

Random Search methods

Random Search methods are based on the use of random number in finding the minimum point. Some of the best known random search methods are like Random Jumping method, Random walk method etc.

- ① Random Jumping Method: - It is used to solve the unconstrained problem. We establish the bounds l_i and u_i for each variable x_i , $i = 1, 2, 3, \dots, n$, for generating the random values of x_i

$$l_i \leq x_i \leq u_i \quad i = 1, 2, \dots, n \quad (6.16) \quad \checkmark$$

Here, we generate sets of n numbers, (r_1, r_2, \dots, r_n) , that are uniformly distributed between 0 and 1. Each set of these numbers, is used to find a point, x , inside the hypercube defined by Eqn (6.16) as

$$x = \begin{Bmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{Bmatrix} = \begin{Bmatrix} l_1 + r_1(u_1 - l_1) \\ l_2 + r_2(u_2 - l_2) \\ \vdots \\ l_n + r_n(u_n - l_n) \end{Bmatrix}$$

and the value of the function is evaluated at this point x . By ~~large~~ generating a large number of random points x and evaluating the value of the objective function at each of these points, we can take the smallest value of $f(x)$ as the desired minimum point. \checkmark

Q Minimize $6x_1^2 - 6x_1x_2 + 2x_2^2 - x_1 - 2x_2$

Find the minimum value in the range

$$-5 \leq x_1 \leq 5, \quad -5 \leq x_2 \leq 5$$

Ans given that $l_1 = -5, u_1 = 5, \quad l_1 < x_1 < u_1$
 $l_2 = -5, u_2 = 5, \quad l_2 < x_2 < u_2$

1st step generate random number between 0 to 1

$$r_1 = 0.5, r_2 = 0.6$$

$$x = \begin{Bmatrix} x_1 \\ \vdots \end{Bmatrix} = \begin{Bmatrix} l_1 + r_1(u_1 - l_1) \\ \vdots \end{Bmatrix} = \begin{Bmatrix} -5 + 0.5(5 - (-5)) \\ \vdots \end{Bmatrix} = \begin{Bmatrix} -5 + 0.5 \times 10 \\ \vdots \end{Bmatrix}$$

$$x_1, x_2$$

$$l_1 \leq x_1 \leq u_1$$

$$l_2 \leq x_2 \leq u_2$$



$$r_1, r_2, \dots, r_n$$

$$(0, 1)$$

$$x = \begin{cases} x_1 = l_1 + r_1(u_1 - l_1) = -5 + 0.6 \dots \\ x_2 = l_2 + r_2(u_2 - l_2) = -5 + 0.6(5 - (-5)) = -5 + 0.6 \times 10 \\ = \begin{cases} -5 + 5 \\ -5 + 6 \end{cases} = \begin{cases} 0 \\ 1 \end{cases} \end{cases}$$

$$f(x) = f(0, 1) = 6 \cdot 0 - 6 \times 1 \times 0 + 2 \cdot 1^2 - 0 - 2 \times 1 = 0 + 2 - 2 = 0$$

2nd Iteration $r_1 = 0.4 \quad r_2 = 0.6$

$$x = \begin{cases} x_1 = -5 + 0.4(10) = -5 + 4.0 = -1 \\ x_2 = -5 + 0.6(10) = -5 + 6.0 = 1 \end{cases}$$

$$f(x) = f(x_1, x_2) = f(-1, 1) = 6(-1)^2 - 6(-1)(1) + 2(1^2) - (-1) + 2 \\ = 6 + 6 + 2 + 1 + 2 = 17.$$

3rd iteration $(r_1, r_2) = (0.25, 0.26)$

4th iteration $(r_1, r_2) = (0.7, 0.8)$

5 " " $= (0.765, 0.766)$

6 " " $= (0.236, 0.238)$

7 " " $= (0.296, 0.297)$

8 " " $= (0.2456, 0.2656)$

9 " " $= (0.97, 0.98)$

10 " " $= (7.45, 7.46)$

(2) $-10 < x_1 < 10, -20 < x_2 \leq 20.$

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