

CE 515: Genetic Algorithms

Tutorial # 01: Classical Optimization methods

1. Find the stationary points of the following function

$$f(x_1, x_2) = -x_1^2 - x_2^2 + x_1x_2 + 7x_1 + 4x_2$$

2. Solve the following quadratic problem using Newton's method. Take $x_0 = [1, 1]$

$$\text{Minimize } f(X) = -4x_1 + x_1^2 - 2x_1x_2 + 2x_2^2$$

3. Solve Q. No 2. using conjugate direction method. Take $x_0 = [0, 0]$

4. Obtain linear and quadratic approximation of the following function at $x = [1, 1]$

$$\text{Minimize } f(X) = 2x_1 + 3x_2 - x_1^3 - 2x_2^2$$

5. For the function given below, obtain the minimum point along the line joining the point $(-3, -4)^T$ and $(3, 2)^T$. Take $x_0 = (-3, -4)^T$.

$$f = 2 + (x_1^2 - x_2)^2 + x_2^2$$

6. Find whether the given direction s at point x is descent for the respective functions.

$$f = (x_1 + 2x_2 + 3x_3)^2 + (x_1^2 - x_3)^2, s = [1, 2, -1]^T \text{ and } x = [1, 0, 1]^T$$

$$f = 2x_1^2 + x_2^2 - 2x_1x_2 + 4, s = [1, 1]^T \text{ and } x = [2, 3]^T$$

7. Compare the golden section search method and interval halving method in terms of the obtained interval after 5 function evaluations for the minimization of the function

$$f(x) = x^2 - 10 \exp(0.1x)$$

in the interval $[-10, 5]$.

8. State whether each of the following functions are convex, concave or neither.

a. $f = 2x^2 + 8x + 4$

b. $f = x^2 + 10x + 1$

c. $f = x_1^2 - x_2^2$

d. $f = -x_1^2 - 4x_1x_2$

e. $f = x_1x_2$

f. $f = (x_1 - 1)^2 + 10(x_2 - 2)^2$

8. Determine each of the following matrices is positive definite, negative definite or neither positive definite nor negative definite.

a. $\begin{bmatrix} 1 & 2 \\ -2 & 1 \end{bmatrix}$

b. $\begin{bmatrix} 3 & 1 & -1 \\ 1 & 3 & -1 \\ -1 & -1 & 5 \end{bmatrix}$

c. $\begin{bmatrix} 4 & 2 & -4 \\ 2 & 4 & -2 \\ -4 & -2 & 4 \end{bmatrix}$
