$	$3/3 = 1$	1
2	10011	3	$3/12 = 0.25$	$3/3 = 1$	1
3	11101	4	$4/12 = 0.333$	$4/3 = 1.3333$	2
4	00110	2	$2/12 = 0.1667$	$2/3 = 0.6667$	0

- total = 12
- Avg = 3
- Max = 4

Iteration - 2 :

Step 1 : Selection :



	fitness		
01110	0.25	⇒	1
10011	0.25		1
11101	0.3333		2
00110	0.1667		0

Step-2 : Crossover :

String no.	Mating pool after reproduction	Mate (randomly selected)	crossover site (random)	New Population	No of 1 counts.
1	011|10	3	3	01101	3
2	10|011	4	2	10110	3
3	111|01	1	3	11110	4
4	00|110	2	2	00011	2

Step-3 : Mutation :

String no.	Population after crossover	Mutation Point	Population after Mutation	No. of 1 counts
1	01101	3	01001	2
2	10110	2	11110	4
3	11110	5	11111	5
4	00011	4	00001	1

Step-4 : Compute fitness

String no.	Population after mutation	No. of 1 counts, f_i	Fitness $f_i/\Sigma f_i$	Expected Count, $f_i/\bar{f_i}$
1	01001	2	$2/12 = 0.1667$	$2/3 = 0.6667$
2	11110	4	$4/12 = 0.3333$	$4/3 = 1.3333$
3	11111	5	$5/12 = 0.4167$	$5/3 = 1.6667$
4	00001	1	$1/12 = 0.0833$	$1/3 = 0.3333$

- Total = 12
- Avg = 3
- Max = 5

Two iteration completed. After two iteration number of 1 counts reaches at the global maximum (5). Therefore, the maximum number of 1 count is 5 and the desires population is 11111.

Question – 06

Answer :

Given equation :

$$Y = (2x - 11) \div 6$$

Step 0 : Selecting initial population at random

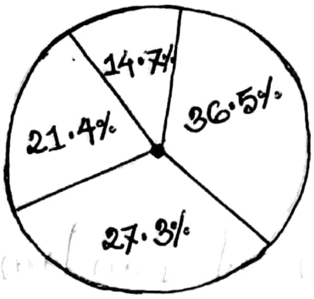
String no.	Initial Population x	Initial Population y	Calculated Y value $Y' = (2x-11)/6$	Deviation $\lvert Y' - Y \rvert$	P Select	Expected Count	Fitness Order	Actual Count
1	3	5	−0.833	5.833	$\frac{5.833}{39.666} = 0.147$	$\frac{5.833}{9.9165} = 0.588$	1	2
2	4	8	−0.5	8.5	$\frac{8.5}{39.666} = 0.214$	$\frac{8.5}{9.9165} = 0.857$	2	1
3	5	11	0.167	10.833	$\frac{10.833}{39.666} = 0.273$	$\frac{10.833}{9.9165} = 1.092$	3	1
4	7	15	0.5	14.5	$\frac{14.5}{39.666} = 0.365$	$\frac{14.5}{9.9165} = 1.462$	4	0

Optimum, Y = −0.833

- Sum = 39.666
- Avg = 9.9165
- Min = 5.833

Iteration – 1 :

Step – 1 : Selection :



		pselect		
3	5	0.147	⇒	2
4	8	0.214		1
5	11	0.273		1
7	15	0.365		0

The best value 0.147 will 2 copies and the worst value 0.365 will die off during reproduction

Step – 2 : Crossover (whole arithmatic crossover considering $\alpha = 0.5$)

String no.	Mating pool after reproduction		Mate (randomly selected)	New Population	
	x	y		x	y
1	3	5	3	3.5	6.5
2	3	5	4	4	8
3	4	8	1	3.5	6.5
4	5	11	2	4	8

Step 3 : Mutation :

String no.	Population after crossover		Population after mutation	
	x	y	x	y
1	3.5	6.5	20	6.5
2	4	8	4	2.5
3	3.5	6.5	3.5	1.5
4	4	8	22	8

Step 4 : Compute fitness :

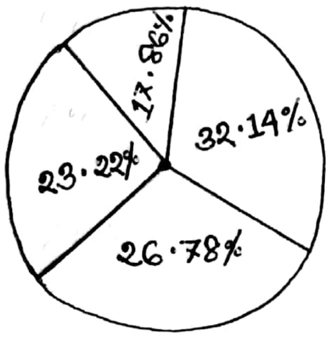
String no.	Population after muta-tion		Calculated y value, $y' = (2x-11)/6$	Deviation $\lvert y'-y \rvert$	PSelect	Expected Count	Fitness order	Actual Count
	x	y						
1	20	6.5	4.833	1.667	$\frac{1.667}{9.334} = 0.1786$	$\frac{1.667}{2.3335} = 0.7144$	1	2
2	4	2.5	−0.5	3	$\frac{3}{9.334} = 0.3214$	$\frac{3}{2.3335} = 1.2856$	4	0
3	3.5	1.5	−0.667	2.167	$\frac{2.167}{9.334} = 0.2322$	$\frac{2.167}{2.3335} = 0.9286$	2	1
4	22	8	5.5	2.5	$\frac{2.5}{9.334} = 0.2678$	$\frac{2.5}{2.3335} = 1.0713$	3	1

Optimal, $Y = 4.833$

- Sum = 9.334
- Avg. = 2.3335
- Min = 1.667

Iteration — 2

Step — 1 : Selection :



		PSelect		
20	6.5	0.1786	$\Rightarrow$	2
4	2.5	0.3214		0
3.5	1.5	0.2322		1
22	8	0.2678		1

Step - 2 : Cross Over (whole arithmatic crossover considering $\alpha = 0.5$)

String no	Mating pool after reproduction		Mate (randomly selected)	New Population	
	x	y		x	y
1	20	6.5	4	21	7.25
2	20	6.5	3	11.75	4
3	3.5	1.5	2	11.75	4
4	22	8	1	21	7.25

Step-3: Mutation :

String no.	Population after Crossover		Population after Mutation	
	x	y	x	y
1	21	7.25	25	7.25
2	11.75	4	17	4
3	11.75	4	11.75	2
4	21	7.25	21	5

Step-4: Compute fitness :

String no.	Population after mutation		Calculated Y-value $Y' = (2x-11)/6$	Deviation $\lvert Y'-Y \rvert$	PSelect	Expected Count	Fitness order	Actual Count
	x	y						
1	25	7.25	6.5	0.75	$\frac{0.75}{1.167} = 0.6427$	$\frac{0.75}{0.2917} = 2.5707$	4	0
2	17	4	3.833	0.167	$\frac{0.167}{1.167} = 0.1431$	$\frac{0.167}{0.2917} = 0.5724$	2 or 3	1
3	11.75	2	2.083	0.083	$\frac{0.083}{1.167} = 0.0711$	$\frac{0.083}{0.2917} = 0.2845$	1	2
4	21	5	5.167	0.167	$\frac{0.167}{1.167} = 0.1431$	$\frac{0.167}{0.2917} = 0.5724$	2 or 3	1
			Optimal, Y = 2.083					

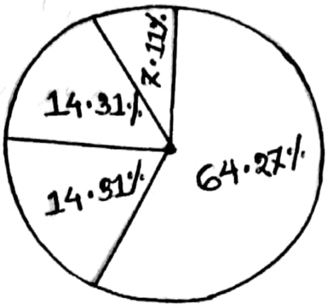
Sum = 1.167

Avg. = 0.2917

Min = 0.083

Iteration – 3

Step – 1 : Selection :



		PSelect		
25	7.25	0.6427	⇒	0
17	4	0.1431		1
11.75	2	0.0711		2
21	5	0.1431		1

Step-2 : Cross Over (whole arithmatic crossover considering $\alpha = 0.5$)

String no.	Mating Pool after reproduction		Mate (randomly selected)	New Population	
	x	y		x	y
1	17	4	2	14.375	3
2	11.75	2	1	14.375	3
3	11.75	2	4	16.375	3.5
4	21	5	3	16.375	3.5

Step 3: Mutation:

String no.	Population after Crossover		Population after mutation	
	x	y	x	y
1	14.375	3	14.375	2.98
2	14.375	3	14.4	3
3	16.375	3.5	16.375	3.6
4	16.375	3.5	16.2	3.5

Step 4: Compute fitness

String no.	Population after mutation		Calculated y-value $y' = (2x-11)/6$	Deviation $\lvert y' - y \rvert$	PSelect	Fitness order
	x	y				
1	14.375	2.98	2.9583	0.0217	$\frac{0.0217}{0.1467} = 0.1479$	1
2	14.4	3	2.9667	0.0333	$\frac{0.0333}{0.1467} = 0.2269$	3
3	16.375	3.6	3.625	0.025	$\frac{0.025}{0.1467} = 0.1704$	2
4	16.2	3.5	3.5667	0.0667	$\frac{0.0667}{0.1467} = 0.4546$	4
			Optimal; Y = 2.958	Sum = 0.1467 Avg. = 0.0367 Min = 0.0217		

3 Iteration complited. After 3 iteration, the optimal value of y is 2.958 for Population $x = 14.375$, $y = 2.98$.