(Q) for a 8-queen problem, in the final Goal State, 8 queens are arranged in the 8×8 chess board in such a way (i.e One queen per each column) that no queen attack each other.

Proceed to Solve the 8-queen problem as an optimization problem.

Maximize F where,

F = objective or fitness function

= "Number of non-attacking pairs".

<u>Sol^n</u>) <u>Step 1 :-</u> To use a GA, we must first Code the decision variables of our problem as Some finite length string / Array. for this problem, we will code the Variable Simply as integers of length 8. This will be the chromosome. we are using the Arrays to repent individuals of a population.
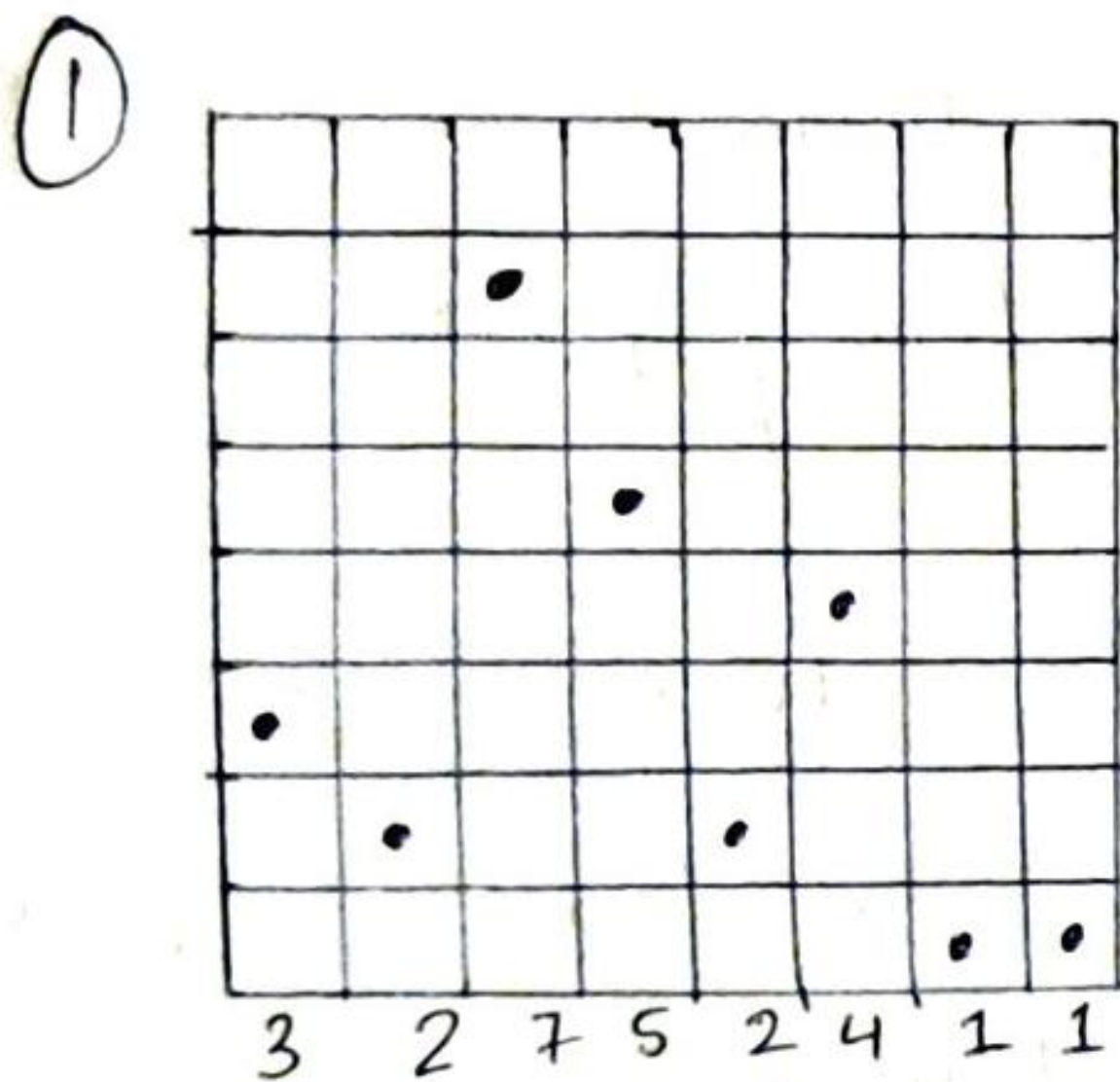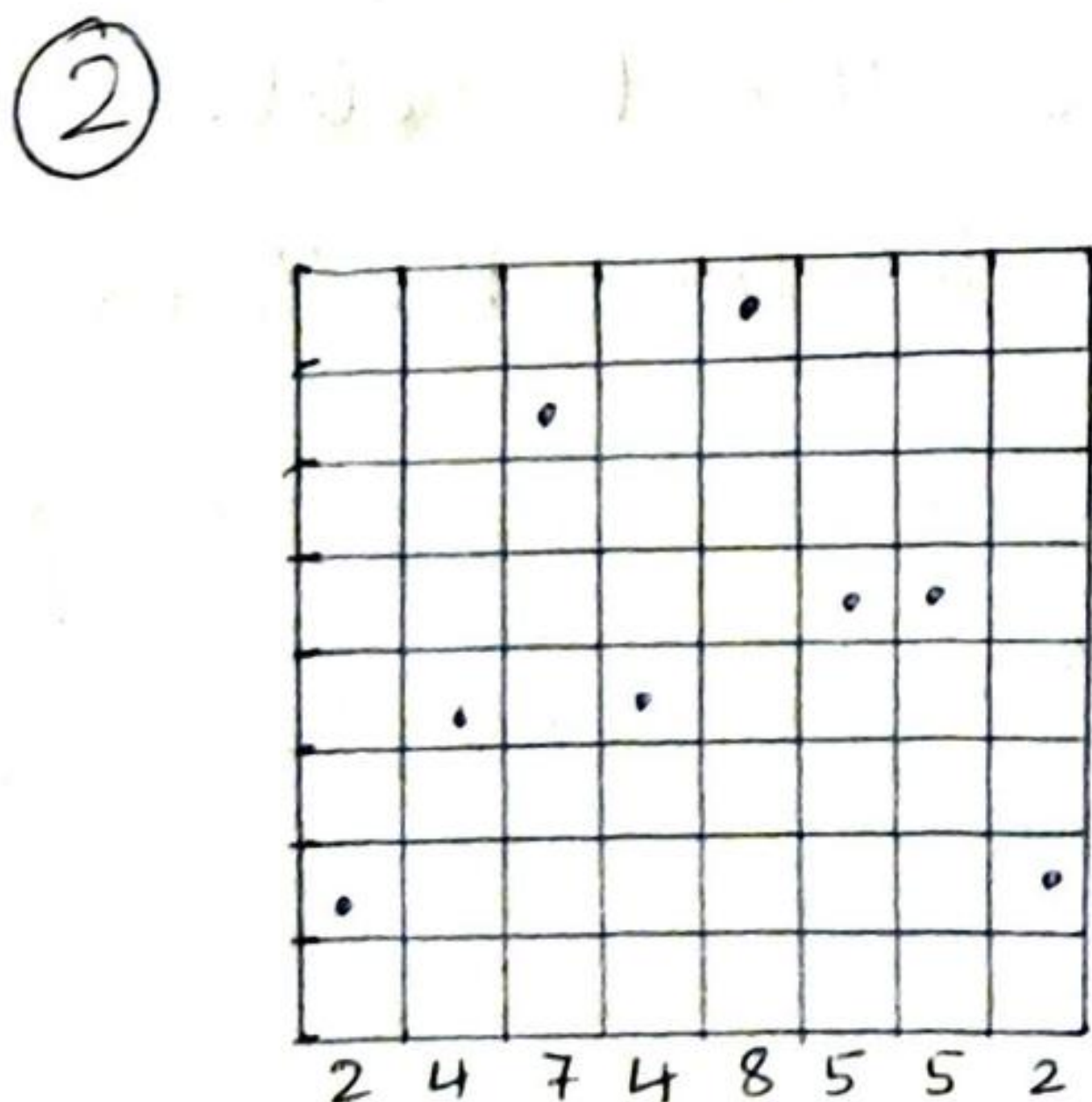
Index : Column

Value : Row.

<u>Step 2</u> :- To start off, we select an initial population of random. we select the population of 4.

```
3  2  7  5  2  4  1  1  → String No. 1
2  4  7  4  8  5  5  2  → String No. 2
3  2  5  4  3  2  1  3  → String No. 3
2  4  4  1  5  1  2  4  → String No. 4
```

<u>Step3</u> :- Apply fitness function.
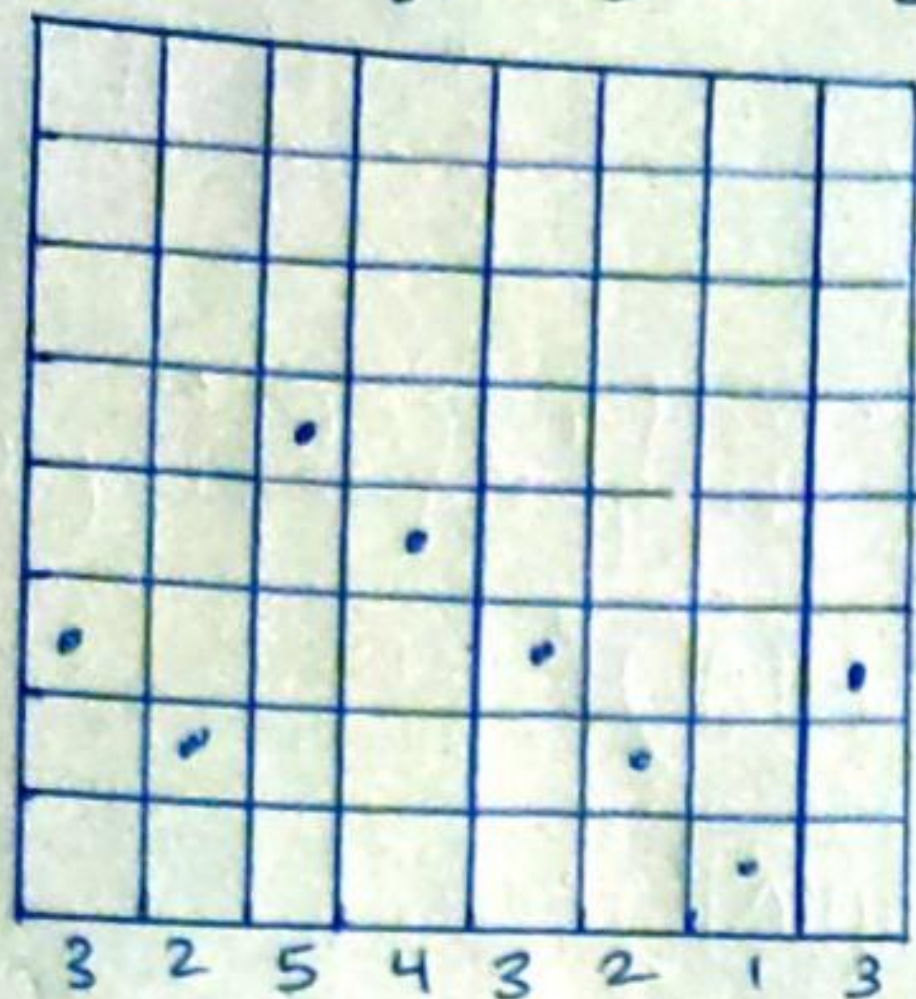
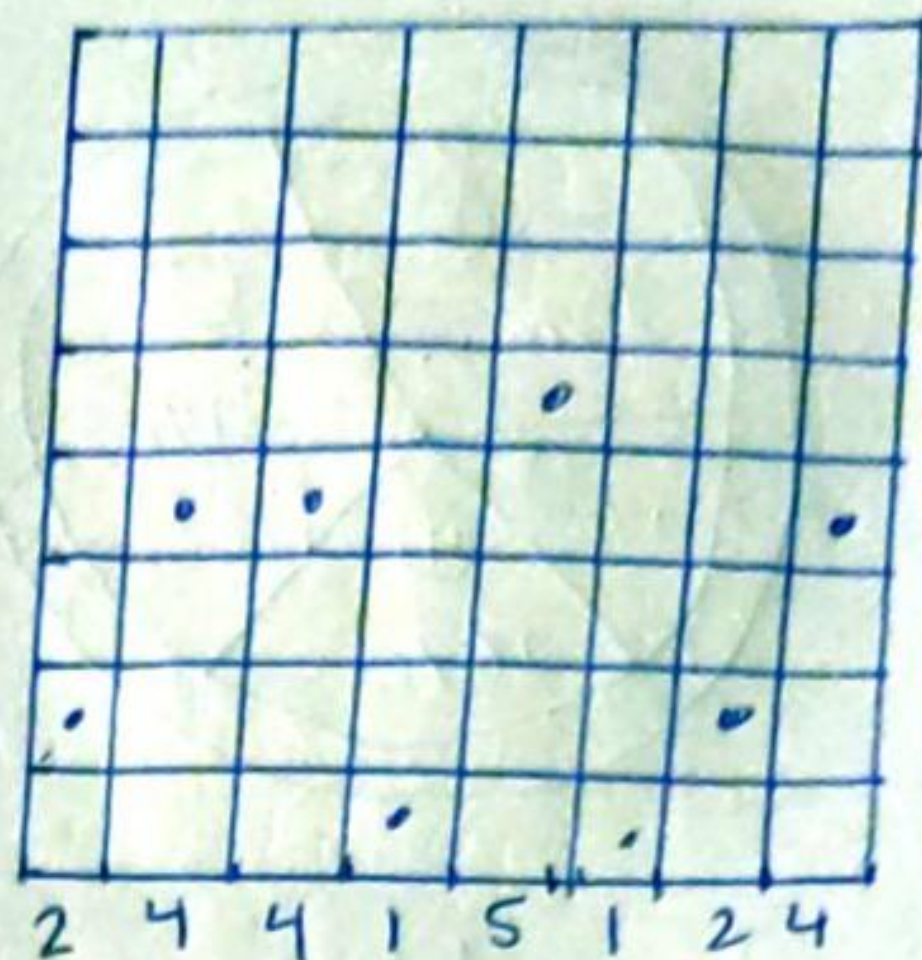Here, [fitness = No. of non-attacking pairs]

①

3 2 7 5 2 4 1 1

Fitness = 23

②

2 4 7 4 8 5 5 2

fitness = 24

③ fitness = 11

3 2 5 4 3 2 1 3

④ fitness = 20

2 4 4 1 5 1 2 4

Step 4 :- looking at this population. following initial table must be prepared to select 4 fit parents for further process of reproduction.

String No.	Initial Population	fitness Value	% of total	Actual count from (Roulette wheel)
1	3 2 7 5 2 4 1 1	23	29	1
2	2 4 7 4 8 5 5 2	24	31	2
3	3 2 5 4 3 2 1 3	11	14	0
4	2 4 4 1 5 1 2 4	20	26	1
Sum		78	100	4
Avg		19.5	25	1
Max		24	31	2

Step 5 :- We select the mating pool of the next generation by spinning the weighted Roulette wheel four times.
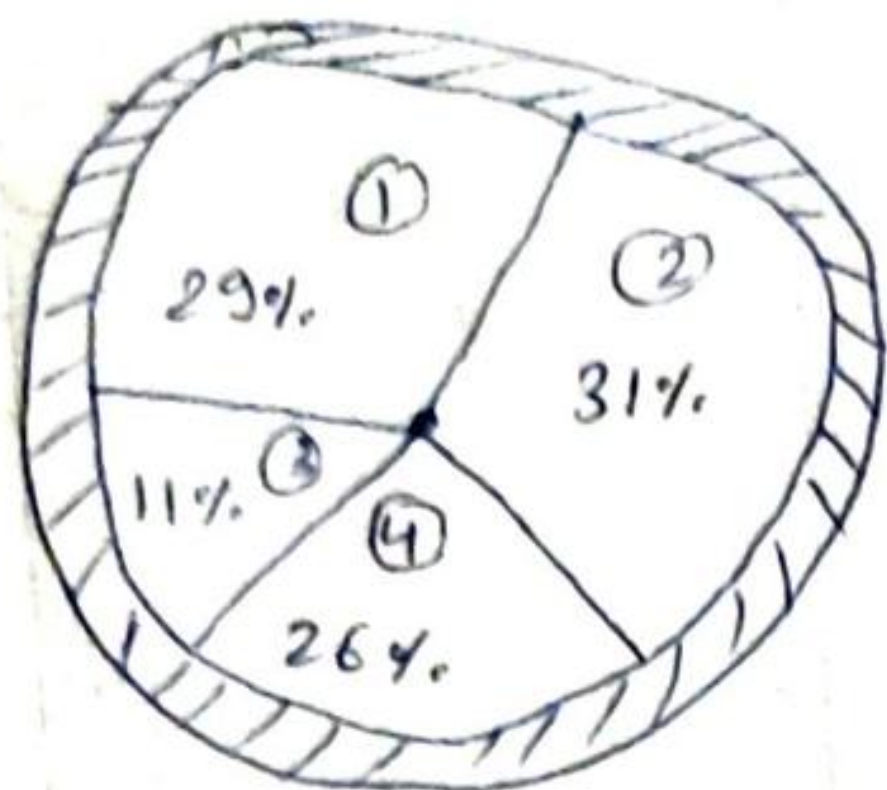
Through the weighted Roulette wheel method following three strings were selected as fit parents for the mating pool.

P_1: 3 2 7 5 2 4 1 1

P_2: 2 4 7 4 8 5 5 2

P_3: 2 4 4 1 5 1 2 4

The parent pairs can be chosen randomly as well as crossover sites among these pairs also be chosen randomly in the mating pool.

Accordingly, we choose parents P_1 & P_2 as one parent pair, and P_1 & P_4 as another.

Mating Pool	Mate (Randomly selected)	Crossover Site	New Population	Offspring (children)	fitness value	% of fitness
3 27 52 411	P_1	3	32748552	C_1	23	27
247 48 552	P_2	3	24752411	C_2	22	25
32752 411	P_1	5	32752124	C_3	21	24
24415 124	P_4	5	24415411	C_4	20	24
Actual Count →				Sum	86	100
				Avg	21.5	25
				Max	23	27

Step 6 :- The last operator mutation is performed on a random bit in C_1, C_3 & C_4.

	Crossover		Mutation	fitness value	% of fitness
C_1	3 2 7 4 8 5 5 2	→	3 2 7 4 8 [1] 5 2	24	28
C_2	2 4 7 5 2 4 1 1	→	2 4 7 5 2 4 1 1	22	26
C_3	3 2 7 5 2 1 2 4	→	3 2 [2] 5 2 1 2 4	1 8	20
C_4	2 4 4 1 5 4 1 1	→	2 4 4 1 5 4 1 [7]	22	26
			Sum →	86	100
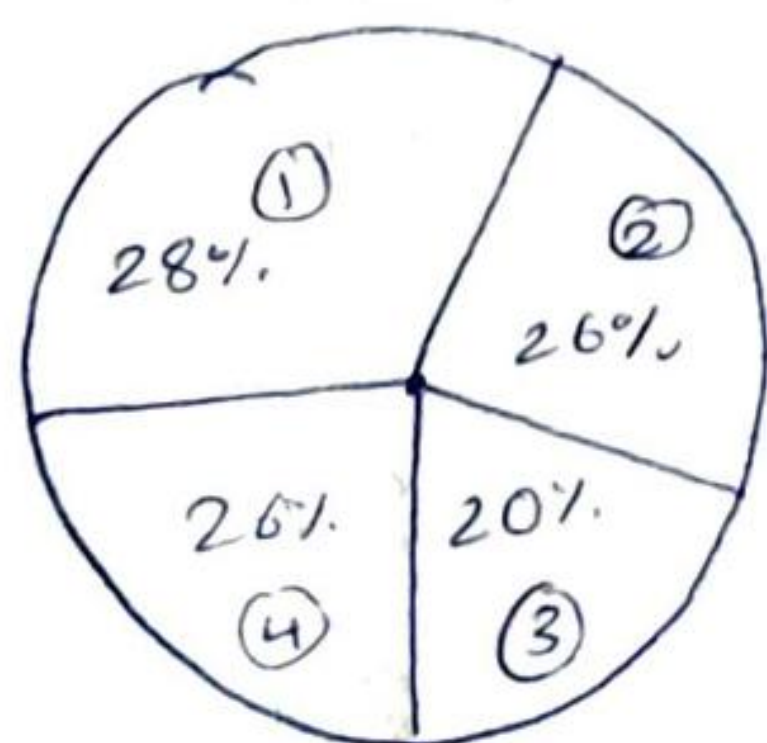
In the present scenario, there is 3 strings ①, ② & ④ have not very high and not very low fitness percentage. But string ③ have ①, ② & ④ and 0 copy of string ③ 2 copy String ①

Through the Roulette wheel method following 4 Strings are selected as fit parents.

P_1 : 3 4 7 5 81 52 → 1 copy

P_2 : 2 2 7 3 8 4 1 1 → 1 copy

P_3 : 7 4 6 1 8 1 5 2 → 1 copy

P_4 : 2 2 8 4 5 3 1 7 → 1 copy

Mating Pool	Mate	Crossover Site	New population	Offspring children	fitness value	% of fitness
3 4 758 152	P_1	(1,5)	3 2 7 38 152	C_1	23	24
2 2 7 38 411	P_2	(1,5)	2 4 7 5 8411	C_2	23	24
7 4 61 8152	P_3	(1,4)		C_3	24	25
2 284 5317	P_4	(1,4)		C_4	25	27
—	—	—	—	Sum	95	100
				Avg	23.75	25
				Max	25	27

Mutation :-

	Crossover	Mutation	Fitness	% of fitness
C_1	3 2 7 38 152 →	6 4 7 38 152	24	23
C_2	2 4 7 5 8 411 →	2 4 7 5 8 6 13	27	26
C_3	7 2 8 4 8 152 →	7 3 6 4 8 152	26	25
C_4	2 4 6 1 5 3 17 →	2 4 6 8 5 3 17	27	26
		Sum ⇒ 104		100

①

6 4 7 3 8 1 5 2

fitness = 24

②

2 4 7 5 8 6 1 3

fitness = 27
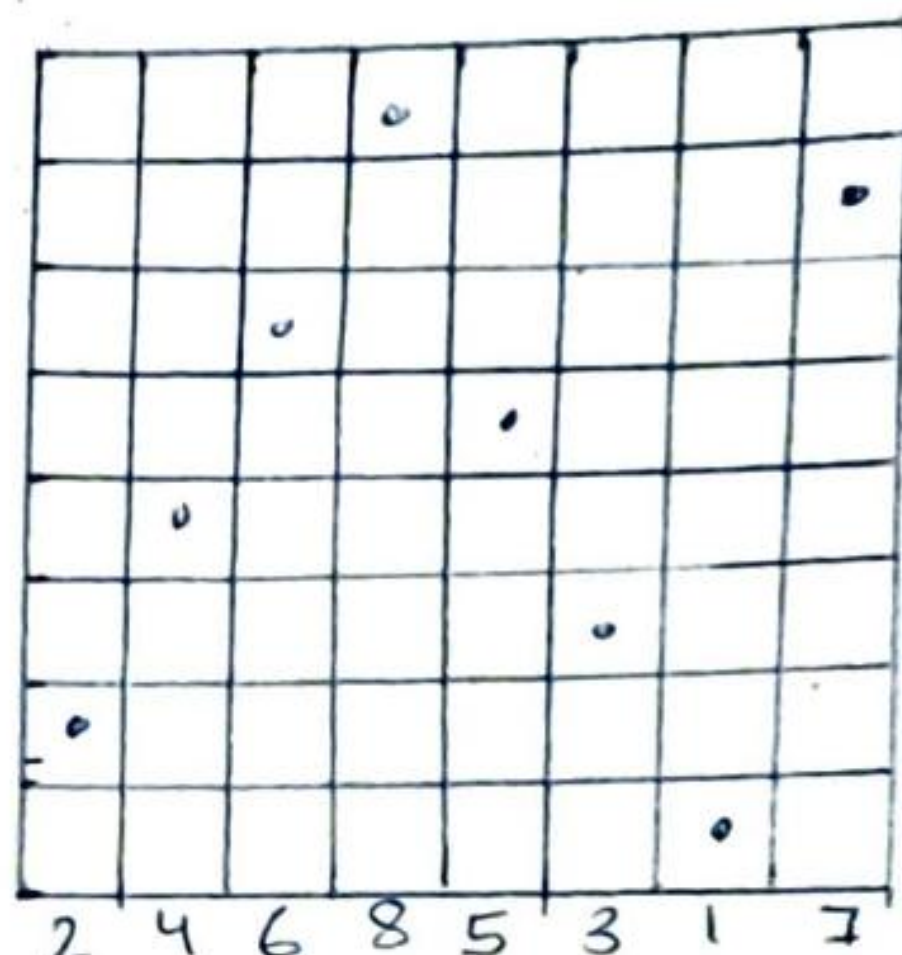
③

7 3 6 4 8 1 5 2

fitness = 26

④

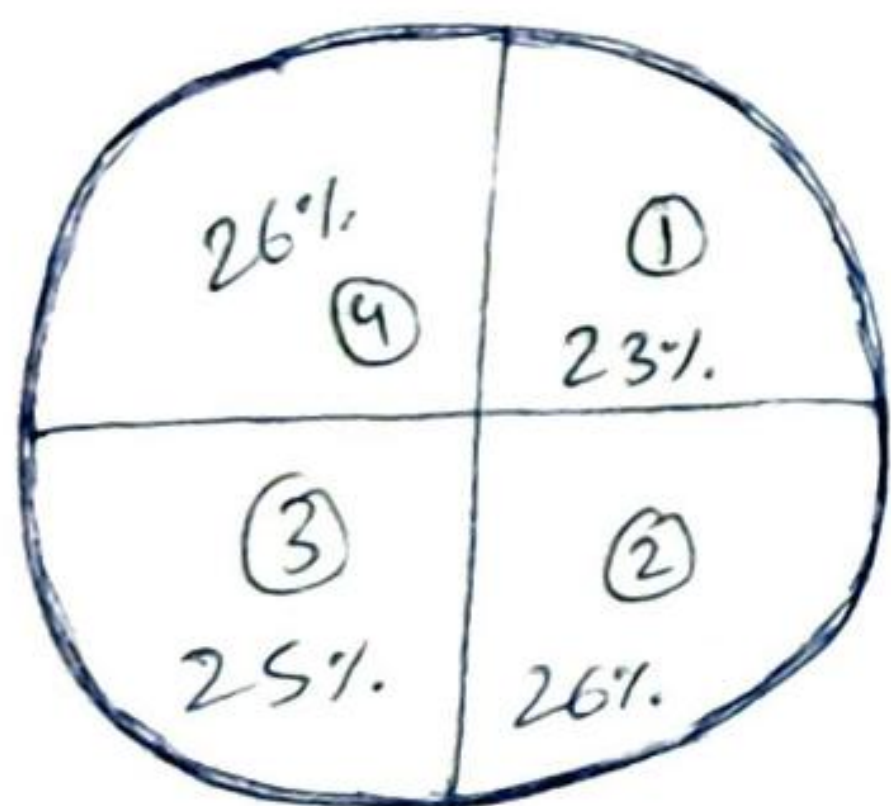2 4 6 8 5 3 1 7

fitness = 27

26% ④ | ① 23%
③ 25% | ② 26%
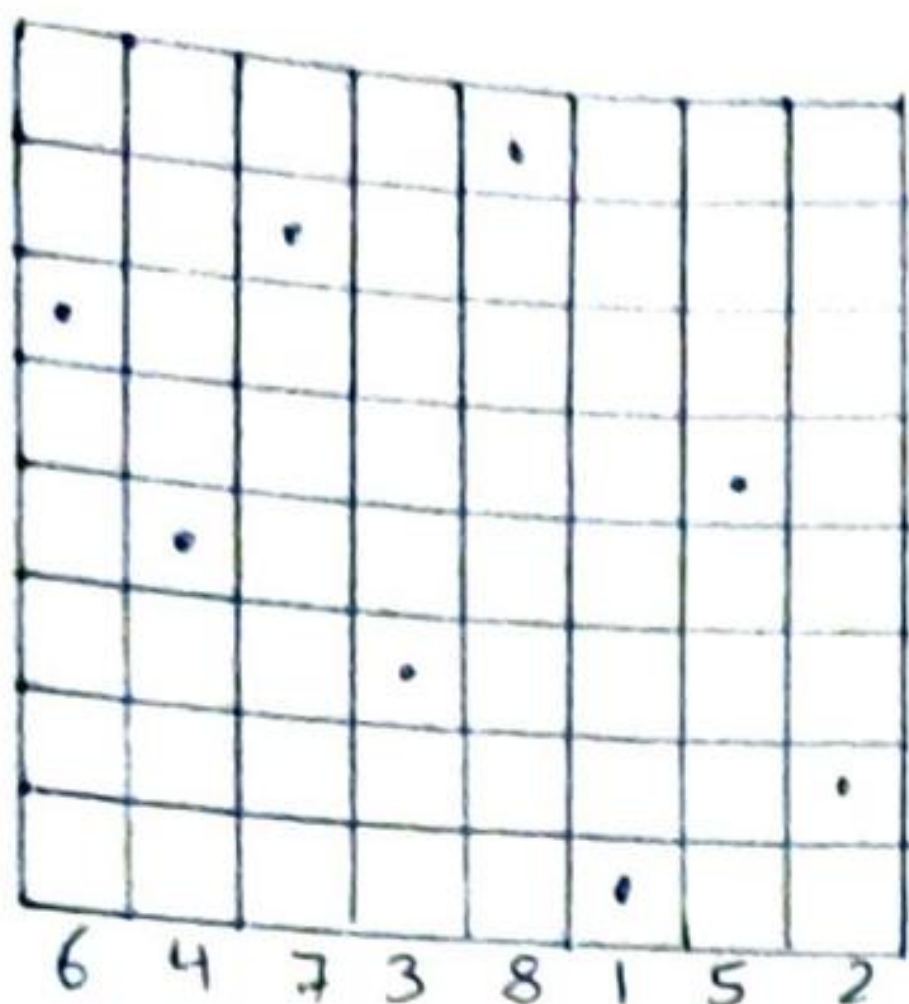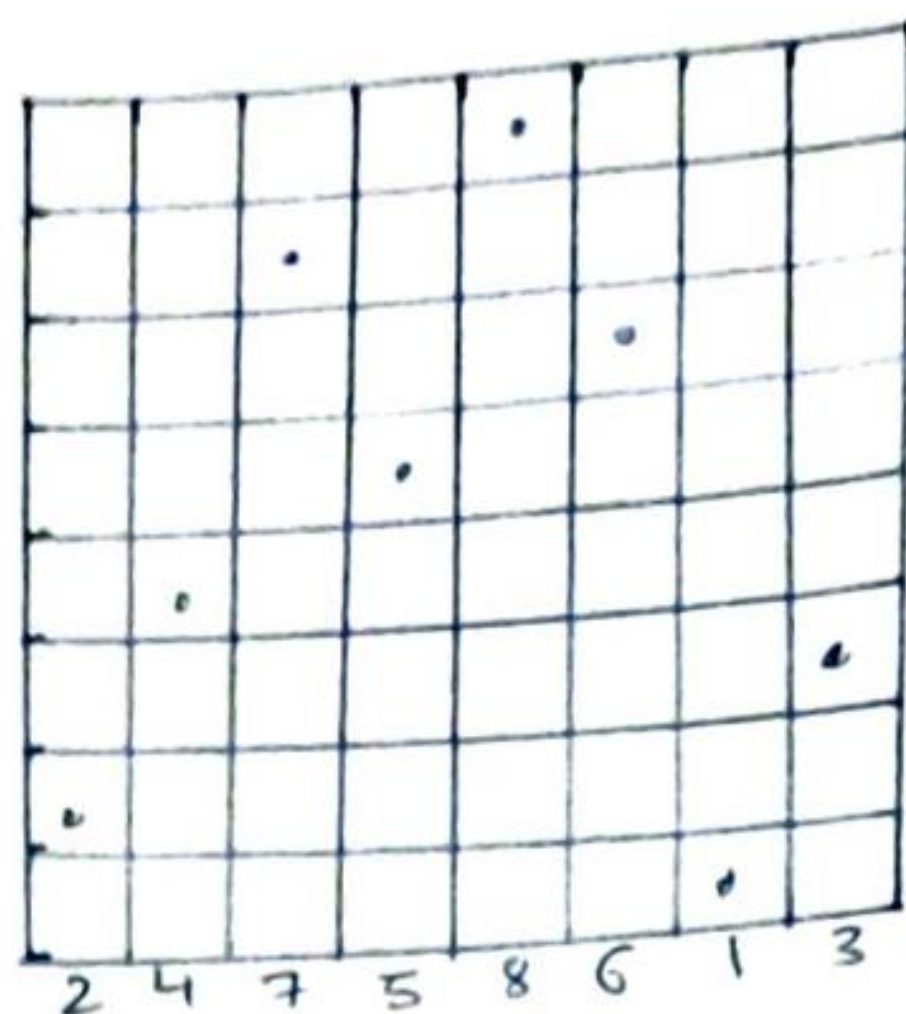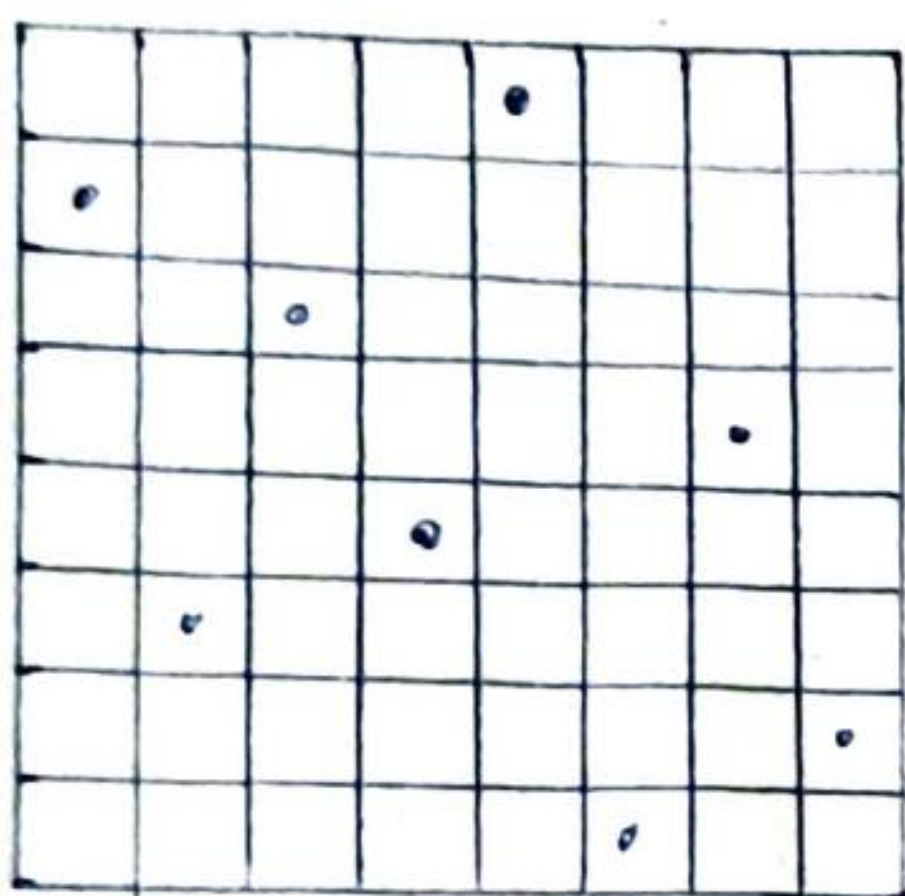
In present scenario there are 4 strings and all are having very high fitness %. So, we can take 1 copy of each strings.