CS 5114 Theory of Algorithms, Spring 2024
Project 3
Due by 22 April 2022, 11:59PM

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: _____

The goal of this project is for students to understand how linear programming can be used to solve optimization problems (maximization or minimization), given constraints of variables. A student is expected to discuss the following in the project report:

1. (25%) Select one optimization problem you want to solve using linear programming and give a specific problem description. You should describe: (1) (5%) an objective function; (2) (5%) constraints; and (3) (5%) expected outputs (i.e., optimal solution(s) and value). In addition, (4) (5%) show the linear programming problem in standard form and slack form. (Hint: You may use various techniques we learned in our class to formulate the linear programming problem in slack form with feasible solution(s) if any). (5) (5%) The difficulty of a chosen problem will be also evaluated in terms of the number of variables (i.e., at least 3 or more), the input size of a given problem evaluated, and the number of key design parameters (i.e., independent variables) to formulate the given problem.
2. (25%) Implement the linear programming solution(s) for the selected optimization problem. (1) (10%) Provide the code and executable file with README file on how to run your program. (2) (15%) Describe feasible solution(s) spaces step-by-step and provide final optimal solution(s) and optimal objective value(s). If the solution is 'infeasible' or 'unbounded,' please describe so. (But try to select a problem with feasible solutions with specific optimal solution(s) that gives an objective value).
3. (25%) Visualize the solutions for your selected optimization problem implemented in #2. (1) (15%) Show x-D graph(s) where x refers to the number of variables in order to visualize your feasible solutions including the optimal objective value(s). If the number of variables is more than 3, you may want to show multiple graphs to show optimal objective value(s), given other variables are set at their optimal. (2) (10%) Describe the trends of the observed solutions and discuss the underlying reasons of the results.
4. (25%) Vary the values of constraints given (i.e., $\mathbf{A}$ or $\mathbf{b}$) and discuss the tendency of the observed optimal solution(s) and objective value(s). (1) (15%) Show the experimental results in graphs. (2) (10%) Provide clear explanations of the observed trends. If you vary the values of constraints partially, you will only obtain partial points. (Note: The number of constraints will vary depending upon a chosen problem)
5. **Submission Format**:
   - Font 11; single-spaced
   - Do not exceed 10 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.

Rubric for P3 Report: Grading Criteria

No.	Total Score	Note
1	25%	Explained clearly the following: • Description of an objective function (5%) • Description of constraints (5%) • Description of an expected output (5%) • The problem formulation in standard and slack forms (5%) • Difficulty of a chosen problem (5%) – the number of variables (i.e., at least 3 or more), the input size of a given problem evaluated, and the number of key design parameters (i.e., independent variables) to formulate the given problem
2	25%	The following criteria are sufficiently met: • Submission of source code, executable file, and README file (10%) • Description of feasible solution(s) spaces step-by-step and discussion/demonstration of final optimal solution(s) and optimal objective value(s) (15%)
3	25%	Demonstrate the following: • Visualization of solutions (15%) • Clear explanations of the observed results (10%)
4	25%	The following criteria are sufficiently met for the experiments under varying the values of constraints: • Demonstration of the results (15%) • Clear explanations of the observed results under varying the values of constraints (10%)

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).

Rubric for P3 Presentation: Grading Criteria

No.	Total Score	Note
1	25%	Explained clearly the following: • Description of an objective function (5%) • Description of constraints (5%) • Description of an expected output (5%) • The problem formulation in standard and slack forms (5%) • Difficulty of a chosen problem (5%) – the number of variables (i.e., at least 3 or more), the input size of a given problem evaluated, and the number of key design parameters (i.e., independent variables) to formulate the given problem
2	15%	The following criteria are sufficiently met: • Description of feasible solution(s) spaces step-by-step and discussion/demonstration of final optimal solution(s) and optimal objective value(s) (15%)
3	25%	Demonstrate the following: • Visualization of solutions (15%) • Clear explanations of the observed results (10%)
4	20%	The following criteria are sufficiently met for the experiments under varying the values of constraints: • Demonstration of the results (10%) • Clear explanations of the observed results under varying values of constraints (10%)
5	10%	Provided proper answers for questions raised during the presentation.
6	5%	Time management: Presented all prepared contents promptly within 25 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).