

# Solving the Vehicle Routing Problem with Multiple Multi-Capacity Vehicles

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## **Abstract**

The Vehicle Routing Problem (VRP) has existed as long as a distributor has needed to deliver items. As such, the VRP has been solved with many different methods, including agent architecture and ant colony modeling. However, these methods have generally been set up for an established organization that has a specific number of vehicles with only a few unique capacities. This project aims to create a program that will solve the VRP, but in a case where all the vehicles could have different capacities. This is the situation faced by some volunteer groups that do not have established vehicle fleets and rely on people volunteering vehicles when something needs to be distributed.

**Keywords:** Vehicle Routing Problem, heuristics, A\* search

## **1 Introduction**

The goal of this project is to create a program to quickly find the most efficient routing of a given number of vehicles with differing capacities to a variety of delivery points with a variety of demands of product. This is a

pure-applied research project. It is being created to assist a volunteer group in their distribution of goods.

The project will involve at least three heuristics. Research will look into the possible heuristics that can be used or the possibility of creating new heuristics. There will be two components to this project. The first will be a route finder that finds road routes between two given points. The second portion will use the route finder to create routes that efficiently distribute the product to all specified delivery points. While “efficiency” has not been defined, it will probably be something similar to product delivered over distance traveled, with the aim of making this number as large as possible.

## 2 Background

A great deal of research has been done into the VRP and its variants, such as the VRP with Time Windows (VRPTW) and Multi-Depot VRP (MDVRP). Projects have looked into using agent architecture and ant colony optimization to solve the problems. These projects have yielded such ideas as Clarke-Wright Algorithm to place delivery points into routes. Mennell, Shmygelska, and Thangiah did a project to evaluate using agents to solve the VRP. The program used agents to represent the vehicles and “auctioneers” that informed the vehicles of the current situation with regards to customers and deliveries. While the resulting program did not find the optimal solutions for any the sample problems, it was extremely adaptable for the MDVRP and VRP with multi-capacity vehicles.

## 3 Development

The project will proceed in two stages. First, the route finder will be created. Upon its successful creation, the route creator will be created. Currently, the route finder is approximately 80% done. It is successful as a breadth-first search, but needs the addition of a heuristic.

### 3.1 Heuristics

This project will make great use of heuristics. At this point, three heuristics will be needed. One will be used in the route finder to find the quickest route. The other two will be used in the route creator to identify the best route for

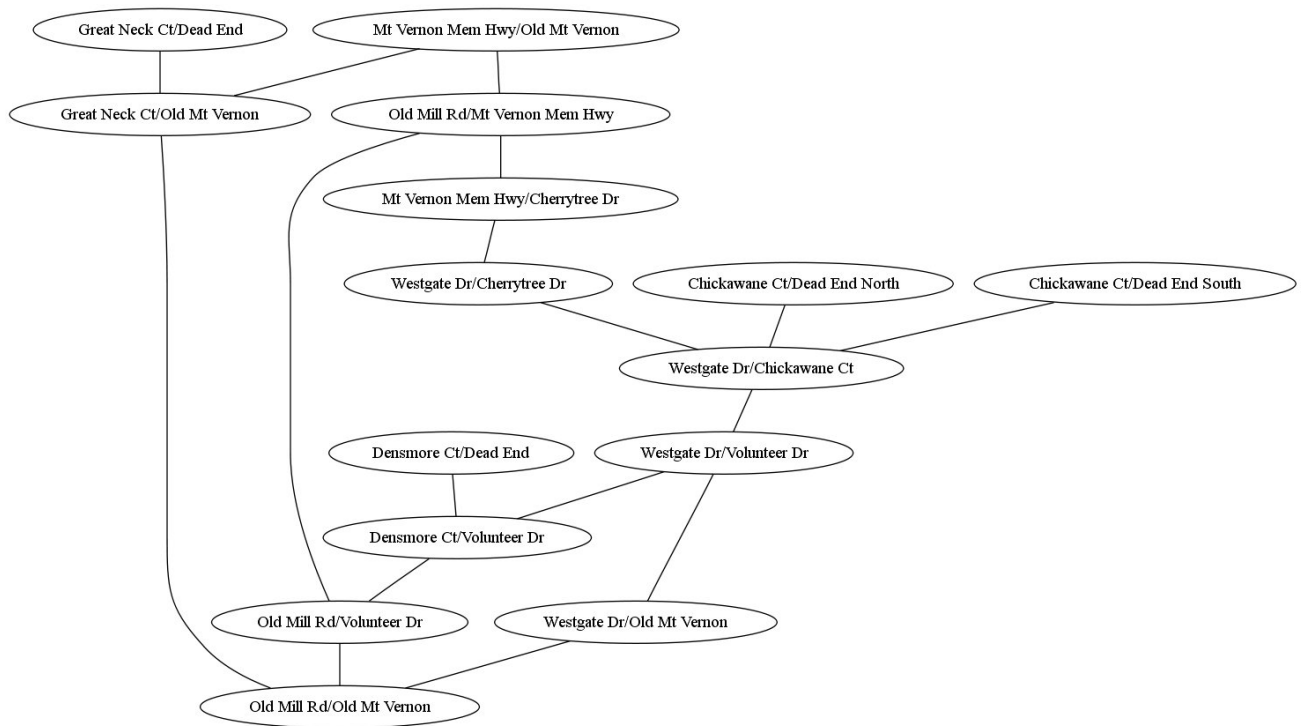


Figure 1: An example of how the program views intersections as nodes and the connections between them

a delivery to be placed in and then which vehicle should be assigned to each route.

### 3.1.1 Testing

The only method to test the final project will be to compare it against what a human could do. The program's result in a form such as product delivered over distance traveled would be compared against a human's result in the same form. Also factored in would be the time required for the program and the human to create their results. The means of testing will depend on how "efficiency" is defined. It will likely involve taking amount of product delivered over distance traveled, with the goal being to maximize that number. This would, for a fixed amount of product, indicate less distance had been traveled.

The route finder can be tested at various points by giving it two intersections that have a known best route and evaluating the result of the program.

## 3.2 Results

The goal of this project is to create a program to assist volunteer groups and other organizations that need to deliver items but do not maintain standardized fleets of vehicles. Success will mean that it will be easier for these groups to have events that require the delivery of items. From a programming standpoint, success will mean the successful implementation of multiple heuristics and the integration of multiple programs.

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