OPTIMAL CHARGING LOCATIONS FOR ELECTRIC VEHICLES

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Problem statement

Electric Vehicles

Range anxiety

Congestion

Minimize the system cost

- Network parameter
- Charging demand
- Fixed budget
- Investment cost
- Value of time
- Driving range

LOCATING FAST-CHARGING STATIONS IN URBAN NETWORKS

Deployment of the charging infrastructure

Route choice behaviour

User equilibrium (Wardrop equilibrium)

- Behavioural principle to describe the spreading of trips over routes in congested conditions
- Travellers choose the feasible route that minimizes their travel times

Research Method

Bi-level Optimization Programme

Upper level

Minimize system cost

= infrastructure investment + monetary value of travel time

Subject to:

1) Maximum number of charging stations to be located

2) Relationship between charging locations and feasible paths

Charging locations ↓

Equilibrium flows ↑

Lower level

Multi-class traffic assignment considering driving-range

Subject to:

1) Limited feasible paths due to the charging infrastructure

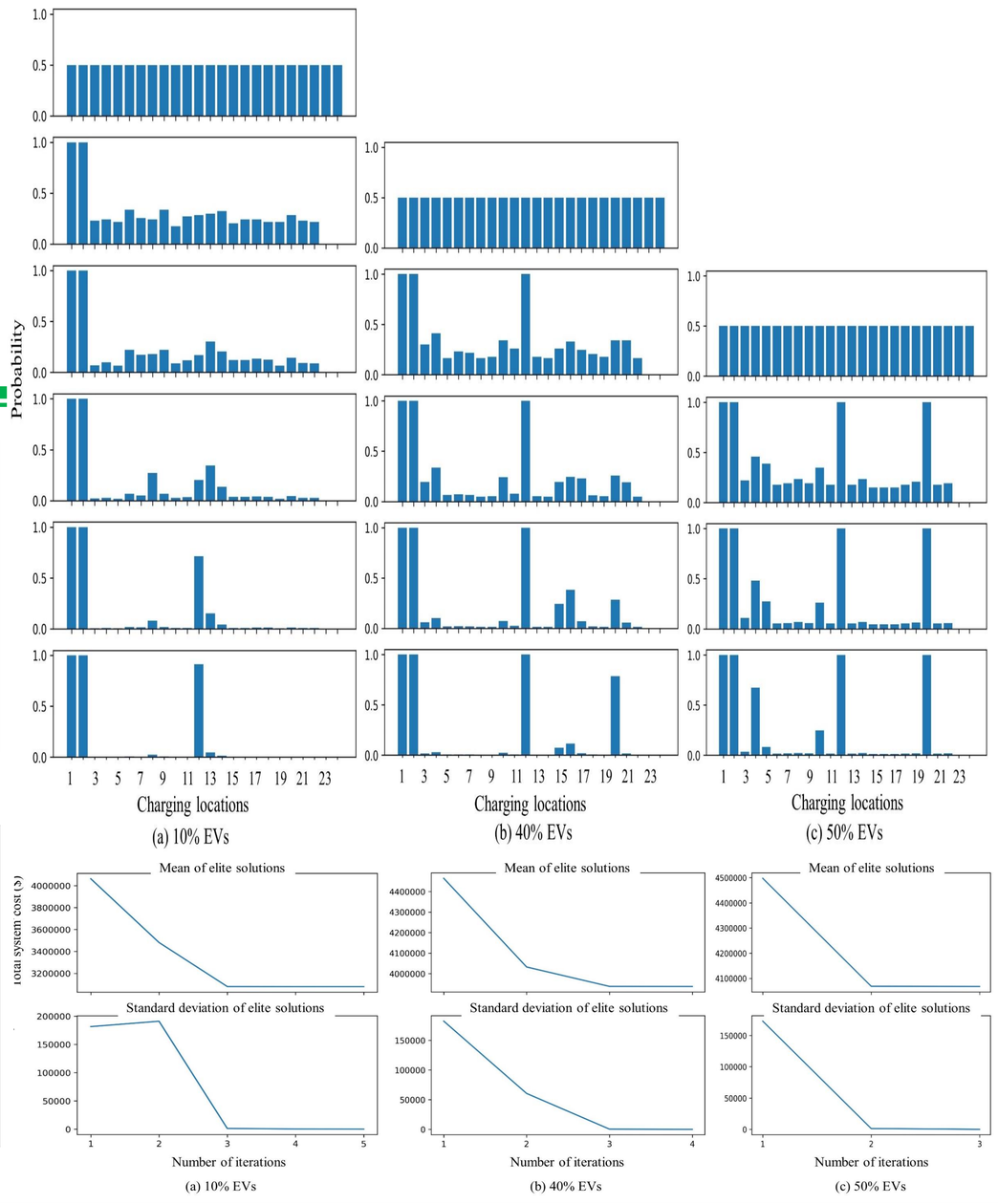
2) Fundamental flow conservation

CEM-based algorithm

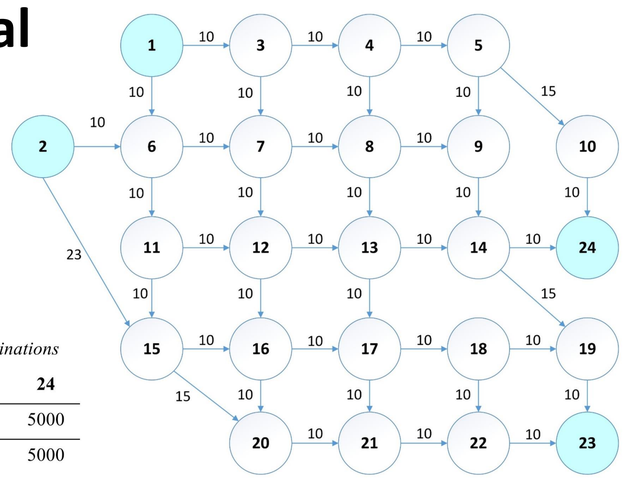
(1) generate a set of candidate solutions

~ a parameterized distribution;

(2) update parameters of the sampling distribution to steer the problem towards the optimal solution in subsequent iterations.

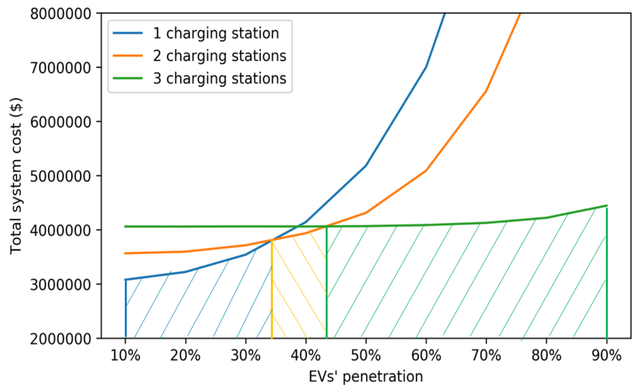


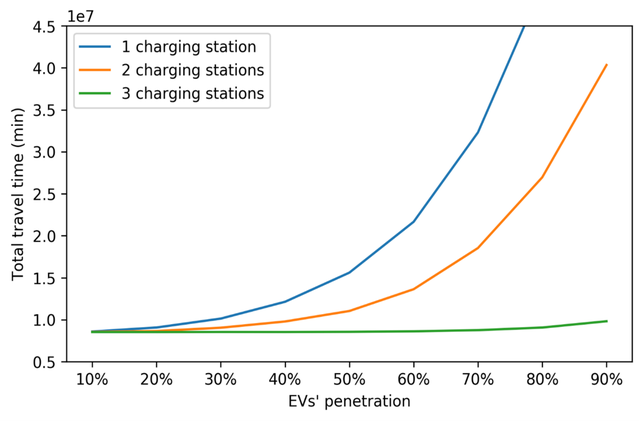
Numerical Test



Total demands (veh/h)

Origins \ *Destinations*	23	24
1	5000	5000
2	5000	5000





% EVs	Charging locations	TTT (min)	TSC ($)	Run time (sec)
10%	12	8,595,099.71	3,078,529.91	9,655.75
20%	12	9,075,361.12	3,222,608.34	7,277.49
30%	12	10,137,048.20	3,541,114.46	7,926.04
40%	12, 20	9,791,352.98	3,937,405.89	9,678.63
50%	12, 20, 4	8,558,667.23	4,067,600.17	3,679.52
60%	12, 20, 4	8,623,766.68	4,087,130.00	519.03
70%	12, 20, 4	8,758,828.17	4,127,648.45	558.35
80%	12, 20, 4	9,069,670.75	4,220,901.22	493.38
90%	12, 20, 4	9,819,150.35	4,445,745.11	513.62