Vehicle Routing Problem With Time Windows

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Content

Overview

The Vehicle Routing Problem is the extension of the well-known Travelling Salesman Problem.

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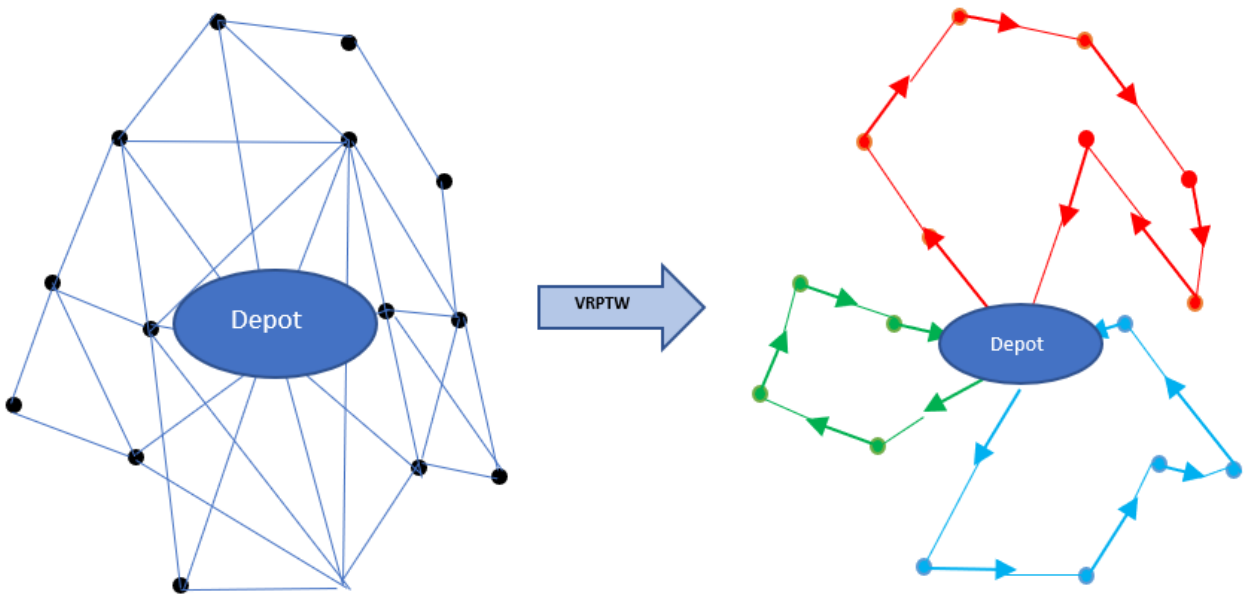
The Vehicle Routing Problem (VRP) aims to find an optimal set of routes to be used by a fleet of vehicles to visit a set of distributed customers.

Overview

The Vehicle Routing Problem with Time Windows (VRPTW) is the case when the service should be executed in a given time frame.

Real Life examples:

School bus routing
Postal deliveries
Bank deliveries and
etc



Background

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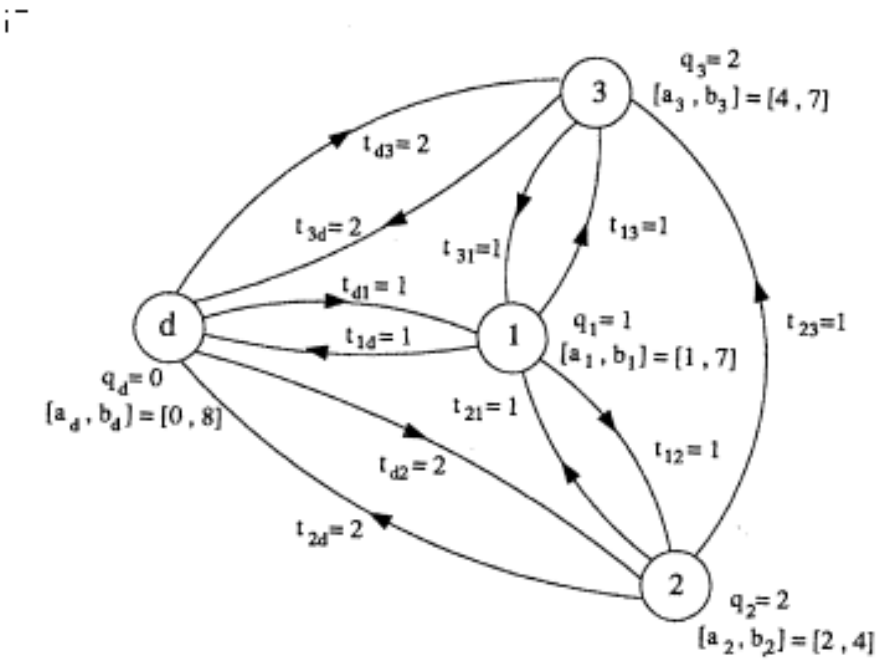
The problem is defined as follows: Let G =(N, A) be a directed graph that represents the road network. Arcs in A represent road segments, and N is the set of nodes. With each arc (i, j) A is associated a travel time t_{ij} and a travel cost c_{ij}. Usually node 0 represent the depot location.

Background

Travel cost is generally taken as distance between customers i and j.



Solution Methods

VRPTW is often modelled as a **set partitioning problem**. It tries to find routes with minimum costs in VRPTW.

$$\textbf{min} \sum_{r \in R} c_r \; x_r$$

$$\sum_{r \in R} \delta_{ir} \; x_r = 1, i \in N \backslash \{d\} \tag{1}$$

$$x_r \in \{0,1\}, r \in R$$

Solution Methods

Dynamic Programming reduces time complexities from exponential to polynomial.

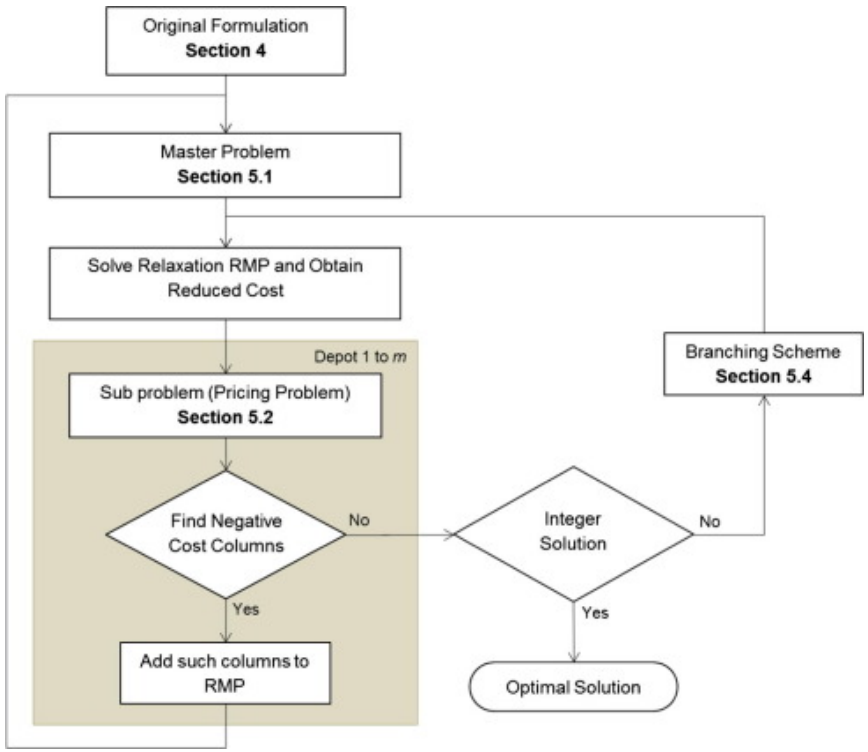
the core idea of Dynamic Programming is to avoid repeated work by remembering partial results.

Solution Methods

Branch and bound methods are fundamental and widely-used approaches for producing exact solutions to NP-hard optimization problems (i.e Vehicle Routing Problem).

Solution Methods

Branch and Price algorithm is a generalization of LP based on Branch and Bound algorithm.The pricing problem is used to determine whether or not there exist columns with profitable reduced cost that are missing from the current formulation.



Solution Methods

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The process of finding columns to add to the existing integer program is called **column generation**.

Conclusion

The set partitioning problem is hard to solve while dealing with a huge number of variables since enumerating all related columns is difficult. One approach can be using branch and price algorithms for smaller instances.

Future Plans

In the continuation of this project, I will implement a pricing procedure and a column generation procedure which might be a part of a branch and price algorithm later.

Thank you for your attention