

Second periodical Assessment

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1 Information

Here in this project you will have to do a number of things! I have already assigned the groups in the class, I would suggest you get a deep understanding of the topics at hand because you will have to also present the solutions to two professors online.

Note: You are not allowed to use already pre-existing libraries in the coding languages to solve these problems. You have to use program your own solvers.

Each student must submit an individual report of the solutions, detailing references on where they found there algorithms and explain clearly, why they have chosen such algorithms to solve their individual problems.

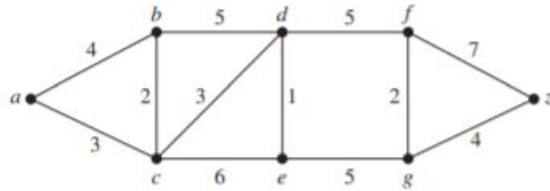
The project report must be done on LaTeX and code must be submitted in your report as well.

The groups for the project have already been assigned in the class! Any questions feel free to contact me anytime.

2 Graph Theory

1) Research the different algorithms for finding the shortest paths in graphs. Then give a brief discussion as to why the preferred method algorithm is Dijkstra's algorithm for finding the shortest path in a graph.

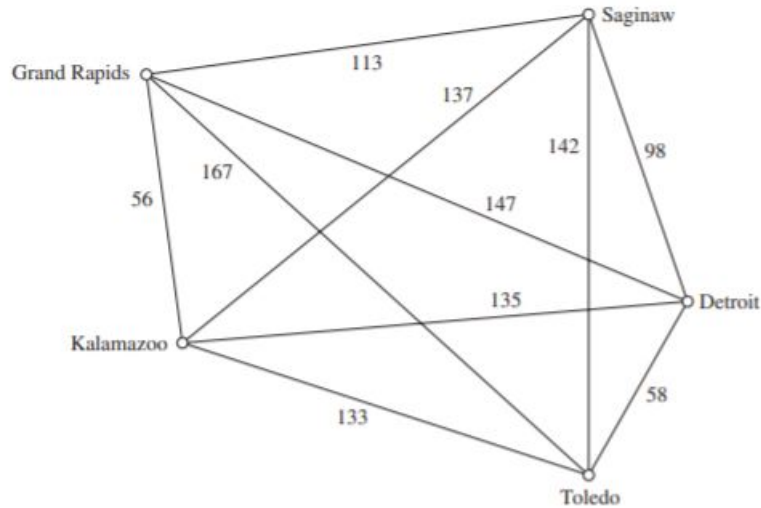
b) Apply this algorithm (by hand) to the following graph



and determine the shortest path between a to z . Furthermore, what is the length of this path?

c) Now using Python/C++/Java or any form of coding platform you wish, code Dijkstra's algorithm and verify that you obtained the correct solution for the same graph posted above

d) Explain the traveling Salesperson problem and apply the knowledge you've learn to the following graph



e) Show that Dijkstra's algorithm may not work if edges can have negative weights

f) From your research on graph theory and different algorithms apply the algorithm which you believe to be the best algorithm for finding the shortest path in a graph with negative weights. You may choose any example you wish (the graph must have at least 10 nodes). Moreover, explain why you chose this algorithm. This problem must also be coded.

3 Matrices

2) Code your own Gaussian elimination script and solve the matrix

$$B = \begin{bmatrix} 0 & 1 & 1 & -2 & \vdots & -3 \\ 1 & 2 & -1 & 0 & \vdots & 2 \\ 2 & 4 & 1 & -3 & \vdots & -2 \\ 1 & 4 & -7 & -1 & \vdots & -19 \end{bmatrix}$$

Verify this solution by hand. Furthermore, compare your algorithm with already pre-existing algorithms (time taken to compute, and memory taken).

ii) What is the corresponding solution?

b) Code your own Inverse matrix solver and solve the following matrix

$$B = \begin{bmatrix} 2 & 1 & 1 & 1 & 1 \\ 1 & 2 & 3 & 4 & 5 \\ 1 & 3 & 6 & 10 & 15 \\ 1 & 4 & 10 & 20 & 35 \\ 1 & 5 & 15 & 35 & 69 \end{bmatrix}$$

Verify this solution by hand. Furthermore, compare your algorithm with already pre-existing algorithms (time taken to compute, and memory taken)

c) Finally, explain what a Determinant of a matrix is. Describe the importance of finding the determinant of a matrix, and how the determinant is used in real-world applications. Moreover, what are the properties of determinant, what happens to the determinant if we change rows, multiple a row by a constant and so forth.

d) Once you've completed part c your job is to calculate the determinant by hand, and by coding the following matrix.

$$B = \begin{bmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 2 & 3 & 4 & 5 \\ 1 & 3 & 6 & 10 & 15 \\ 1 & 4 & 10 & 20 & 35 \\ 1 & 5 & 15 & 35 & 69 \end{bmatrix}$$