1. **Initialization of Population**
2. **Selection**
3. **Crossover/Recombination**
4. **Mutation**
5. **Survival/Accept**

### **1. Solving 8-Queen Using GA**

Place 8 queens on an 8×8 chessboard so that no two queens attack each other.

### **A) Initial Population (Chromosomes)**

Each chromosome is an array where the **index is the column** (1–8) and the **value is the row** (1–8).

|  |  |  |  |
| --- | --- | --- | --- |
| **Chromosome (state)** | **Representation** | **Attacking Pairs** | **Non-Attacking (max 28)** |
| Chromosome 1 | 1 6 2 5 7 4 8 3 | 4 | 24 |
| Chromosome 2 | 2 4 7 3 6 8 5 1 | 5 | 23 |
| Chromosome 3 | 5 3 1 6 8 4 2 7 | 8 | 20 |
| Chromosome 4 | 6 1 3 2 8 7 5 4 | 17 | 11 |

### **Step 1: Fitness Calculation**

Total fitness sum = 24 + 23 + 20 + 11 = 78

**Fitness Probabilities:**

* Chromosome 1: 24/78 = 31%
* Chromosome 2: 23/78 ≈ 29%
* Chromosome 3: 20/78 ≈ 26%
* Chromosome 4: 11/78 ≈ 14%

### **Step 2: Selection**

Randomly select **2 parents**, say:

* **Parent 1** = **1 6 2 5** **7 4 8 3**
* **Parent 2** = **2 4 7 3** **6 8 5 1**

**Step 3: Crossover**

Suppose crossover happens at position 4.

* Offspring = First 4 genes from Parent 1 + last 4 from Parent 2
* **Child** = 1 6 2 5 | 6 **8** 5 1

### **Step 4: Mutation**

Mutation might occur in 1 gene. Suppose column 6 (value = 8) mutates to row = 7.

* **Mutated Child** = 1 6 2 5 6 **7** 5 1

### **Step 5: Repeat**

This new child is evaluated, added to the next generation, and the process repeats.

### **Final Goal:**

Eventually, a chromosome like 1 5 8 6 3 7 2 4 appears, with:

* **0 Attacking Pairs**
* **Fitness = 28**

**Valid 8-Queen solution found!**

**2. Maximize , when x in [0 to 31]**

**Binary Encoding – 5 digits**

1. **Initialization of Population**
2. **Selection**
3. **Crossover/Recombination**
4. **Mutation**
5. **Survival/Accept**

**Update Population**

1. **Selection (Let us take 6 chromosomes in initial population)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **String**  **No** | **Initial**  **Population** | **x** |  | **Probability** | **Bin** |
| 1 | [1,0,0,1,0] | 18 | 108 | 0.211 | 0.001-0.211 |
| 2 | [1,0,0,1,1] | 19 | 123.5 | 0.242 | 0.212-0.453 |
| 3 | [1,0,1,1,1] | 23 | 195.5 | 0.383 | 0.454-0.836 |
| 4 | [0,1,1,1,0] | 14 | 56 | 0.110 | 0.837-0.946 |
| 5 | [0,0,1,0,1] | 5 | 0 [if negative] | 0 | --- |
| 6 | [0,1,0,1,1] | 11 | 27.5 | 0.054 | 0.947-1.00 |
| **Total** |  |  | **510.5** | **1.00** |  |

Let us select 4 parents and perform 2. crossover and 3. mutation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Random**  **Number** | **Selected**  **Bin No.** | **Chosen**  **Parent** | **Offspring after**  Crossover at random point | **Offspring after**  **Mutation (1% chance)** |
| **0.54** | 3 | **[1,0,1,1,1]** | **[1,0,1,1,0]** | [1,**1**,1,1,0] |
| **0.88** | 4 | **[0,1,1,1,0]** | **[0,1,1,1,1]** | [0,1,1,1,1] |
| **0.45** | 2 | **[1,0,0,1,1]** | **[1,0,0,1,0]** | [1,0,0,1,0] |
| **0.20** | 1 | **[1,0,0,1,0]** | **[1,0,0,1,1]** | [1,0,0,1,1] |

**4. Accept/Survival**

|  |  |  |
| --- | --- | --- |
| **Offspring** | **x** | **Fitness, f(x)** |
| [1,1,1,1,0] | 30 | 360 |
| [0,1,1,1,1] | 15 | 67.5 |
| [1,0,0,1,0] | 18 | 108 |
| [1,0,0,1,1] | 19 | 123.5 |

[Select survivors and add to population]

**Updated Population:**

|  |  |
| --- | --- |
| **String**  **No** | **Initial**  **Population** |
| 1 | [1,0,0,1,0] |
| 2 | [1,0,0,1,1] |
| 3 | [1,0,1,1,1] |
| 4 | [0,1,1,1,0] |
| 5 | [0,0,1,0,1] |
| 6 | [0,1,0,1,1] |
| 7 | [1,1,1,1,0] |

**Check termination [Condition]**

New Cycle: