Indian Institute of Technology Jodhpur
Optimization for Data Science (PGD)
Assignment I

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1. Find the minimum of the function
$$f(x) = 0.65 - \frac{0.75}{1+x^2} - 0.65x\tan^{-1}(\frac{1}{x})$$
using Newton method with starting point $\lambda_1 = 0.1$. Use $\epsilon = 0.01$ for checking convergence.

2. Consider the problem of minimizing $f(x, y, z) = 2x^2 + 2xy + z + 3y^2$ starting with $x_1 = (1, -2, 3)^t$. Perform a single iteration of the
   (a) Newton method
   (b) Steepest descent method

   Compare the results obtained by these two methods.

3. Starting with $(-2, 4)^t$, minimize $f(x, y) = \frac{3}{2}x^2 + \frac{1}{2}y^2 - xy + 2x$ using conjugate gradient method.

4. Find the mutually conjugate directions w.r.t. the following matrices
   (a) $A = \begin{bmatrix} 1 & 2 \\ 2 & 8 \end{bmatrix}$
   (b) $A = \begin{bmatrix} 2 & -2 & 0 \\ -2 & 3 & -1 \\ 0 & -1 & 6 \end{bmatrix}$

5. $minf(x) = x^5 - 5x^3 - 20x + 5$ using fibonacci search method. The initial interval of uncertainity is $[-2, 2]$ and allowable error is 0.5.

6. Solve the question 5 using Golden section method. Compare your results with the results obtained using fibonacci search method.

7. Show that the following functions have local minima at the indicated points
   (a) $f(x, y) = x^4 + y^4 + 4x - 32y - 7 \qquad (x_0, y_0) = (-1, 2)$
   (b) $f(x, y) = x^3 + 3x^2 - 2xy + 5y^2 - 4y^3 \qquad (x_0, y_0) = (0, 0)$

8. The temperature at a point (x, y, z) in the 3D space is given by $T(x, y, z) = 400xyz^2$. Find the highest temperature on the unit sphere $x^2 + y^2 + z^2 = 1$.

9. Use the lease square method to find best approximate solution to the following system of the equations
$$\begin{aligned} 2x + 4y &= 3 \\ x - y &= 0 \\ 3x + 3y &= 2 \end{aligned}$$

10. Perform two iterations of DFP's method to minimize the function $f(x,y) = 100(y - x^2)^2 + (1 - x)^2$ from the starting point $(-1.2, 1.0)$.