IE 203 - HOMEWORK 1

Due Date: April 18, 2024, 23:59

In this homework, you are expected to model a <u>continuous single facility location problem</u> <u>with *L₁-norm objective*</u> and program the problems in a computer environment. The goal is to determine the coordinates of the facility while minimizing the total distance to the customers. From the lectures and the problem sessions, you are introduced to two approaches on how to linearize the model *L₁-norm* objective function. The three methods that are to be implemented are specified in the following tasks.

Task 1: Formulate an unconstrained nonlinear program with *L₁-norm*, then solve using *CVXPY* package.

Task 2: Formulate a linear program with introducing non-negative decision variables of distance differences (The method introduced in the lectures). Then, solve using the *Pulp* Package.

Task 3: Formulate a linear program with introducing two sets of non-negative decision variables in a way that only one takes the value of the absolute distance differences (The method introduced in the problem sessions). Then, solve using the *Pulp* Package.

Three sets of data are provided with customer numbers 100, 1000 and 10000. Define and solve models for each data set and each task above.

Task 4: Provide three tables for each dataset regarding the relevant information (objective value and the optimal facility location). Either prepare and print *pandas* data frames or provide tables in markdown cells with markdown syntax. The table may have the following form.

$n = 10$	z^*	x^*	y^*	Runtime in seconds
Task 1				
Task 2				
Task 3				

Task 5: Analysis and Conclusion. For each task and case, calculate the number of decision variables and constraints. Do this algebraically, without running any code. Compare the runtimes for each task and case, make judgements.

Task 6 (Bonus): For each case, plot your map with customers and the optimal facility location. (You can use *matplotlib*)

Download the datasets assigned to you from:
https://drive.google.com/drive/folders/1UiVp0HfNr1_2iGD2ASFSIu6rnNHwQiT8?usp=sharing

Remarks:

- The data for each student is unique. Use the data assigned to your student id.
- Readability of code is important. While writing your code, use comments and name your variables and constraints properly.
- Submit just one file to the Moodle submission system. Either an exported HTML (.html) of your IPython Notebook or the IPython Notebook (.ipynb) file itself.
- Make sure the report (either .html or .ipynb) contains all the code and its outputs. Do not include unnecessary information in your code output such as the values of the newly introduced decision variables.
- This is an individual homework. If any resemblance between two submissions is found, both will be assigned grade 0 with extra implications.
- Instead of hardcoding the input dataset, read the .txt file using Python.