Two-Stage VRP

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Outline

- Capacited Vehicle Routing Problem
- Two-Stage Vehicle Routing Problem

Mathematical model

- problem formulation
- a simple model-checking problem

Capacited Vehicle Routing Problem

- Unlimited number of vehicles with a certain capacity, which are located in a certain depot with unlimited capacity
- Set of delivery points with a certain demand (the orders have to be delivered in full)
- Minimal distances between all the pairs of delivery points and also between the customers and the depot are known
- The goal is to find optimal vehicle routes in such a way that each customer is visited only once by exactly one vehicle, all routes start and end at the depot, and the total demands of all customers on one particular route must not exceed the capacity of the vehicle.

Two-stage VRP - problem formulation

- We consider distribution system of some company, which is provided a distribution of homogenous commodities from a central depot with unlimited capacity to a set of delivery points (central depot is also considered to be delivery point) with a known distances between all the pairs of delivery points.
- The distribution can be made with the use of unlimited number of 2 types of vehicles (the vehicles with the large capacity – 1-st type and the vehicles with the smaller capacity – 2-nd type).
- The vehicles with the large capacity are located only in the central depot, vehicles with the smaller capacity are located in every delivery point – so each delivery point could be considered to be entrepot, from which the orders of another delivery points could be met.

Two-stage VRP – problem formulation

- The distribution could be realized in two stages: the 1-st stage is the distribution from the central depot to entrepots with the use of 1-st type vehicles and the 2-nd stage is the distribution from the entrepots with the use 2-nd type of vehicles.
- The goal is to find optimal distribution in such a way that the demand of each delivery point is met, the route of vehicles with a large capacity start and end at the depot and the route of vehicles with a smaller capacity start at entrepot and could be ended in any entrepot, so that the number and location of entrepots is not set in advance.

Input data

b – vector of demands = (0,5,2,2,20,10,6,3,9,10)

***g* – capacity of the large car = 50**

***k* – capacity of the smaller car = 15**

***n_1* – cost per unit of the larger car = 10**

***n_2* – cost per unit of the smaller car** = 6

D	1	2	3	4	5	6	7	8	9	10
1	0	111	48.5	216.7	82.5	207.8	40.8	182.5	105.1	118.8
2	111	0	77.5	301.6	33.5	125.9	151.8	80	78.9	121.9
3	48.5	77.5	0	265.2	67	169.2	89.3	137.5	132.2	145.9
4	216.7	301.6	265.2	0	273.1	424.5	182.1	374.5	259.1	272.8
5	82.5	33.5	67	273.1	0	151.4	123.3	105	79.1	93.4
6	207.8	125.9	169.2	424.5	151.4	0	248.6	91.5	184.4	228.1
7	40.8	151.8	89.3	182.1	123.3	248.6	0	223.3	145.9	159.6
8	182.5	80	137.5	374.5	105	91.5	223.3	0	117.9	161.6
9	105.1	78.9	132.2	259.1	79.1	184.4	145.9	117.9	0	46.2
10	118.8	121.9	145.9	272.8	93.4	228.1	159.6	161.6	46.2	0

Results

f = 9142.202