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Applied Evolutionary Optimization
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Tutorial 1: Classical Optimization

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1. Identify the optimum points of the following functions. Mention and justify whether the points are minimum or maximum.

   (a) $f(a) = a^3 + 2a^2 - 10a + 10$.

   (b) $f(x_1, x_2) = 2x_1^3 - 3x_1^2 - 6x_1x_2(x_1 - x_2 - 1)$.

2. In trying the find the maximum of the following function, the point $x^{(t)} = (3, 2, -1)^T$ is encountered:

   $$f(x_1, x_2, x_3) = 6x_1^2x_2 - 5x_3 + 2x_1(x_2^2 + x_3^2).$$

   Determine whether the search direction $s^{(t)} = (-1, 1, -2)^T$ would be able to find better solutions locally from $x^{(t)}$.

3. Given the function:

   $$f(x) = 10 - x_1 + x_1x_2 + x_2^2.$$

   Using two iterations of the golden section search method, estimate the minimum point along the line joining the points $(-3, -4)^T$ and $(3, 2)^T$. Restrict the search between the above two points.
   Extra: Can you find the exact minimum point along the line and compare with the exact minimum of the function!

   beginenumerate

4. Write down the Kuhn-Tucker conditions for the following problem:

   $$\text{Maximize} \quad 3x_1^2 - 2x_2 + 10$$

   subject to

   $$\begin{gathered} 2x_1 + x_2 = 4, \\ x_1^2 + x_2^2 \leq 19.4, \\ x_1 \geq 0. \end{gathered}$$

   Find out whether points $(0, 4)^T$ and $(3.4, -2.8)^T$ are Kuhn-Tucker points.

5. Consider the NLP problem:

   $$\text{Minimize} \quad f(x) = 10 + x^2 - 8x$$

   subject to

   $$x \geq 6.$$

   (a) Use the penalty function method with the following penalty terms to find the constrained minimum point of the above problem. Use the bracket operator penalty term with the following values of R: 0.01, 10.0, and ∞. Form the penalized function and use the exact differentiation technique to compute the optimal point in each sequence.