EV Fleet Route Planning - Optimization (Write-up in progress)

Aksh Garg - Stanford CS '25

February 2023

1 Variables

1.1 Constants:

- N : Number of Vehicles
- T : Number of Time Steps to Run Optimization For
- C : Number of Charging Stations
- K : Number of Chargers Per Charging Station
- $MROC$: Max Rate of Charge
- $CO2$: Charge CO2 Emissions

1.2 Optimization Variables:

- X, (Vehicle Trajectories)
- B (Battery Level of Cars)
- C (How much charge is being provided at a given time step),
- D (Helper var for encapsulating L1 Distance).

1.3 Variables Dimensions:

- $|X| : [N, T, 2]$
- $|B| : [N, T]$
- $|C| : [N, C, T]$
- $|C_{cond}| : [N, C, T]$
- $|C_{diff}| : [N, C, T, 2]$
- $|D| : [N, C, 2]$

2 Constraints

Subject to: (1)

$$0 \leq X_{i,j,k} \leq Size \quad \forall i \in \{1,2,\ldots,N\}, j \in \{1,2,\ldots,T\}, k \in \{1,2,\ldots,D\} \tag{2}$$

$$10 \leq B_{i,j} \leq 100 \quad \forall i \in \{1,2,\ldots,N\}, j \in \{1,2,\ldots,T\} \tag{3}$$

$$D_{i,j,k} \geq 0 \quad \forall i \in \{1,\ldots,N\}, j \in \{1,\ldots,T-1\}, k \in \{1,2,\ldots,D\} \tag{4}$$

$$0 \leq C_{i,c,t} \leq \text{MROC} \quad \forall c \in \{1,\ldots,C\}, i \in \{1,\ldots,N\}, t \in \{1,\ldots,T-1\} \tag{5}$$

$$0 \leq Ccond_{i,c,t} \leq 1 \quad \forall c \in \{1,\ldots,C\}, i \in \{1,\ldots,N\}, t \in \{1,\ldots,T-1\} \tag{6}$$

$$B_{i,0} = starting\_battery_i \quad \forall i \in \{1,2,\ldots,N\} \tag{7}$$

$$B_{i,T-1} = end\_battery_i \quad \forall i \in \{1,2,\ldots,N\} \tag{8}$$

$$C_{\text{diff}i,ci,t,0} \geq X_{i,t,0} - charger\_loc_{ci,0} \tag{9}$$

$$C_{\text{diff}i,ci,t,0} \geq -(X_{i,t,0} - charger\_loc_{ci,0}) \tag{10}$$

$$C_{\text{diff}i,ci,t,1} \geq X_{i,t,1} - charger\_loc_{ci,1} \tag{11}$$

$$C_{\text{diff}i,ci,t,1} \geq -(X_{i,t,1} - charger\_loc_{ci,1}) \tag{12}$$

$$B_{i,j} = B_{i,j-1} + \sum_{k=1}^{D} D_{i,j-1,k} - \sum_{ci=1}^{C} C_{i,ci,j-1} \quad \forall i \in \{1,2,\ldots,N\}, j \in \{1,2,\ldots,T\} \tag{13}$$

$$C_{\text{cond}i,ci,t} = C_{\text{diff}i,ci,t,0} + C_{\text{diff}i,ci,t,1} \tag{14}$$

$$C_{i,ci,t} \leq C_{\text{cond}i,ci,t} - 1 \tag{15}$$

$$\sum_{i=1}^{N} C_{i,ci,t} \leq K \cdot MROC \tag{16}$$

(17)

(to be continued)

3 Objective Function

Objective Defined Below (18)

$$\text{Emissions} = \sum_{ci=0}^{C-1} \sum_{t=0}^{T-2} \left(\sum_{i=0}^{N-1} c_{i,ci,t} \cdot CO_{2_{ci}} \right) \tag{19}$$

$$\text{Dist} = \sum_{i=1}^{N} \sum_{t=1}^{T-1} \sum_{k=0}^{1} d_{i,t-1,k} \tag{20}$$

$$\text{Time} = \sum_{i=1}^{N} \sum_{t=1}^{T-1} ((d[i,t,0] + d[i,t,1]) * t) \tag{21}$$

$$\text{Objective} = \alpha * Emissions + \beta * Dist + \gamma * Time \tag{22}$$