CS 5114 Theory of Algorithms, Spring 2022
Project 2: Due on 21 March 2022, 11:59PM (firm deadline)

Add the following lines, your name, and signature in the beginning of your report.

I pledge that this test/assignment has been completed in compliance with the Graduate Honor Code and that I have neither given nor received any unauthorized aid on this test/assignment.

Name (Print): _____

Signed: _____

This project aims to enhance the understanding of greedy algorithms in solving optimization problems. A project will be graded based on the following criteria:

1. (15%) Select one optimization problem you want to solve using greedy algorithms and give a specific problem description including:

   (a) (3%) Input parameters

   (b) (3%) A formally defined objective function (i.e., minimization or maximization)

   (c) (3%) Expected outputs.

   (d) (6%) Whether a chosen problem is challenging enough for a large size problem in terms of the formulation of the objective function and complexity.

2. (20%) Develop two greedy algorithms and provide the following:

   (a) (10%) Describe the first greedy algorithm with the corresponding pseudo code (5%) and clear explanation (5%)

   (b) (10%) Describe the second greedy algorithm with the corresponding pseudo code (5%) and clear explanation (5%).

3. (40%) Conduct the comparative performance analysis of the two greedy algorithms you developed with a baseline brute-force algorithm in terms of two metrics measuring optimality (i.e., metrics to maximize or minimize) and complexity (**use both asymptotic complexity and simulation running time**). Since the brute-force algorithm cannot be easily solved for large-size problems due to its high complexity, conduct the following performance comparative study:

   (a) (15%) Solve the chosen problem with the **ranges of small-size problems** that can be easily solved by the **three algorithms**, including brute-force algorithm and the two greedy algorithms.

      i. (10%) Show the experimental results (i.e., three curves for these three algorithms, respectively) with respect to varying the input size.

      ii. (5%) Provide clear explanations on the results observed. x-axis is the problem size (i.e., n) and y-axis is either an optimal value or complexity (in asymptotic complexity, Θ, Ω, or Big-O, and simulation running time). There should be three graphs showing the experimental results where each graph has three curves for the three algorithms compared in terms of three metrics (i.e., achieved optimality, asymptotic complexity, and simulation running time).

(b) (25%) Solve the chosen problem with the **ranges of large-size problems** using the **two greedy algorithms** you developed.

    i. (15%) Show the experimental results (i.e., two curves for these two algorithms, respectively) with respect to varying the size of a problem.

    ii. (10%) Provide clear explanations on the results observed. x-axis is the problem size (i.e., n) and y-axis is either an optimal value or complexity (in asymptotic complexity, Θ, Ω, or Big-O, and simulation running time). There should be three graphs showing the experimental results where each graph has two curves for the two greedy algorithms compared in terms of three metrics (i.e., achieved optimality, asymptotic complexity, and simulation running time).

4. (25%) Identify/discuss additional key design parameter(s) or input values that may significantly affect optimality and/or complexity.

    (a) (15%) Show experimental results of the two developed greedy algorithms for a large problem size when varying the values of key design parameters. If you provide experimental results (in optimality, asymptotic complexity, and running time – three graphs) under varying the values of two or more two design parameters, you will have full points. If you show only one, you will have the half of the points.

    (b) (10%) Provide clear explanations for the observed results. Note that unreasonable results and/or unclear explanations will lead to point deductions.

5. **Submission Format**:

- Font 11; single-spaced
- Do not exceed 5 pages in total
- Submit the report in .pdf
- Make a single .zip file including: (1) Report; (2) Source codes files under a subfolder named 'source codes'; and (3) README file describing how to run your code.

6. P2 presenters should submit the slides by the same due, 3/21/2022, 11:59PM, at the P2 submission site of the canvas.

Rubrics for P2 Report: Grading Criteria

Total Score	Note	Comments	Score
15%	Explained clearly the following: • Input parameter description (3%) • A formally defined objective function (3%) • Expected output description (3%) • The extent of a chosen problem being highly challenging (6%)		
20%	The following criteria are sufficiently met: • Clear description of the first greedy algorithm developed (5%) • Clear description of pseudo code of the first greedy algorithm (5%) • Clear description of the second greedy algorithm developed (5%) • Clear description of pseudo code of the second greedy algorithm (5%)		
40%	Conduct the comparative performance analysis as follows: • Demonstration of the comparative analysis of the three algorithms for small-size problems in optimality and complexity (three graphs for the results) (10%) • Clear explanations for the observed results (5%) • Demonstration of the comparative analysis of the two greedy algorithms for large-size problems in optimality and complexity (three graphs for the results) (15%) • Clear explanations for the observed results (10%)		
25%	The following criteria are sufficiently met: • Sensitivity analysis conducted by varying the values of the key design parameters (15%) – (one sensitivity analysis: 7.5%; 2+ sensitivity analyses: 15%) • Clear explanations of the observed results under the sensitivity analysis. (10%) – (explanation for one sensitivity analysis is counted with 5%)		

Late penalty: 10% off per day (Any minute later after the deadline will be counted as one day late, e.g., 1 day late for the submission on 12:00am on the next day).

Rubrics for P2 Presentation: Grading Criteria

Total Score	Note	Comments	Score
15%	Explained clearly the following: • Input parameter description (3%) • A formally defined objective function (3%) • Expected output description (3%) • The extent of a chosen problem being highly challenging (6%)		
20%	The following criteria are sufficiently met: • Clear description of the first greedy algorithm developed (5%) • Clear description of pseudo code of the first greedy algorithm (5%) • Clear description of the second greedy algorithm developed (5%) • Clear description of pseudo code of the second greedy algorithm (5%)		
30%	Conduct the comparative performance analysis as follows: • Demonstration of the comparative analysis of the three algorithms for small-size problems in optimality and complexity (three graphs for the results) (5%) • Clear explanations for the observed results (5%) • Demonstration of the comparative analysis of the two greedy algorithms for large-size problems in optimality and complexity (three graphs for the results) (10%) • Clear explanations for the observed results (10%)		
20%	The following criteria are sufficiently met: • Sensitivity analysis conducted by varying the values of the key design parameters (10%) – (one sensitivity analysis: 5%; 2+ sensitivity analyses: 10%) • Clear explanations of the observed results under the sensitivity analysis. (10%) – (explanation for one sensitivity analysis is counted with 5%)		
10%	Provided proper answers for questions raised during the presentation.		
5%	Time management: Presented all prepared contents in a timely manner within 10 min. presentation time.		

Late penalty: 10% off per day (Any minute later after the deadline will be counted as one day late, e.g., 1 day late for the submission on 12:00am on the next day).