

1. Consider the problem of maximising the following function.

$$f(\mathbf{x}) = - \sum_{i=1}^m \left( \sum_{j=1}^4 (x_j - C_{ji})^2 + \beta_i \right)^{-1}, \text{ where}$$

$$m = 10$$

$$\beta = \frac{1}{10}(1, 2, 2, 4, 4, 6, 3, 7, 5, 5)^T$$

$$\mathbf{C} = \begin{pmatrix} 4.0 & 1.0 & 8.0 & 6.0 & 3.0 & 2.0 & 5.0 & 8.0 & 6.0 & 7.0 \\ 4.0 & 1.0 & 8.0 & 6.0 & 7.0 & 9.0 & 3.0 & 1.0 & 2.0 & 3.6 \\ 4.0 & 1.0 & 8.0 & 6.0 & 3.0 & 2.0 & 5.0 & 8.0 & 6.0 & 7.0 \\ 4.0 & 1.0 & 8.0 & 6.0 & 7.0 & 9.0 & 3.0 & 1.0 & 2.0 & 3.6 \end{pmatrix}$$

Develop a Genetic Algorithm-based solution to solve the above-stated problem. Following guidelines should be used to develop the solution.

- The function is usually evaluated on the hypercube  $x_j \in [0,10] \forall j=1,2,3,4$
  - Binary encoding approach should be used to design the chromosome.
  - The population size is 20, and it is fixed.
  - Initial population should be constructed randomly.
  - Proper parent selection mechanism should be incorporated.
  - A single-point crossover operator should be used. The probability of the crossover operator is 0.5.
  - Bit flip operation should be used in the mutation operator. The probability of the mutation operator is 0.1.
  - An appropriate metric should be used to assess the population's quality.
  - Demonstrate the approach's effectiveness by showing the population up to a minimum 500 generations.
2. Given an undirected weighted graph  $G=(V, E, W)$ , a minimum spanning tree (MST) or minimum weight spanning tree is a subset of the edges of  $G$  that connects all the vertices together, without any cycles and with the minimum possible total edge weight. Assume  $G$  is connected and any edge weight  $w_j \geq 0, w_j \in W$ .  
Develop a Genetic Algorithm-based solution to solve the above-stated problem. Following guidelines should be used to develop the solution.
    - Let  $G$  is a complete graph where  $|V|=30$ . You may assign the edge weight randomly within the range of 0 to 1.
    - Use an appropriate chromosome encoding approach.

- The population size is 50, and it is fixed.
- Initial population should be constructed randomly.
- Proper parent selection mechanism should be incorporated.
- A multi-point crossover operator should be used. The probability of the crossover operator is 0.8 and it will be gradually reduced to 0.1
- Use an appropriate mutation operator, and the probability of the mutation operator is 0.05.
- An appropriate metric should be used to assess the population's quality.
- Demonstrate the approach's effectiveness by showing the population up to a minimum 500 generations.