Indian Institute of Technology, Guwahati

A

PROJECT

REPORT

ON

BINARY CODED GENETIC ALGORITHM

Submitted to: **Submitted by:**

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Binary Coded Genetic Algorithm

1. Introduction to Genetic Algorithm

A genetic algorithm is a population based search technique used in computing to find true or approximate solutions to optimization and search problems.

Genetic algorithms are categorized as global search heuristics. Genetic algorithms are a particular class of evolutionary algorithms that use techniques inspired by evolutionary biology such as inheritance, mutation, selection, and crossover.

2. Binary Coded Genetic Algorithm

In binary coded GA, a gene or chromosome is represented by a string of binary bits (0's and 1's). The size of string depends upon the variable range and desired accuracy

3. Given Problem Statement -

Develop a generalize computer program for a binary-coded GA with Roulette-wheel reproduction scheme, two point crossover and bit-wise mutation.

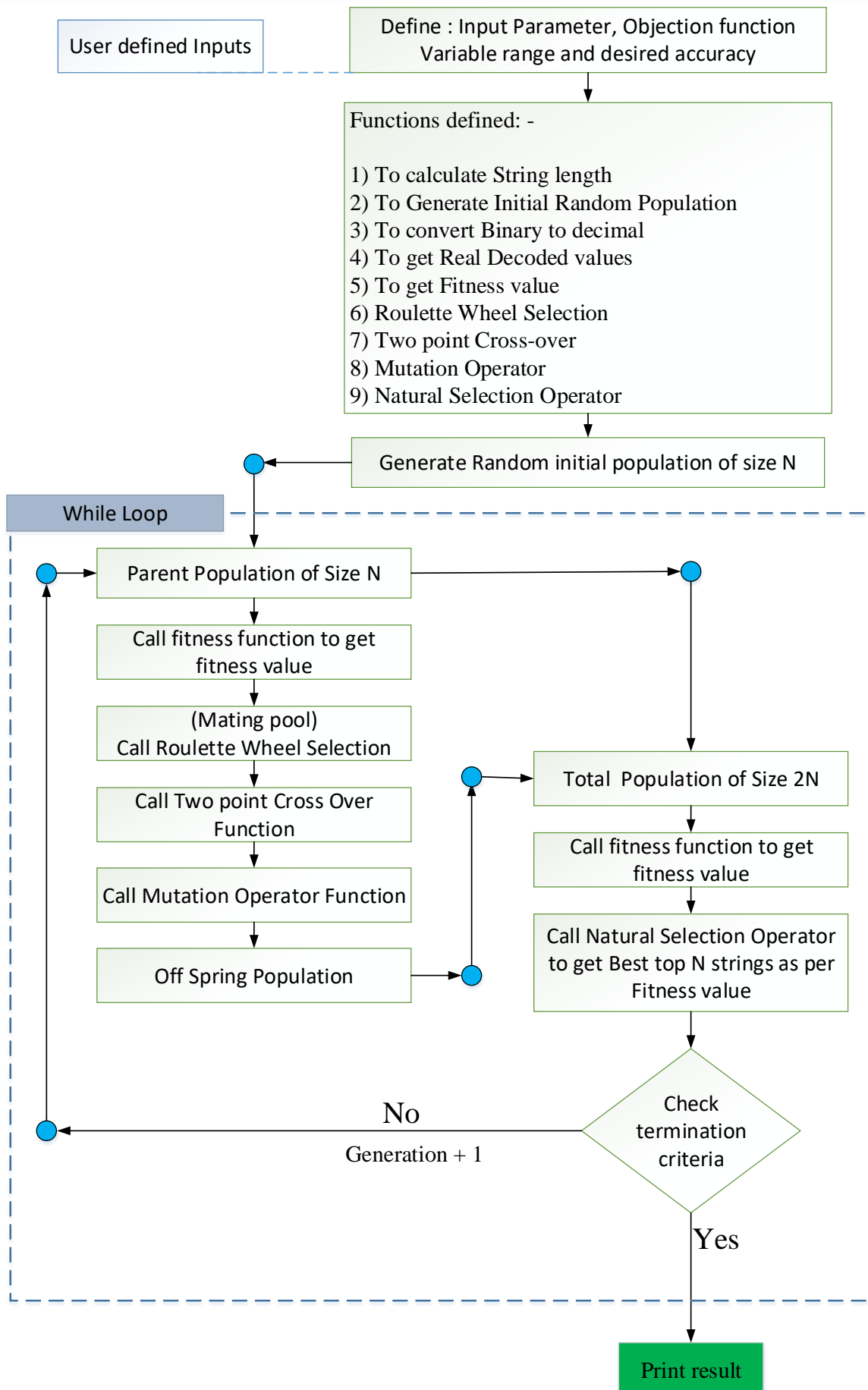$$Minimize \ f(x_1, x_2) = x_1 + x_2 - 2x_1^2 - x_2^2 + x_1 x_2$$

$$in \ range \ of \ \ 0.0 \leq x_1, x_x \leq 0.5$$

4. Features of General Python Code developed -

⇨ Can handle n number of variable problems $(i.e \ x_1, x_2, x_3, ...x_n)$

⇨ Can handle both maximization and minimization problems

⇨ The desired accuracy of each variable can be defined independently

5. **Flow Chart of Python Code -**

Flow Chart for General Python Code developed for Binary coded Genetic Algorithm for n numbers of variables

User defined Inputs

Define : Input Parameter, Objection function Variable range and desired accuracy

Functions defined: -

1) To calculate String length
2) To Generate Initial Random Population
3) To convert Binary to decimal
4) To get Real Decoded values
5) To get Fitness value
6) Roulette Wheel Selection
7) Two point Cross-over
8) Mutation Operator
9) Natural Selection Operator

Generate Random initial population of size N

While Loop

Parent Population of Size N

Call fitness function to get fitness value

(Mating pool)
Call Roulette Wheel Selection

Call Two point Cross Over Function

Call Mutation Operator Function

Off Spring Population

Total Population of Size 2N

Call fitness function to get fitness value

Call Natural Selection Operator to get Best top N strings as per Fitness value

Check termination criteria

No
Generation + 1

Yes

Print result

6. Natural Selection Operator:

With this approach the population after mutation (off spring population) is combined with parent population and then out of total combined population top N solution are selected based on the Ranking of Fitness value. Which further is considered for next generation

This operator is also known as "Survival of Fittest", which pass on only best solution after crossover and mutation to next generation

Objective - Minimization of two variable problem with given geometric constrains

Input parameters:-
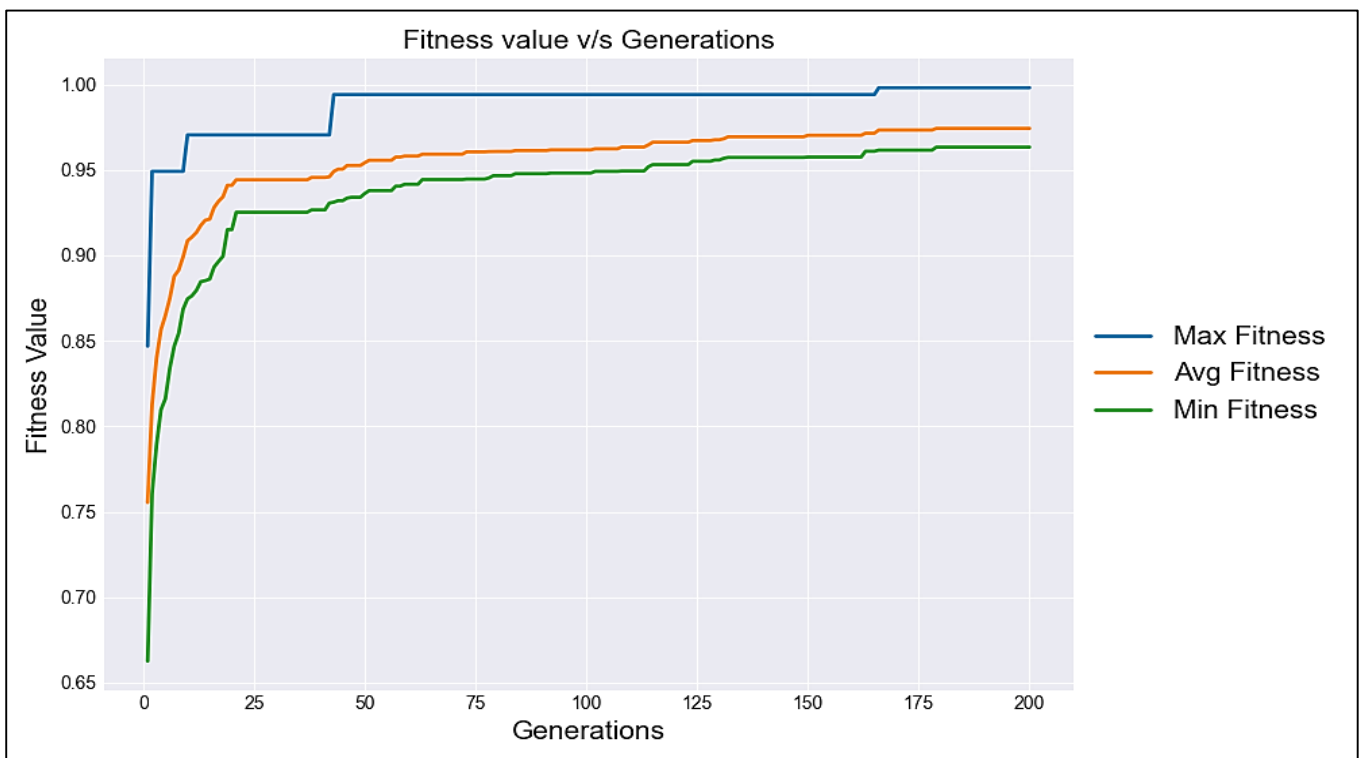
Population Size (N) = 20
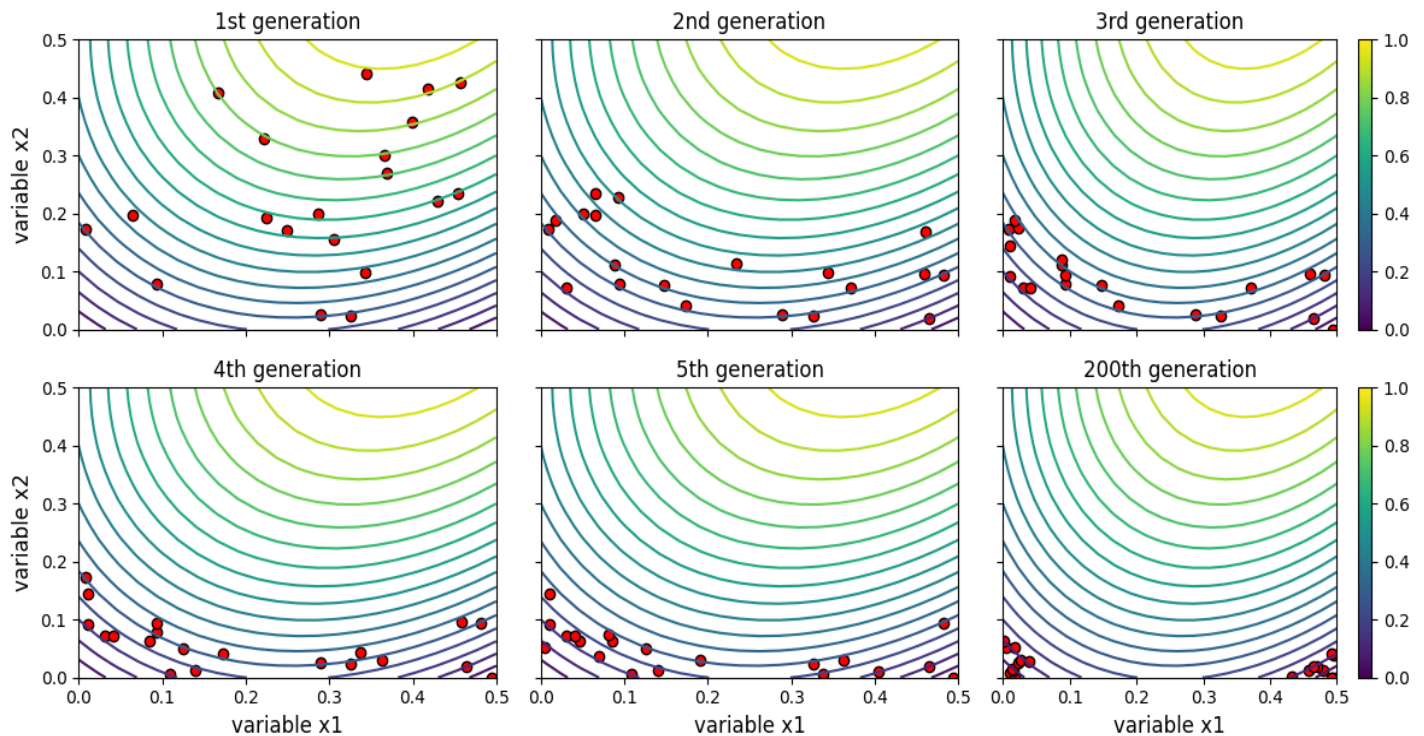Max Generation Limit = 200
Cross over Probability (Pc) = 0.9
Mutation Probability (Pm) = 0.5
Desired accuracy of each variable (e) = 0.0001

Fitness v/s generations Plot-

Solutions of different generations on objective function's contour plot-

From above plot we can see the binary coded genetic algorithm converge to optimum solution very quickly as shown by the scatter plot on objective function's contour plot. Looking at the variation in solutions over generation we can see the at 200th generation the solutions form two cluster around optimum solutions

Optimum value of Solutions from Binary coded GA:

    1) (0.0019, 0.0065)
    2) (0.4929, 0.0012)

7. Conclusion:-

Plot of genetic algorithm shows convergence rate to optimal Solution, if there are multiple optimal solution it is capable to finds all of those. For given problem there are two optimal solution and final generation of GA is forming cluster about those optimal solutions.