

UNIVERSITY OF MALAYA

ALTERNATIVE ASSESSMENT FOR THE DEGREE OF MASTER OF DATA  
SCIENCE (Part 2)

ACADEMIC SESSION 2022/2023 : SEMESTER II

WQD7011 : Numerical Optimization

June 2023

Time : 1 hour

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INSTRUCTIONS TO CANDIDATES :

Answer **ALL** questions (20 marks).

(This question paper consists of 3 questions on 3 printed pages)

3. Refer to cost function  $f(\mathbf{x}): \mathbb{R}^2 \rightarrow \mathbb{R}$  and its derivatives as follows:

$$f(\mathbf{x}) = 2x_1^3x_2 - 3x_1x_2^2 + x_1 \sin(x_2)$$

$$\nabla f(\mathbf{x}) = \begin{bmatrix} 6x_1^2x_2 - 3x_2^2 + \sin(x_2) \\ 2x_1^3 - 6x_1x_2 + x_1 \cos(x_2) \end{bmatrix}$$

$$\nabla^2 f(\mathbf{x}) = \begin{bmatrix} 12x_1x_2 & 6x_1^2 - 6x_2 + \cos(x_2) \\ 6x_1^2 - 6x_2 + \cos(x_2) & -6x_1 - x_1 \sin(x_2) \end{bmatrix}$$

Assume that a sequence of searches for minimizers will be performed at the starting point  $\mathbf{x}_0 = \begin{bmatrix} 1 \\ 2 \end{bmatrix}$ . Two friends, John and Caine are discussing how these searches can be completed.

a) John suggests to use Steepest Descent method. Help John to determine the following:

- i) The steepest descent direction at  $\mathbf{x}_0$ .
- ii) Without computing a feasible step length, John assume that  $\alpha=1$  is a good choice. Find  $\mathbf{x}_1$ , the first point in the sequence of searches using this step length. Hence, determine if the cost function value at  $\mathbf{x}_1$  decreases compared to  $\mathbf{x}_0$ .  
(6 marks)

b) On the other hand, Caine suggests that Newton method would be faster for this case and propose to use it. Do you agree with Caine suggestion? Provide evidence that support your argument.

(3 marks)

4. a) Explain the concept of trust region methods.

(3 marks)

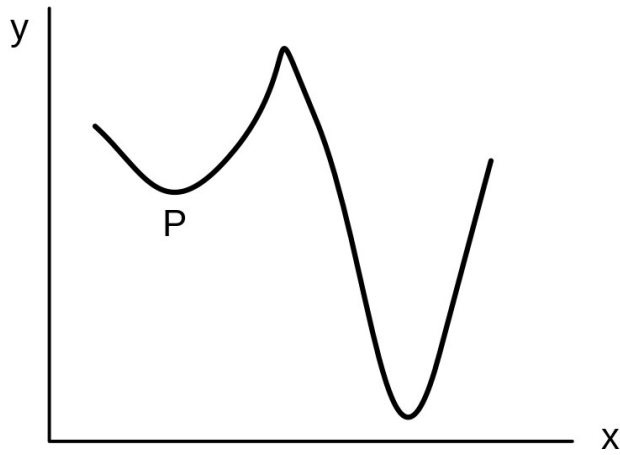
b) Discuss how the performance of the last iteration in trust region methods affect the next iteration.

(3 marks)

c) In every step of the trust region method,  $\rho$ , the ratio between actual reduction and predicted reduction is always computed. Explain why  $\rho$  with a negative value is not acceptable.

(2 marks)

5. Differentiate local and global minimizer. Refer to the figure below, P is a local or global minimizer?



(3 marks)

**END**