CAB203 Graphs Project Sample Report

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This sample project report is based on the Transporter Transportation Problem from Lecture 9, written up as though it were a task in the project.

1 Transporter Transportation Problem

The *transporter transportation problem* (TTP) (L, s, e) is defined by a set L of *links*, and starting point s and an ending point e. Each link is a pair of points (a, b) representing a link between two cities a and b. Links are symmetric so that a link (a, b) is taken to be the same as (b, a), although only one of each is present in L. The links are given in a CSV file with two columns, which we model as a set of pairs, where each pair corresponds to a single row. In this way L corresponds directly to the CSV file.

The objective of a TTP is to find a sequence of intermediate cities $c_1, c_2, \ldots c_n$ so that there is a link between s and c_1, between c_n and e, and between each c_j and c_{j+1} so that teleporters can be used to transport goods from s to e through the sequence of intermediate cities via links. The solution will be such a sequence of minimal length.

The transporter transportation problem can be solved by finding a shortest path in a graph (see [3] for an introduction to graphs) where vertices are cities and edges are links. More specifically, the graph is given by $G = (V, E)$ where E is a *symmetric* (see [1] for a definition) version of L:

$$E = L \cup \{(b, a) : (a, b) \in L\} \tag{1}$$

and V is the set of first items from each pair in E, which is all cities since E is symmetric:

$$V = \{a : (a, b) \in E\}. \tag{2}$$

In G we find a shortest path from s to e. If no such path exists then there is no solution to the corresponding TTP. Otherwise, suppose that we find a shortest path $s = v_1, v_2, \ldots, v_n = e$. Then the solution to the TTP is given by $v_2, \ldots, v_{n-1}$.

The Python implementation closely follows the description above, and so variables `L`, `E` and `V` are sets. We first use the `csv` module to read the CSV file into a set `L` of rows, where we convert each row from a list (as returned by the `csv.reader` object) to a tuple, which is hashable and can be stored in a set, unlike lists. Sets `E` and `V` are computed using Python set comprehensions analogous to equations (1) and (2). The `solveSPP` function from the `graphs` module [2] is used to find a shortest path and the intermediate vertices are finally returned using a slice.

References

[1] Matthew McKague, *CAB203 Lecture 6*. https://canvas.qut.edu.au/courses/16665/files/3497108/download?download_frd=1 QUT, 2024.

[2] Matthew McKague, *graphs.py*. https://canvas.qut.edu.au/courses/16665/pages/graphs-project?module_item_id=1551933 QUT, 2024.

[3] Vitaly Voloshin, *Introduction to graph theory*. New York: Nova Science Publishers, 2009.