Optimizing Campus Mobility with a focus on Sustainability: A Graph Theory Approach to Intra-Campus Transportation Networks

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IMPLEMENTATION AND RESULTS

The idea of public transportation is supported by most in theory but often neglected in practice. Once modeled, our program thus charts the future by improving the need to optimize intra-campus transportation, alleviate user tension, and decrease user fuel cost. The algorithm created can be used to optimize transportation routes, alleviate user tension, and decrease the carbon footprint of transportation networks. Our project thus charts the future by improving student transportation methods and people movement between urban campuses in an environmentally friendly and efficient way.

The UNO campus stretches across three major streets in Omaha: Dodge, Pacific, and Center. This distance is roughly 2 miles wide. According to UNO 2013 Factbook, the UNO campus has a weekday population of over 17,702 making the university larger than the population of La Vista, NE (Verdis Group 34). Each school day, students need to be able to move among the three campuses for classes, meals, parking, etc. The major way UNO student’s move between campuses is the UNO Shuttle System. The shuttle system currently moves between all three campuses with three different routes, as shown in diagram A.

Some basic terminology for this project includes the following:

**Definition**

Graph = (V,E), V is set of vertices and E is set of edges between vertices.

Weighted Graphs – graphs for which each edge has an associated weight, represented by a weight function w: E → R

Adjacency-matrix Representation - of a graph G = (V,E), vertices are numbered in an arbitrary manner composing a matrix of |V| x |V|.

**PROPOSED SOLUTION**

The graph theory approach was chosen for two reasons. First, the graph theory approach is scalable to a high degree: which in the event of an extreme data set or matrix size, the problem can be handled with our proposed implementation. Secondly, the solution can be implemented in a generic sense in the programming, so that different matrices can be handled with the same solution. This makes for a “one size fits all” solution that can be used as-is for all use cases. The code itself is written in Java and is based around the standard implementation of Dijkstra’s famous shortest-path algorithm. This algorithm finds the shortest path, lowest cost, and least effort through a set of given nodes in a graph. Using this, we are able to read in a set of nodes in a graph and determine which path is the best based on a variety of factors that can be distinguished between.

**DESCRIPTION**

The idea of public transportation is supported by most in theory but often neglected in practice. Once modeled, our program thus charts the future by improving the need to optimize intra-campus transportation, alleviate user tension, and decrease the carbon footprint of transportation networks. Our project thus charts the future by improving student transportation methods and people movement between urban campuses in an environmentally friendly and efficient way.

The University of Nebraska-Omaha (UNO) is a growing metropolitan institution that uses a shuttle system to transport students among their three campuses daily. As of 2015, the current total student enrollment is approximately 16,000; UNO plans to enroll 20,000 students by 2020. The expected student growth is also reflected by the current construction of new buildings and expansion of UNO’s campus. Like most metropolitan universities, space and parking on a college campus is a limited resource, and UNO’s shuttle transportation system plays a vital role in ensuring student mobility between campuses.

With growing pressure from the UNO community to improve kinetics there is a need to optimize intra-campus transportation in an environmentally sustainable manner. To alleviate the tensions involved with the UNO shuttle system, we have created an algorithm to model shuttle routes using graph theory. Once modeled, our program chooses an optimized route based on various conditions: time, volume of students anticipated to use the shuttle, and fuel cost. The algorithm created can be used to optimize transportation routes, alleviate user tension, and decrease the carbon footprint of transportation networks. Our project thus charts the future by improving student transportation methods and people movement between urban campuses in an environmentally friendly and efficient way.

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**CONTENT**

**CONCLUSIONS**

Our graph theory model of the UNO shuttle system has produced a sound model that demonstrates areas where the system can be improved and optimized for future users. This project compares the current blue shuttle route to an augmented route proposed in this project. The augmented route contains a new node between PKI and Mammel Hall on 67th street. The implementation of this new node is shown by node in our augmented graph is shown by our model to an average of 1.2 minutes per shuttle run, which translates to a savings of 308.4 minutes per day, and 1542 minutes per week. Overall, the augmented route with a new node in the graph alleviates tensions associated with the shuttles being too slow - and does this in a sustainable manner. In the long run, a savings like this can pay off substantially in terms of fuel consumption, cost, and CO2 emissions.

References: