Assignment – 1

Topic – Finding the best Charging Station for Electric Vehicle

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Introduction:

Due to demand for Electric Vehicles (EV) has been continuously increased nowadays, electric vehicle users must make their decision on selection of charging stations (CS). The lowest price and the shortest distance are best to make decisions to select CS but they are not enough. The parameters considered below presents an optimal solution by considering price, distance, as well as charging waiting time and driving time to CS. This are the important parameters to EV because all factors affect to make decisions.

Locations of CS and EV:

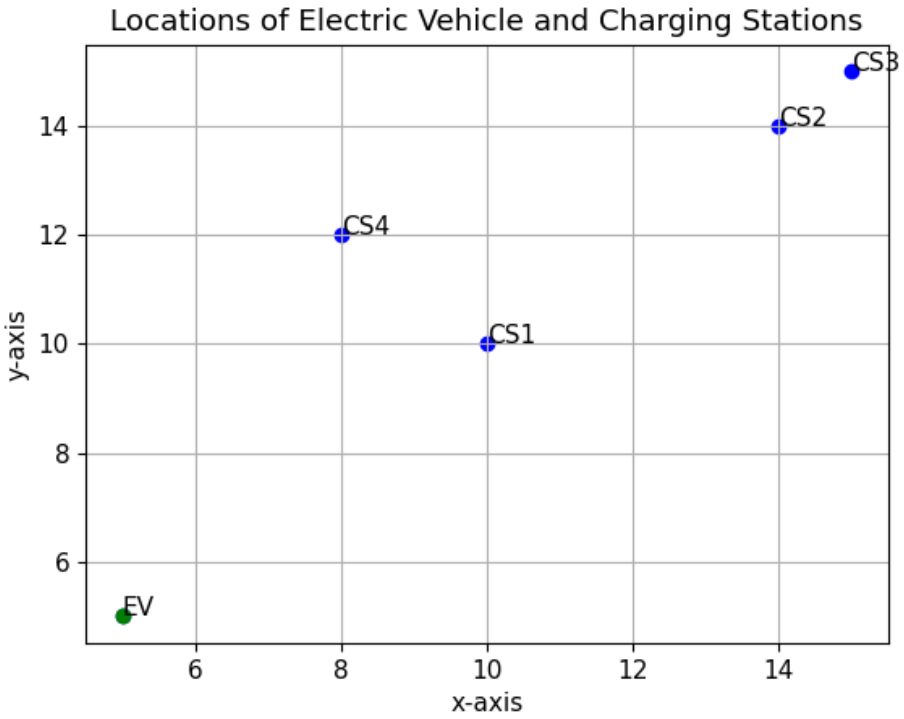


Fig no. 1

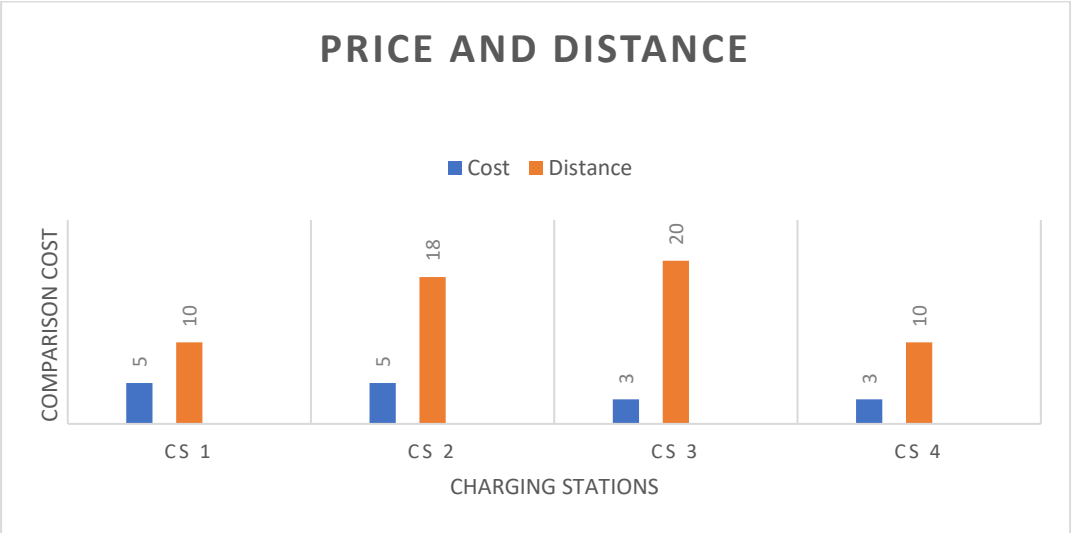
The distance between EV and CS is calculated using **City Block Distance** formula:

D (p, q) = |x-s| + |y-t|

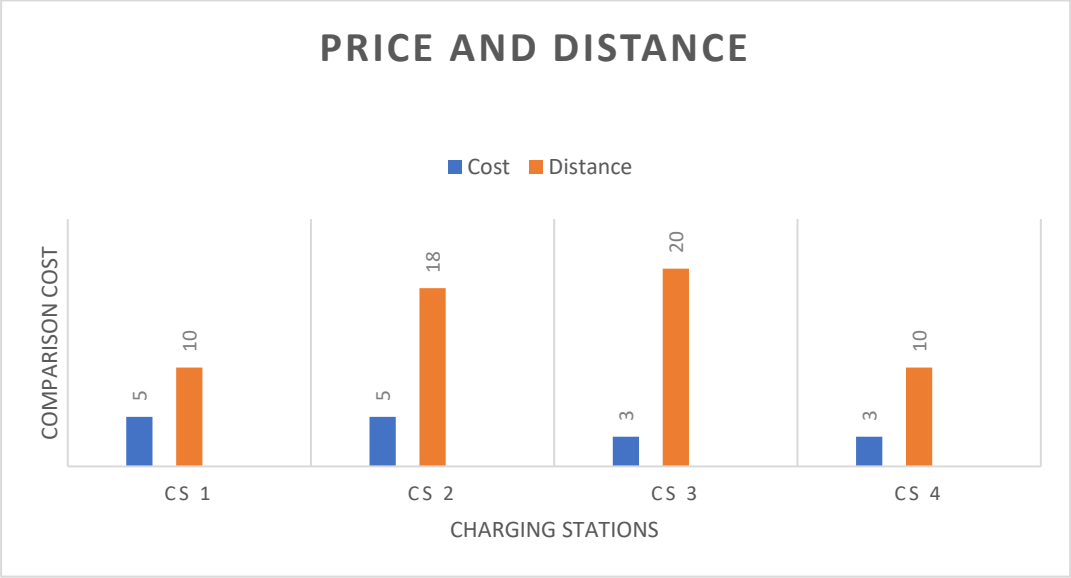
<u>User Preference:</u>

Traditional solution considering only price and distance.

1. **PRICE:** Both CS3 and CS4 have the same price. Therefore, preference will be based on distance and hence CS4 will be preferred because of shorter distance.



2. **DISTANCE:** Both CS1 and CS4 have the same distance. Therefore, preference will be based on price and hence CS4 will be preferred because of lower price.



Optimal solution:

Optimal solution considering price, distance and time.

Costs considered:

1. Cost of Charging:

   C_c = [(1 - %SOC) * BC + A*D] *P_n

2. Travelling Cost:

   $C_t = \left(\frac{D}{V}\right) * P_t$

3. Waiting Cost:

   $C_w = \left[\frac{(1 - \%SOC) * BC + A*D}{R}\right] * P_w$

4. Charging Fast:
   - If 0 does not consider fast charging.
   - Else each station has its own fixed cost for providing fast charging, as example we have taken 4.

$TC = C_c + C_t + C_w + C_f$

Definitions:

TC = Total Cost

C_c = Cost of Charging

C_t = Travelling Cost

C_w = Waiting Cost

C_f = Charging fast

BC = Battery Capacity

SOC = State of Charge (Remaining Battery)

n = Number of Charge Station

d = Distance travelled by EV

A = The energy consumption of EV (BC / d)

D = The distance between EV and CS

P_n = Charging Price

P_t = Traveling Price

P_w = Waiting Price

R = Rate of charge

S = Speed of EV in (km/hr)

V = Rate of movement speed $\left(\frac{D}{S}\right)$

The information for calculating price, distance and times as an example:

- Speed = 60km/hr
- Distance travelled by EV(d) = 20km
- Battery Capacity = 40kwh
- Travelling price =20 B/hr
- Waiting price = 20 B/hr
- Energy Consumption = 2 kwh/km
- Rate of Charge = 50kw

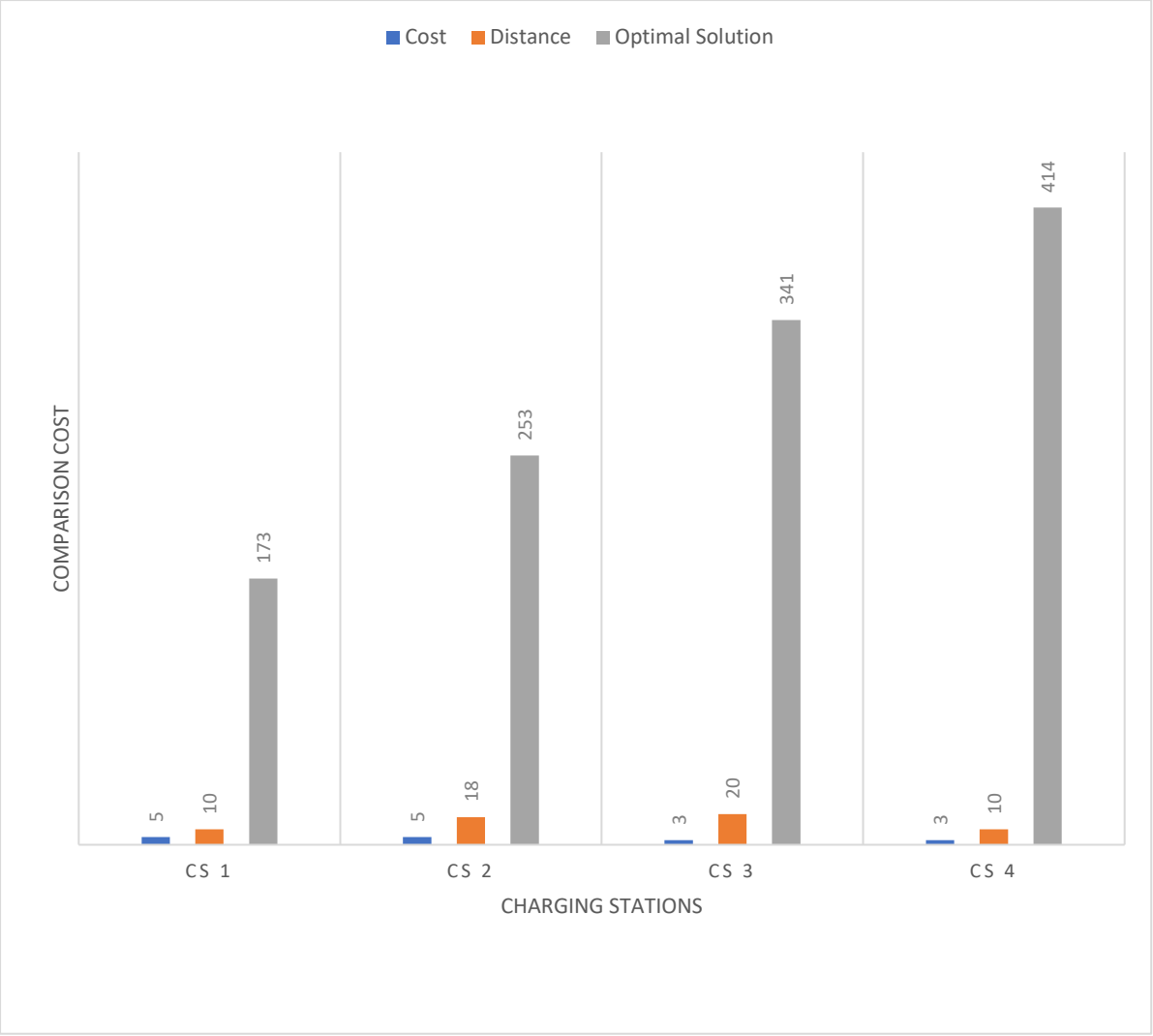
Table constructed after considering all the above values:

Charging Stations	Price	Distance (Km)	C_c	C_t	C_w	C_f	TC
CS1	5	10	200	33.3	16	4	253.3
CS2	5	18	280	108	22.4	4	414.4
CS3	3	20	180	133.3	24	4	341.3
CS4	3	10	120	33.3	16	4	173.3

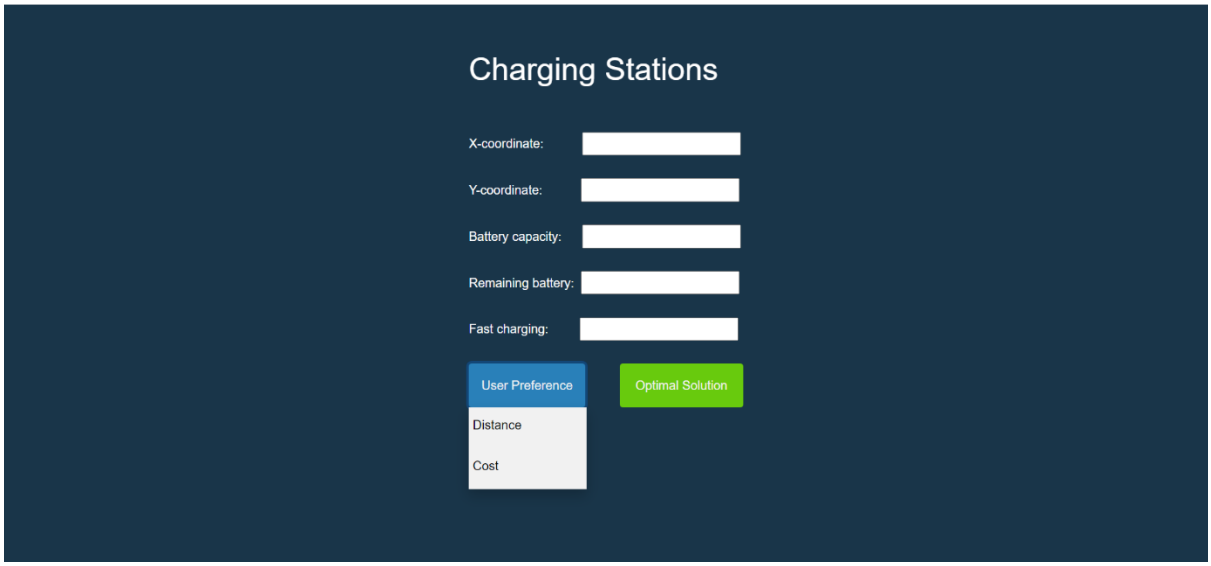
Case 1: Both of CS1 and CS2 with both of CS3 and CS4 have the same price but different distances. Therefore, the model will choose CS4 and then CS1 because it is shorter distance.

Case 2: CS1 and CS4 have the same distance but different price. Therefore, the model will choose CS4 because it has lower price than CS1.

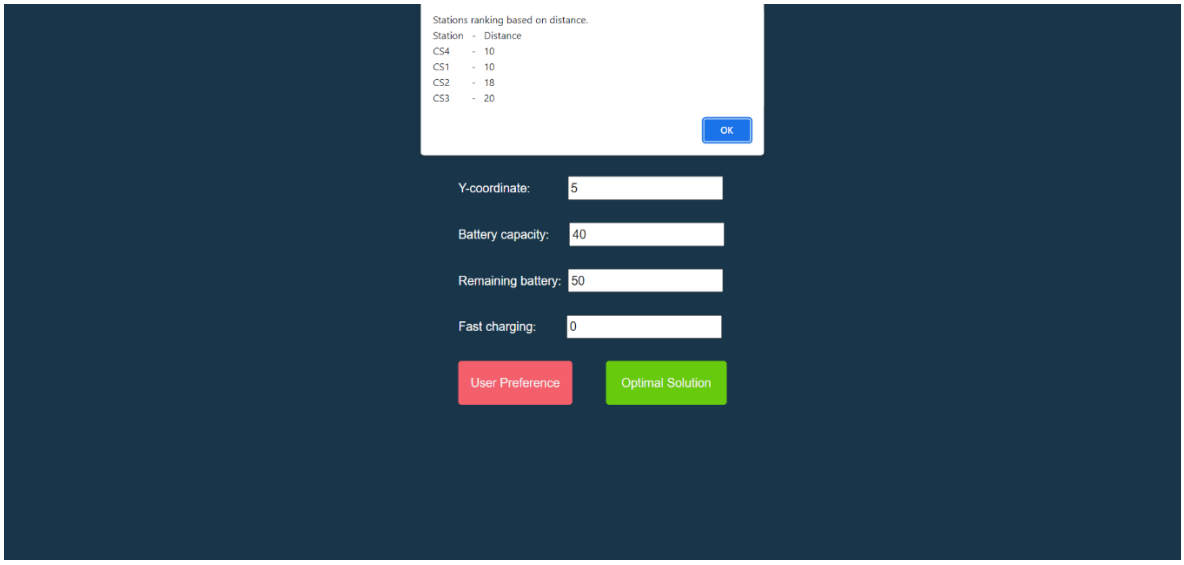
Case 3: CS2 and CS3 have different price and distance it can't consider only price and only distance but it has to consider with other factor to make decisions. Therefore, considering optimal solution provided by above considered parameters by taking TC CS4 will be preferred.



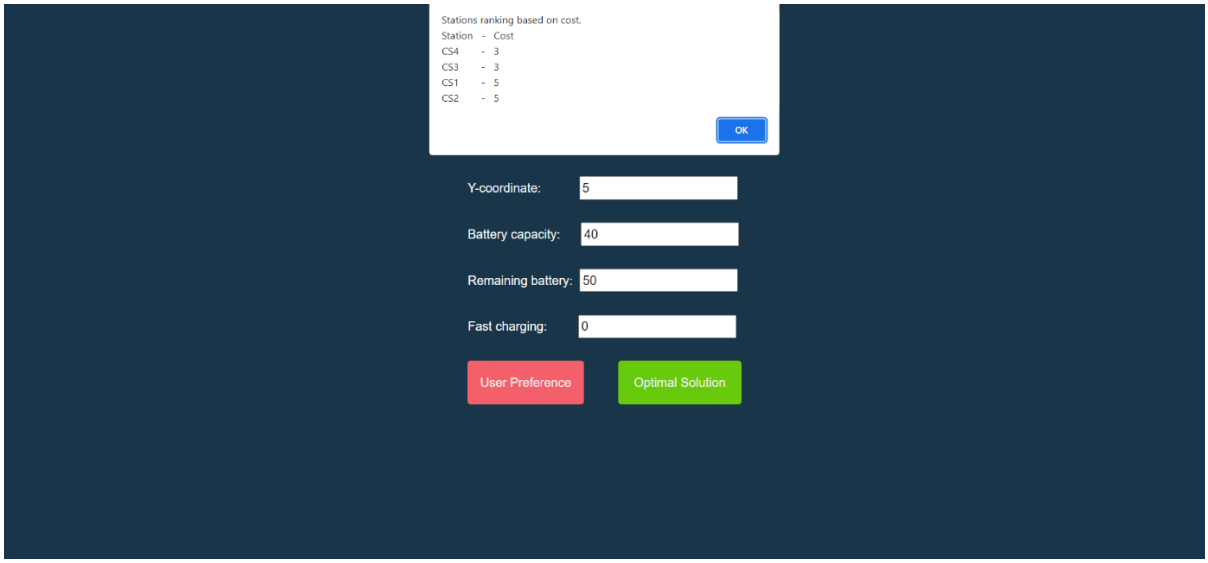
Snapshots:



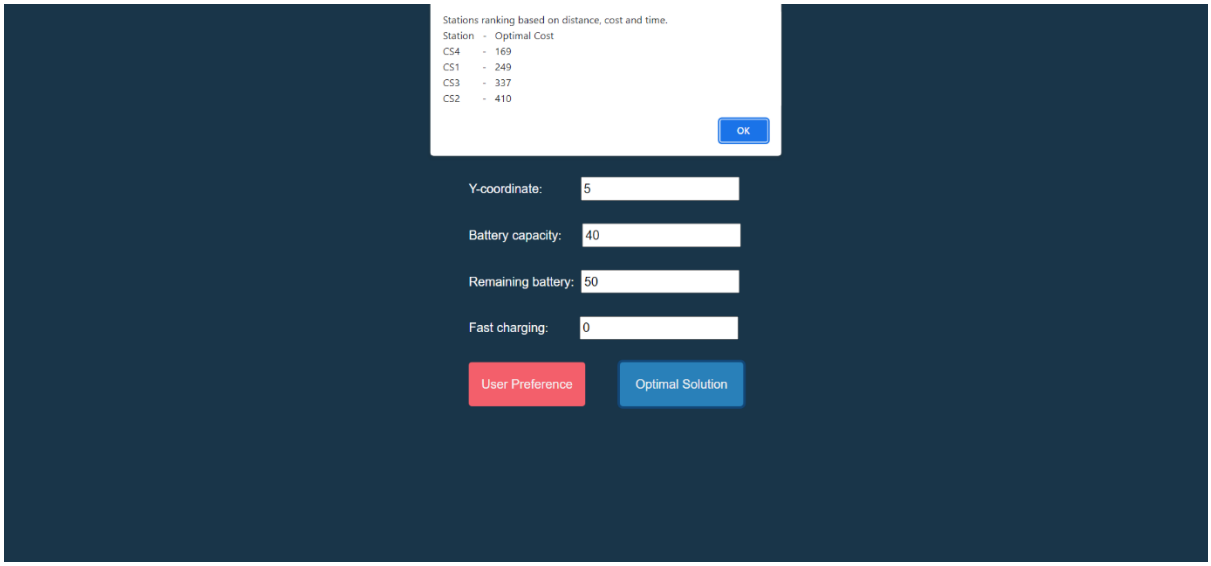
Home page



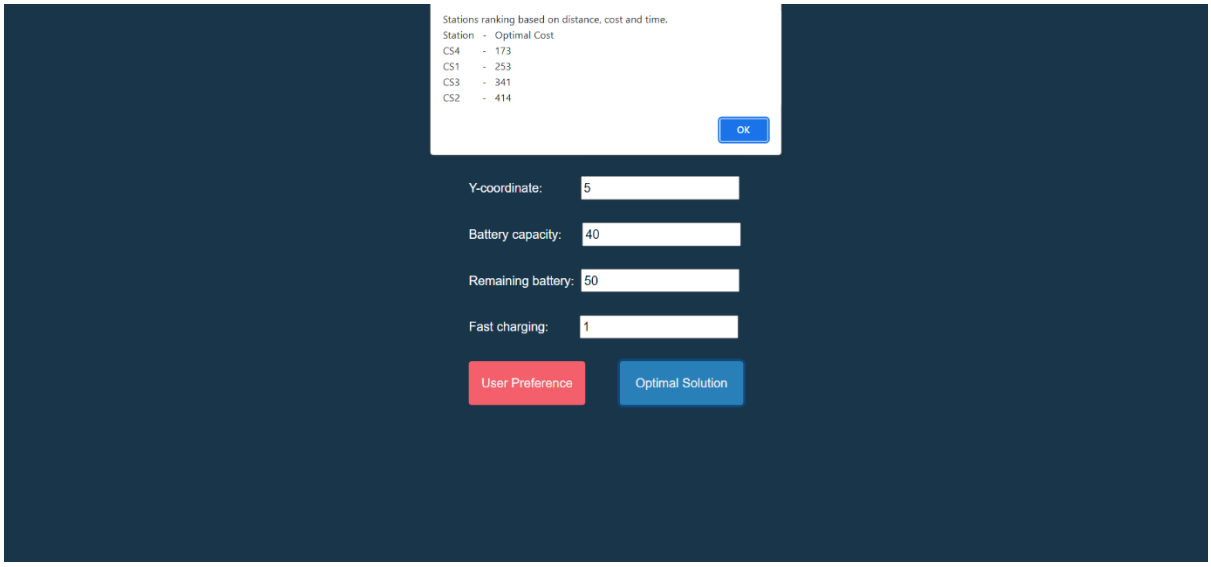
Displaying stations according to distance



Displaying stations according to cost



Displaying stations based on distance, cost, time and no fast charging



Displaying stations based on distance, cost, time and fast charging