6. IMPLEMENTATION

6.1 Dijkstra’s shortest path algorithm

Dijkstra's algorithm allows us to find the shortest path between any two vertices of a graph.
It differs from the minimum spanning tree because the shortest distance between two vertices might not include all the vertices of the graph.
This is how the algorithm works:

- ❖ Start with a weighted graph
- ❖ Choose a starting vertex and assign infinity path values to all other devices
- ❖ Go to each vertex and update its path length
- ❖ If the path length of the adjacent vertex is lesser than new path length, don't update it
- ❖ Avoid updating path lengths of already visited vertices
- ❖ After each iteration, we pick the unvisited vertex with the least path length. Notice how the rightmost vertex has its path length updated twice
- ❖ Repeat until all the vertices have been visited

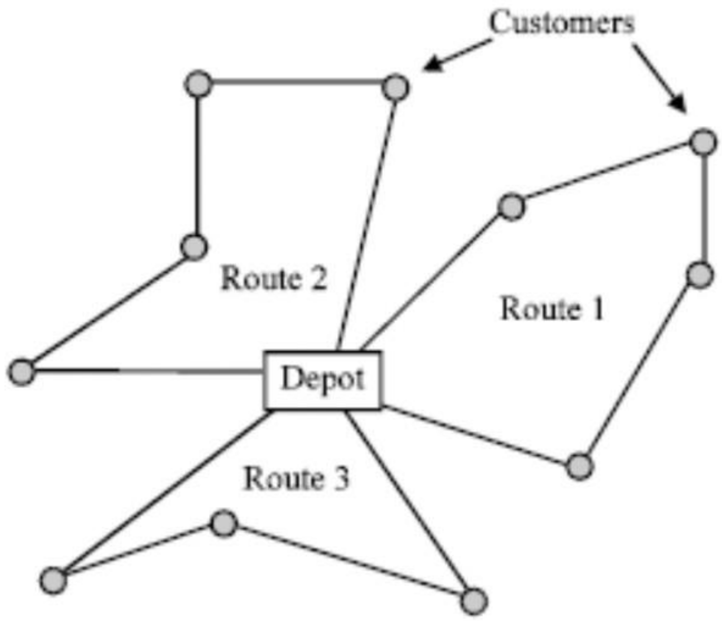
6.2 Google OR Tools

OR-Tools is an open source optimization software package designed to solve the world's most difficult problems in vehicle routing, flows, integer and linear programming, and constraint programming. Problems like these typically have a large number of viable solutions—too numerous for a computer to sort through.

7. Effective Local Search Algorithms for the Vehicle Routing Problem with General Time Window Constraints

The Vehicle Routing Problem (VRP) is a generalization of the Traveling Salesman Problem. In a VRP, the goal is to find the optimal set of routes for a 51 fleet of vehicles delivering goods or services to various locations.

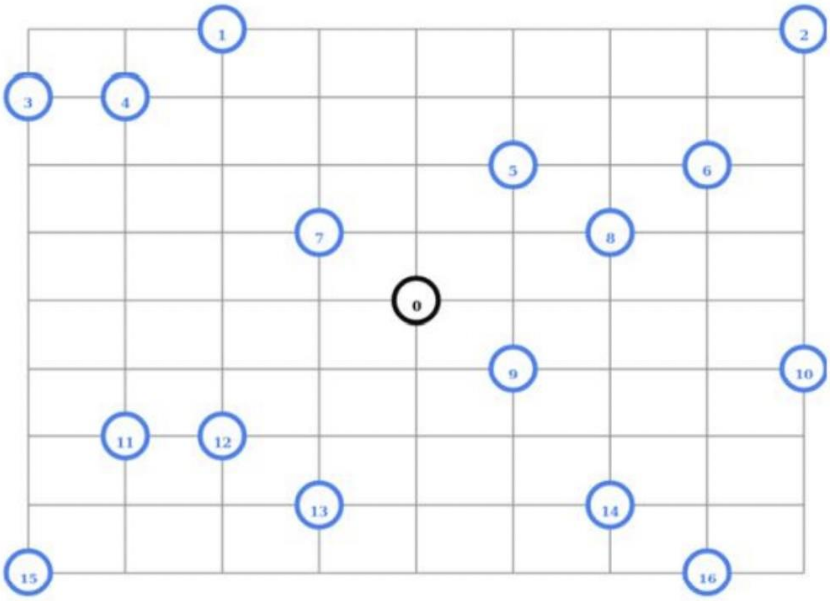
Like the TSP, the VRP can be represented by a graph with distances assigned to the edges. If you try to find a set of routes with the least total distance, with no additional constraints on the vehicles, the optimal solution is to assign all locations to a single vehicle and leave the rest idle. In this case, the problem reduces to a TSP. A more interesting problem is to minimize the length of the longest single route for all vehicles, as shown in the next example. VRPs can also have additional constraints on the vehicles, for example, lower and upper bounds on the number of locations each vehicle visits, or the length of each route. In later sections, we'll discuss other types of VRP constraints, including: Capacity constraints: the total demand of the locations on a vehicle's route cannot exceed its capacity. The demands could, for example, be the sizes of products that the vehicle must transport to each site, with the overall size of all the packages not exceeding the vehicle's carrying capacity. Waiting times are acceptable, however each location must be serviced within a time window [ai, bi]. Precedence relations between pairs of locations: for example, location j cannot be visited before location i. We can solve VRPs using the OR Tools vehicle routing library.



8. MANHATTAN DISTANCE

The Manhattan distance is a measure for measuring the distance between two points in an N-dimensional vector space. It is the sum of the lengths of the line segment projections onto the coordinate axes between the points. It is the total of the absolute differences between the measures in all dimensions of two points in basic terms.

This example uses a definition of distance that differs from the usual Euclidean metric, called the Manhattan distance. The Manhattan distance between two points, (x1, y1) and (x2, y2), is the absolute value of the difference in their x coordinates plus the absolute value of the difference in the y coordinates: This distance is motivated by routing problems in a city that is laid out in rectangular blocks (like Manhattan), where you can only travel in directions 52 parallel to the sides of the blocks. In this situation, the formula above gives the travel distance between any two street locations in the city. (For example, if you have to go four blocks east and seven blocks north, your travel distance is eleven blocks.)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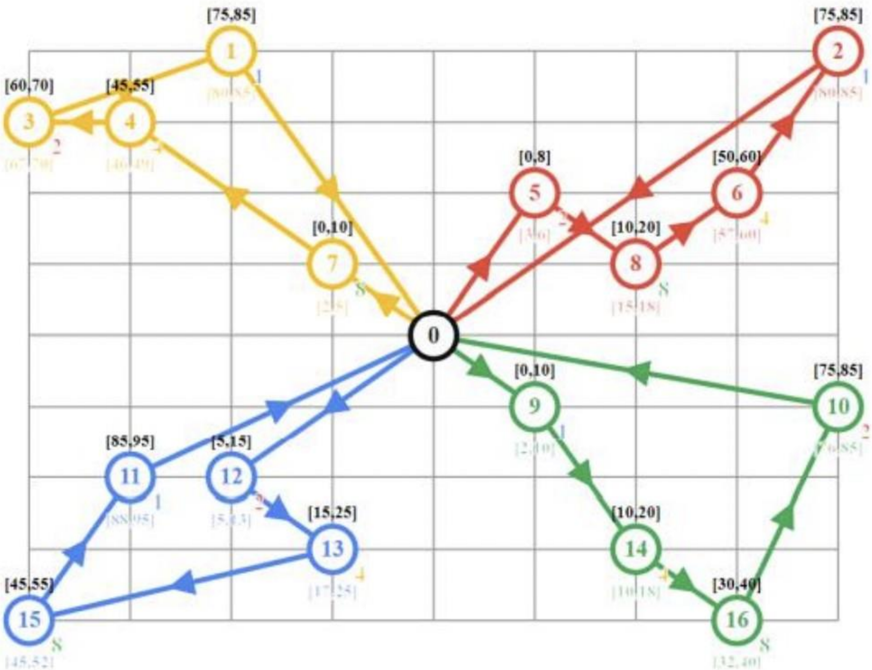
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