ME 674 : Soft-computing in Engineering

Tutorial # 3, Total Marks: 20

1. In a three variables problem, the following variable bounds are specified.

$$-5 \le x \le 10, \qquad 0.001 \le y \le 0.005, \qquad 10^3 \le z \le 10^4$$

What should be the minimum string length of any point $(x, y, z)^T$ coded in binary string to achieve the two significant digits accuracy in the solution.

2. We would like to use GA to solve the following problem:

Minimize $(x_1 - 1.5)^2 + (x_2 - 4)^2$

subject to, $4.5x_1 + x_2^2 - 18 \le 0 \qquad 2x_1 - x_2 - 1 \ge 0, \qquad 0 \le x_1, x_2 \le 4$

Write down the fitness function which you would be using in reproduction.

3. In the Simulated Annealing processes, a neighbouring point is created with the following probability distribution;

$p(x,\sigma) = \dfrac{a}{\sigma^2 + x^2}$, what must be the value of a, in order to have a valid probability distribution? The current point is x = 10.0 and variance σ = 2.0 is used. If a random number 0.723 is chosen to create a point, what is the new point?

4. In order to solve the maximization problem

$$f(x) = \begin{cases} 2x & \text{if } 0.0 \le x \le 0.3 \\ 1.5 - 3x & \text{if } 0.3 \prec x \le 0.5 \\ 5x - 2.5 & \text{if } 0.5 \prec x \le 0.8 \\ 2.4 - 2x & \text{if } 0.8 \prec x \le 1.2 \end{cases}$$

using simulated annealing, we begin with an initial point $x^0 = 0.2$. A normal probability distribution is used to create a neighbouring point. Calculate the probability of creating the optimal solution as neighbouring point.

5. In a real coded GA the probability distribution for expanding crossover is given by the expression $E_x(\alpha) = 0.5(q+1)\dfrac{1}{\alpha^{q+2}}$, where α is the spread factor, assume q= 0.4. Determine two new children solutions from the given parent solutions. Use a random number equal to 0.8.

Pr1 : 10.5; 20.6; 30.5

Pr2 : 12.8; 19.1; 38.9

6. Use a binary-coded GA to minimize the function $f(x_1, x_2) = x_1 + x_2 - 2x_1^2 - x_2^2 + x_1 x_2$, in the range of $0.0 \le x_1, x_2 \le 0.5$. using a random population of size N = 6, a single point crossover with probability p_c = 1.0, neglect mutation and assume 5 bits for each variable. Show only one iteration by a hand calculation.