

assignment_04

March 21, 2025

1 Assignment #4

1. Point-to-Point Routing

Consider a 5×5 grid-like network (Table 1.)

From	To	d_{ij} (km)	t_{ij} (mins)	f_{ij} (l)
1	2	1.30	1.08	0.99
1	6	1.38	1.39	1.33
2	3	1.80	1.48	1.17
2	7	1.07	2.23	1.41
3	4	1.83	1.43	1.28
3	8	1.39	1.37	1.03
4	5	1.77	1.20	1.12
4	9	1.54	1.54	1.24
5	10	1.75	1.29	1.15
6	7	1.40	1.36	1.07
6	11	1.45	1.52	1.19
7	8	1.23	1.83	1.36
7	12	1.60	1.46	1.21
8	9	1.72	1.50	1.10
8	13	1.12	2.01	1.37
9	10	1.65	1.35	1.08
9	14	1.35	1.25	0.98
10	15	1.95	1.34	1.30
11	12	1.70	1.29	1.11
11	16	1.55	1.38	1.16
12	13	1.47	1.49	1.09
12	17	1.72	1.28	1.18
13	14	1.27	1.75	1.40
13	18	1.61	1.40	1.22
14	15	1.81	1.33	1.14
14	19	1.19	1.78	1.39
15	20	1.85	1.31	1.25
16	17	1.66	1.22	1.06
16	21	1.58	1.37	1.13

From	To	d_{ij} (km)	t_{ij} (mins)	f_{ij} (l)
17	18	1.49	1.27	1.04
17	22	1.67	1.41	1.15
18	19	1.42	1.45	1.10
18	23	1.64	1.32	1.17
19	20	1.36	1.52	1.35
19	24	1.78	1.42	1.20
20	25	1.99	1.37	1.28
21	22	1.53	1.39	1.12
22	23	1.61	1.35	1.09
23	24	1.50	1.31	1.08
24	25	1.70	1.42	1.15

Assuming node 1 as the origin node 25 as the destination, answer the questions below.

- Formulate the objective functions for the shortest route, fastest route, and eco-route. (1)
- Formulate all constraints. (5)
- Formulate the above optimisation problems (each) in a spreadsheet. (9)
- Report the optimal solution. (1)

2. Location Routing Problem

Amazon plans to serve 10000 customers in a service region of size 307.78 km² from the following potential distribution facilities (Table 1.) using a fleet of diesel and electric vans (Table 2.). Considering a planning horizon of 7 years, each with 330 working days, which facilities should Amazon choose to operate from in order to minimize the total cost? (Hint: calculate total cost as the sum of fixed costs and net present value of the operational cost estimated using continuous approximation; $k = 0.57$)

Table 1. Potential Distribution Facility Locations

Location	Fixed Cost (in cr)	Distance from Service Region (in km)	Capacity (in customers)
Location #1	75	1	3000
Location #2	50	5	10000
Location #3	10	20	30000

Table 2. Fleet Characteristics

Vehicle Type	Purchase Cost ()	Operational Cost (per km)	Maximum Fleet Size	Maximum Tours	Maximum Customers
#1 Diesel Van	6,00,000	35	20	3	200
#2 Electric Van	9,00,000	28	-	2	150

Using the following notations, answer the questions below,

Notations:

- number of type v delivery vehicles purchased at depot node d : $f_v^d \forall v \in [1, 2], d \in [1, 3]$
- number of tours per type v delivery vehicle at depot node d : $m_v^d \forall v \in [1, 2], d \in [1, 3]$
- number of customer per delivery tour per type v delivery vehicle at depot node d : $c_v^d \forall v \in [1, 2], d \in [1, 3]$: $c_i \forall i \in [1, 3]$

- Formulate the objective function. (1)
- Formulate the constraints. (3)
- Formulate the above optimisation problem in a spreadsheet. (3)
- Report the optimal solution. (2)