PVRP

Aaron Rockburn and Joshua Sarver

Advisor: Dr. Sam Thangiah

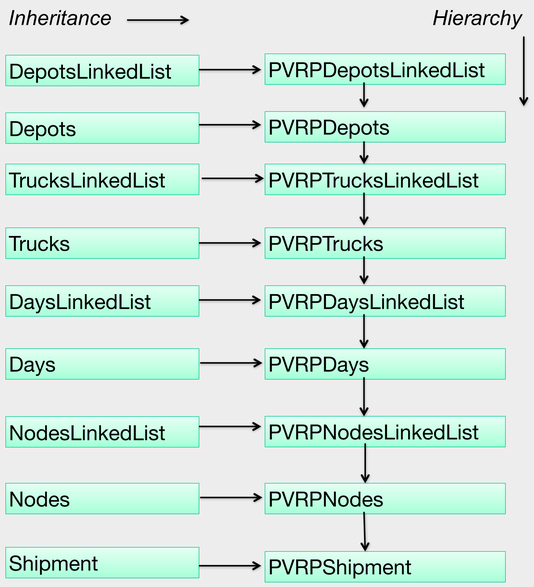
Slippery Rock University

What is PVRP?

Periodic Vehicle Routing, or PVRP, is the routing of various vehicles to various nodes over a specified time period. Each node has a frequency it needs to be visited over a time period and which day sets can be visited. PVRP takes this information, determines what is a good valid day combination for each node and then routes trucks to each day — attempting to minimize distance travelled.

Abstract

A municipality removes trash from various properties throughout a six-day period. This service can include residents, restaurants, and retail stores – all of which have different needs. For example, a popular restaurant may need daily visits, whereas a resident may need visited once per week. This problem is referred to as a Periodic Vehicle Routing Problem (PVRP), an extension of the vehicle routing problem (VRP). In the vehicle routing problem, multiple trucks are used to visit customers no more than once. In PVRP, multiple vehicles are used to visit a set of customers over a defined period while minimizing time, distance, and fleet size. Our research describes research conducted on implementing heuristics for solving PVRP.



Bridging the Gap

While PVRP is built atop routing program *Zeus* and alongside a different vehicle routing problem (VRP), there was still much work to be done in terms of properly creating a hierarchy and routing shipments efficiently. Essentially PVRP is VRP (Vehicle Routing Program) spread over multiple days.

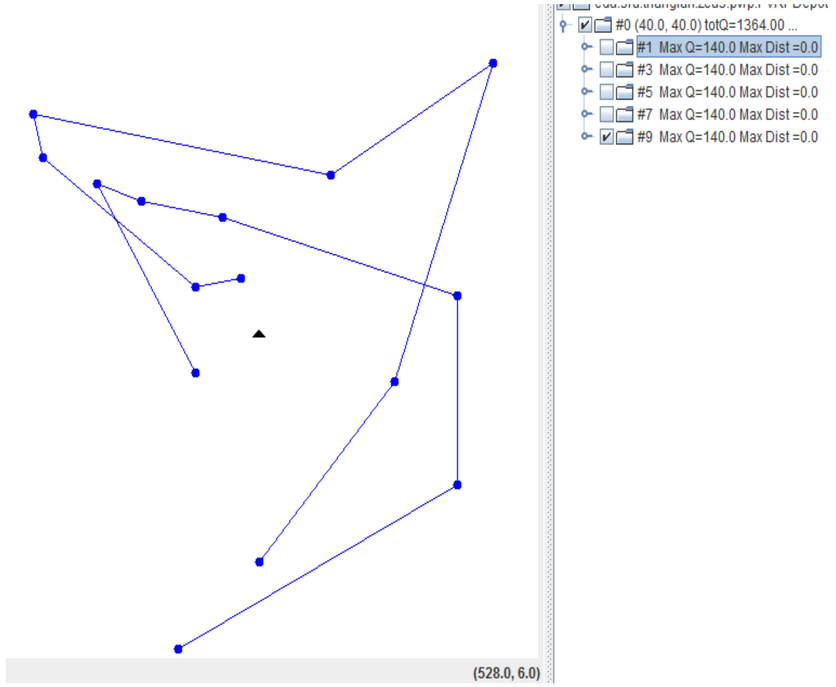
Initially we had to decide how to best choose which valid day combination to choose for each node. After some tinkering we noticed that random assignment usually resulted in evenly distributed demand for each day. This was a very simple heuristic which simply chose a random number between specified values, where each number represented a day combination. Also, this saved processing time compared to a heuristic which would critically analyze each node and day.

After assigning days to each node we were able to, more or less, run VRP heuristics on each day to determine the route. Of course, these all had to be implemented with PVRP classes. The routing heuristic find the nearest polar angle from the current point and adds that to the next point in the route. Then the heuristic looks for the next closest polar angle from the most recently added node until the truck is full or the maximum distance allowed to travel is reached. Then each truck must be routed back to its depot (of which PVRP only has one depot).

To picture the problem: This could be applied to high school bus routing.

CPSC_464	%_Difference_Best
955.7409668	82.18470583
2524.661133	90.84725882
1019.079346	94.25835793
1816.675537	117.4982086
4053.724365	99.88877486
1863.075928	123.0026845
1914.021606	131.6824759
4867.53418	139.2908183
1810.455688	119.1463539
3822.382324	139.8809077
1751.253052	124.7905234
2247.251221	87.91611372
1205.459229	26.25253755
2364.046875	26.92187668
3778.918945	31.43151591
2429.003418	52.02650089
4763.019043	51.70348165
7178.02832	48.48000596
12313.84668	47.16455147
3904.508301	79.88069256
8104.248047	93.23663961
13368.42969	108.2079659
7532.790039	104.2812678
7290.933594	93.02737762
7532.790039	98.47575538
45300.49219	106.3239761
47717.36328	113.9279799
45300.49219	100.0918389
183209.2344	146.0364669
176749.0469	130.8868085
180581.6719	131.2988478
3458.402344	56.55821784

Sample Results



Future Work

To achieve optimal results we need to include heuristics for local optimization. This may include moving customers within the current route or moving to new routes to see if it may decrease the distance travelled.

Some local optimization was written but for some of the tougher problems a more aggressive approach is needed

Customers with a frequency of one are a primary target for revaluation because they often have the most flexible day combination options.

Most papers regarding this topic have several local optimization algorithms. Some are expensive, needless, or simply redundant. Local optimization itself may not improve the solution as the combination of optimizations used also have a large impact.

Bibliography

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