Heuristic Approach to Transportation/Delivery Optimization: Research Abstract

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The project's purpose was to create an algorithm capable of optimizing transportation/ delivery to an event location in the most efficient way possible. Through the implementation of a heuristic algorithm I also set out to devise a method to approximate an optimal solution to the Travelling Salesman Problem.

The motivation for my project was trying to figure out a more efficient way for first responders to pick people up and get them to safety in the event of an emergency situation or natural disasters such as Hurricane Harvey and Hurricane Katrina. After detailing the objective to create a simple application that would make it easy for users to get back the best route, I researched the problem and decided to create the heuristic based off of modified GRASP (Greedy Randomized Adaptive Search Procedure) logic. I chose this logic because it yields locally optimal solutions that approximate a global optimal solution in a reasonable time and it is cleaner than select others. The difference between the base Greedy Heuristic logic and my GRASP adaptation of it is that this version accounts for the heuristic's problem regarding getting stuck in local optimums through a series of variable iterative swapping, which switches the order in which passengers are picked up in each carrier's list then swaps the passengers between different carriers.

First, the algorithm creates a path from each carrier to the closest nodes around them and set the carriers to go to the nodes in the order of closest ones first. The program keeps track of the distances found using the Haversine Formula to account for curvature of the Earth. Once the passengers have all been assigned to vehicles, the algorithm switches the order in which two passengers are picked up until no more switching can be done with improvement. The amount of switches conducted will be repeated up to however many times the operator prefers. At the end, the best results from each carrier will be compared and a final best distance will be presented. Finally, this is all repeated several times to guarantee that it has found all of the very efficient, if not perfectly optimal, routes possible.

Tested over 20 different scenarios, the modified GRASP algorithm surpassed hypotheses and made travelling much faster and efficient in comparison to contemporary algorithms, with about 65% improvement on average versus the base Greedy path, and an average of 7.5% improvement over another popular heuristic program, the 2-Opt model. With this immense savings in distance, time to calculate, and time to travel, more lives can be saved.

To serve the purpose as an example, the project focuses on the algorithm’s usefulness in emergency situations such as hurricanes (Harvey, Katrina, Maria) where time and resources are essential for first responders to get people to safety. However, the algorithm also has numerous applications outside of emergency, including military resupplying logistics, the ever-growing package delivery system and commercial airline traveling. In the future I plan to improve upon the current algorithm (priority, neural net), and eventually make it accessible for all to use.