UNIVERSIDAD AUTÓNOMA DE NUEVO LEÓN

Facultad de Ingeniería Mecánica y Eléctrica

Homework 1

Due date: Mon 18-Ago-2025 20:00

Course: **Selected Topics on Optimization**

Semester: Fall 2025

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Answer each question.

1. Formally define an optimization problem.
   An optimization problem is defined as:
   Find $x \epsilon X \leq L^n$ that maximizes or minimizes f(x)
   Where:
   - F: $L^n \rightarrow L$ is the objective function
   - X is the feasible region, typically defined by a set of constraints $g_i(x) \leq 0$ and $h_j(x) = 0$.
2. Formally define a linear optimization problem (also called linear programming problem).
   Is an optimization problem where:
   - The objective function is linear:
     Min (or max) $c^T x$
   - All constraints are linear equations or inequalities:
     $Ax \leq b, A_{eq}x = b_{eq}, \ x \geq 0$
3. Formally define an integer optimization problem (also called integer programming problem).
   An integer programming problem (IP) problem is an optimization problem where the objective function and constraints can be linear (or nonlinear), and some or all decision variables are restricted to integer values.
4. What is the method typically used for solving linear programming problems (of any size)?
   Simplex method.
5. What is the method typically used for solving integer programming problems?
   Branch and bound
6. What is the main difference between a linear programming problem and an integer programming problem?
   In a linear programming problem, decision variables can take any real values within the feasible region while in integer programming problems some or all decision variables are restricted to integers, making the problem generally harder to solve.
7. When do we say that an optimization problem is “easy” to solve?
   When there exists a polynomial- time algorithm to find the optimal solution.
8. When do we say that an optimization problem is “hard” to solve?

When no known polynomial-time algorithm exists and the computation time grows exponentially with problem size.

9. What is a heuristic method for optimization problems?
   It is an approach that seeks good-enough solutions within reasonable time, without guaranteeing optimality.
10. What is an exact method for optimization problems?
    An exact method guarantees finding the optimal solution (and proving it is optimal).
11. What is a brute-force method for optimization problems?
    This method checks all possible solutions in the search space and picks the best one. It always finds the optimum but is computationally infeasible for large problems.
12. What are the main reasons heuristic methods are used?
    Need for a good enough solution quickly (real time or near real time decisions).
13. What is a combinatorial optimization problem?
    Is one where the feasible region consists of a finite but very large set of discrete solutions (often permutations, subsets, or integer assignments), and the goal is to find the best one according to an objective function.

Note: You must submit a PDF file (named: **HW1-*Firstname_Lastname*.pdf**) typeset electronically with your answers to both: roger@yalma.fime.uanl.mx and rz.rios@utexas.edu by the due date.