IE801B Homework Assignment 6

Implement the Lagrangian relaxation method of Klincewicz and Luss (1986) for the location problem therein: `https://www.jstor.org/stable/2582672?seq=2`.

Chapter 10 of the following book may be useful: `https://www.chkwon.net/julia/juliabook/juliabook2.html`.

1 Data

Two types of data:

USA Download this data: `http://www-personal.umich.edu/~msdaskin/files/sortcap.grt`.

- The first column is the index.
- The second column is the longitude, and the third column is the latitude.
- Generate other data randomly. You may use other columns in the data.
- To calculate c_{ij}, use the *haversine* formula: see `https://www.movable-type.co.uk/scripts/latlong.html`.

Random Generate random coordinates of locations and use the Euclidean distance for c_{ij}. Generate other data also randomly.

Since you are generating some data randomly, you may find some instances are infeasible or some instances are too easy to solve. Please try to make sufficiently meaningful instances.

2 Tasks

1. Find an exact solution using Gurobi, CPLEX, or HiGHS.
2. Use the Lagrangian relaxation method of Klincewicz and Luss (1986) to find both lower and upper bounds. Plot the progress of lower and upper bounds for iterations.
3. Repeat the above tasks for different problem sizes. If exact solutions require a long time, give the solver a time limit.
4. Create visualizations of the solutions (both exact and Lagrangian heuristic solutions). Plot the customer and candidate locations and mark the selected locations. Then, connect each customer location with an assigned location by a line.

3 Submission

Submit the following files for this assignment:

1. A PDF report that summarizes your code, experiments, and findings. LaTeX is recommended but not required. Using a Jupyter notebook is fine. Describe your experimental settings: CPU, RAM, OS, language version, package version, computational time, etc. In most cases, this is the only file that I will read. I will read your source code if necessary. In your report, describe how you used AI tools; this is not for grading but for my own education on how students are using AI tools.

2. Your code files.

   - Do NOT submit your algorithm code as a Jupyter Notebook. You can use Jupyter while developing your code but not in the submission.
   - You can write your main code as `main.py` and import it to your Jupyter notebook to create the final report.
   - In your report, specify which source file is the file that I need to run to reproduce the results. If you choose to use C/C++/Java, describe how I can compile and run the code. For C/C++, `cmake` is recommended.
   - I read your submissions in VSCode. So files readable within VSCode are allowed (except `.ipynb`). Examples are `.pdf, .m, .cpp, .jl, .py, .csv, .png, .gif`, etc.

Please upload each file (PDF and source codes) separately without zipping unless you have too many separate files or use special directory structures. If you prefer to submit your code via a GitHub repo, that is okay, too. You need to mention the repo URL and the specific commit SHA. Please make sure that I have access to the repo. My GitHub account name is `chkwon`.

References

Klincewicz, J. G. and Luss, H. (1986). A Lagrangian relaxation heuristic for capacitated facility location with single-source constraints. *Journal of the Operational Research Society*, 37(5):495–500.