Indian Institute of Technology Kharagpur

Department of Mechanical Engineering

Instructions: Answer all the questions. Each question carries two marks. There is no negative marking for wrong answer. There is no part marking for the questions.

First Test (2020-2021) ; Total Marks: 20

Subject: MF41601: Soft Computing; Maximum Time: 1 hour; Date: 24.09.2020

Name:	Roll No.

Q1. Let us consider a function $y = f(x) = x^6$. At the point $x = x^* = 0$, it has the

(a) Maximum point,
(b) Minimum point,
(c) Saddle/inflection point,
(d) None of the above

Answer:

Q2. To minimize $y = f(x_1, x_2, x_3) = x_1^2 + x_2^2 + x_3^2 - x_1 + x_2 + x_3$ in the range of $-6.0 \leq x_1, x_2, x_3 \leq 6.0$ using Random walk method, let us start with an initial solution $X_1 = \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} = \begin{Bmatrix} 0.0 \\ 0.0 \\ 0.0 \end{Bmatrix}$.

Take step length $\lambda = 0.5$ and random numbers $\begin{Bmatrix} r_1 \\ r_2 \\ r_3 \end{Bmatrix} = \begin{Bmatrix} 0.2 \\ -0.3 \\ 0.4 \end{Bmatrix}$. In the first iteration, the search direction and value of the objective function (approximately) will be as follows:

$(a) \begin{Bmatrix} -0.45 \\ 0.85 \\ 0.95 \end{Bmatrix}$ and 1.2546

$(b) \begin{Bmatrix} 0.60 \\ 0.70 \\ -0.85 \end{Bmatrix}$ and 2.2548

$(c) \begin{Bmatrix} 0.37 \\ -0.56 \\ 0.74 \end{Bmatrix}$ and 0.1545

$$(d)\begin{Bmatrix} 0.85 \\ 0.23 \\ -0.75 \end{Bmatrix} \text{ and } 3.5678$$

Answer:

Q3. To minimize $y = f(x_1, x_2, x_3) = x_1^2 + x_2^2 + x_3^2 + x_1 - x_2 - x_3$ in the range of $-8.0 \leq x_1, x_2, x_3 \leq 8.0$ using Steepest Descent method, let us start with an initial solution $X_1 = \begin{Bmatrix} x_1 \\ x_2 \\ x_3 \end{Bmatrix} = \begin{Bmatrix} 0.0 \\ 0.0 \\ 0.0 \end{Bmatrix}$. In the first iteration, the search direction and optimal step length are found to be as follows:

$$(a)\begin{Bmatrix} -1 \\ 1 \\ 1 \end{Bmatrix} \; and \; \lambda_1^* = \frac{1}{2}$$

$$(b)\begin{Bmatrix} 1 \\ 1 \\ -1 \end{Bmatrix} \; and \; \lambda_1^* = \frac{1}{3}$$

$$(c)\begin{Bmatrix} 1 \\ -1 \\ -1 \end{Bmatrix} \; and \; \lambda_1^* = \frac{1}{6}$$

$$(d)\begin{Bmatrix} -1 \\ -1 \\ -1 \end{Bmatrix} \; and \; \lambda_1^* = \frac{1}{4}$$

Answer:

Q4. A binary-coded GA is to be used to solve a mixed integer optimization problem involving one real and one integer variables. The real and integer variables are allowed to vary in the ranges of (0.1, 10.33) and (0, 1023), respectively. Let us assume that a precision level of 0.01 is to be maintained for the real variable. The numbers of bits to be assigned to denote the real and integer variables are as follows:

(a) 8, 9
(b) 7, 9
(c) 9, 8
(d) 10, 10

Answer:

Q5. Let us try to solve a maximization problem of the form:y $= f(x_1, x_2) = x_1 + x_2$, where x_1 and x_2 are two real variables lying in the range of (1.0, 10.0). Use a binary-coded GA to solve this maximization problem. Its initial population of size N = 4 created at random is given below. Let us use 5 bits to represent each of the variables.

10101 00111
01010 10100
11011 11001
10110 10101

Using Roulette-Wheel selection, their probability values of being selected in the mating pool are approximately found to be as follows:

(a) 0.30, 0.40, 0.20, 0.10
(b) 0.54, 0.25, 0.15, 0.06
(c) 0.44, 0.10, 0.25, 0.21
(d) 0.19, 0.20, 0.33, 0.28

Answer:

Q6. Let us consider a schema H: **0******1 of a binary-coded GA. Its probability of destruction due to a single-point crossover of probability $p_c = 0.8$ is calculated as

(a) 0.95
(b) 0.85
(c) 0.62
(d) 0.15

Answer:

Q7. Let us consider two parents participating in single-point crossover of a binary-coded GA as given below.

Pr1: 10101001|010110101010

Pr2: 01101110|001010111011

Crossover site

The crossover site is selected at random, as given above. Children solutions are found to be as follows:

(a) 11011010111100000011

11000000101001011010

(b) 10101001001010111011

01101110010110101010

(c) 00101011101110101001

00100110010100101010

(d) 10001110001110000111

01011111001010111001

Answer:

Q8. Let us assume that the following two parents are participating in uniform crossover of a binary-coded GA.

$$\begin{array}{l} \quad\quad\quad\;\; * \quad\;\;\; * \quad\;\;\; * \quad\;\;\; * \\ \text{Pr}\,1\;: 1\,0\,1\,0\,1\,0\,1\,1\,1\,1\,0\,0\,1\,0\,1\,0 \\ \text{Pr}\,2:\;0\,1\,1\;\,0\,0\,1\;\,0\,1\,1\;\,0\,0\,1\;\,0\,1\,0\,1 \end{array}$$

Let us also assume that 3rd, 6th, 9th and 12th bit positions counting from the left-most bit have been selected for this crossover.

Children solutions are found to be as follows:

(a) 0110010110010100

1010101101001011

(b) 1010100110010101

0110011111001010

(c) 1010101010101010

0101010101010101

(d) 1010111111011010

0110000110000101

Answer:

Q9. To solve an optimization problem using a real-coded genetic algorithm (RCGA), let us use polynomial mutation to determine a mutated solution from the parent solution $\text{Pr}_{original} = 20.58$. Let us assume the random number r = 0.6 for which the perturbation factor $\bar{\delta} = (2r)^{\frac{1}{q+1}} - 1$, where the exponent q is set equal to 5. Assume the maximum value of perturbation δ_{max} = 1.0.

The mutated solution is approximately found to be equal to

(a) 13.65
(b) 12.85
(c) 20.61
(d) 25.81

Answer:

Q10. In a two-objectives optimization problem, to obtain Pareto-front of optimal solutions, they should

(a) increase simultaneously
(b) decrease simultaneously
(c) contradict one another
(d) be independent

Answer:

ANSWER KEYS

Q. 1:	Q. 2:	Q. 3:	Q. 4:	Q. 5:
Q. 6:	Q. 7:	Q. 8:	Q. 9:	Q. 10:

Name: Roll No.