# INNOVATION LAB PROJECT

# OPTIMAL SCHEDULING OF ELECTRIC VEHICLE

## Problem Statement:

Given Electric Vehicle Charging Station where EVS come for charging. Develop an algorithm to Schedule the Electric vehicle in optimal way. here optimal is to fulfill the EV owner and charging station requirement.

## Motivation:

The vehicle electrification will have a significant impact on the power grid due to the increase in electricity consumption. It is important to perform intelligent scheduling for charging and discharging of electric vehicles (EVs). However, there are two major challenges in the scheduling problem. First, it is challenging to find the globally optimal scheduling solution which can minimize the total cost. Second, it is difficult to find a distributed scheduling scheme which can handle a large population and the random

arrivals of the EVs. In this project propose optimaly scheduling of Scheduling EVS through various Algorithm.

## Proposed Solutions:

In this Project Scheduling of Electric Vehicle is done through various algorithm . the main motive to fulfill user's and charging Station requirement to **minimize the waiting time for user and overall time in which all EVS get charged, and more no. of EVS will ge**t **charged**. First Come First Serve , Shortest Job first , Priority Based according to Deadline if deadline same then according to fcfs  and optimized algorithm (consist of all solutions) is used to schedule the EVS.

## Constraint Given For the Problem:

There will be n number of vehicles whose information like  arrival time , departure time and charge needed will taken as input and there will be three interval for charging of EVS and charging rate may be different for each interval also taken as input.

## Algorithm Approach:

For the optimized algorithm used the concept of dp bitmasking. dp will store all possible 2 power n solution for n evs for charging. it will store the minimum ending time for each vehicle to charge.so overall minimizing the total ending time and more no of evs get charged.

For FcFs algorithm sorting on the based of first arrival and scheduled. for shortest job first sorting based on the difference between departure and arrival and scheduled

for priority based algorithm sorting on the basis of deadline if deadline same then on the basis if first arrival.

## Observation of Test Results for different test case:

### Test case 1:

## Optimized Algorithm solution:

```
Enter no. of EVS
3
Enter the arrival,departure and charge of every EVS
9 12 10
8 11 10
7 10 30
Enter the ending time of morning, afternoon and evening respectively
12 17 23
Enter the rate of charging during morning, afternoon and evening respective
10 6 5
In the most optimal solution, which maximizes no. of cars charged in least
EVS: 0 will get charged
EVS: 1 will get charged
EVS: 2 will get charged

The optimal solution is: {EVS no. , Time when car is placed }
2 10
1 11
0 12
```

## FCFS(first come first serve)

```
Enter no of vehicles
3
Enter arrival, departure, charge needed for each EV
9 12 10
8 11 10
7 10 30
Enter ending time of three interval
12 17 23
Enter rate of three time interval
10 6 5
arrival and end time for EV 2
7 10
arrival and end time for EV 1
8 11
arrival and end time for EV 0
9 12
```

## Shortest Job First:

```
Enter no of vehicles
3
Enter arrival, departure, charge needed for every EV
9 12 10
8 11 10
7 10 30
Enter ending time of three interval
12 17 23
Enter rate of three time interval
10 6 5
arrival and end time for EV 2
7 10
arrival and end time for EV 1
8 11
arrival and end time for EV 0
9 12
```

**Priority Based:**

```
priority_based_according_to_deadline.cpp -o priority_b
Enter no of vehicles
3
Enter arrival, departure, charge needed for every EV
9 12 10
8 11 10
7 10 30
Enter ending time of three interval
12 17 23
Enter rate of three time interval
10 6 5
arrival and end time for EV 2
7 10
arrival and end time for EV 1
8 11
arrival and end time for EV 0
9 12
```

**observation for this test case:**

In this testcase ending time in which all EVS get charged and no. of evs gey charged is same for optimized , fcfs, SJS and Priority Based.

## Testcase 2:

## optimized algorithm

```
optimized_algo.cpp -o optimized_algo } ; if ($?) { .\optimized_algo }
Enter no. of EVS
10
Enter the ending time of morning, afternoon and evening respectively
12 17 23
Enter the rate of charging during morning, afternoon and evening respectively
10 9 8
In the most optimal solution, which maximizes no. of cars charged in least time, the following cars will be able to get fully charged
EVS: 0 will get charged
EVS: 1 will get charged
EVS: 2 will get charged
EVS: 3 will get charged
EVS: 4 will get charged
EVS: 5 will get charged
EVS: 7 will get charged
EVS: 8 will get charged
EVS: 9 will get charged

The optimal solution is: {EVS no. , Time when car is placed }
0 5
1 8
2 10
7 13
3 14
4 17
5 19
9 22
8 23
```

## FCFS:

```
Enter no of vehicles
10
Enter arrival, departure, charge needed for each EV
4 6 8
7 9 3
9 11 9
12 15 6
16 17 4
18 20 3
11 1 4
12 13 4
22 23 6
21 23 7
Enter ending time of three interval
12 17 23
Enter rate of three time interval
10 9 8
arrival and end time for EV 0
4 5
arrival and end time for EV 1
7 8
arrival and end time for EV 2
9 10
arrival and end time for EV 6
11 -1
arrival and end time for EV 3
12 13
arrival and end time for EV 7
12 -1
arrival and end time for EV 4
16 17
arrival and end time for EV 5
18 19
arrival and end time for EV 9
21 22
arrival and end time for EV 8
22 23
```

## Shortest job first

```
Enter no of vehicles
10
Enter arrival, departure, charge needed for every EV
4 6 8
7 9 3
9 11 9
12 15 6
16 17 4
18 20 3
11 1 4
12 13 4
22 23 6
21 23 7
Enter ending time of three interval
12 17 23
Enter rate of three time interval
10 9 8
arrival and end time for EV 6
11 -1
arrival and end time for EV 7
12 13
arrival and end time for EV 4
16 17
arrival and end time for EV 8
22 23
arrival and end time for EV 0
4 -1
arrival and end time for EV 1
7 8
arrival and end time for EV 2
9 10
arrival and end time for EV 5
18 19
arrival and end time for EV 9
21 22
arrival and end time for EV 3
12 -1
```

## Priority Based (accordind to deadline and FCFS)

```
Enter no of vehicles
10
Enter arrival, departure, charge needed for every EV
4 6 8
7 9 3
9 11 9
12 15 6
16 17 4
18 20 3
11 1 4
12 13 4
22 23 6
21 23 7
Enter ending time of three interval
12 17 23
Enter rate of three time interval
10 9 8
arrival and end time for EV 6
11 -1
arrival and end time for EV 0
4 5
arrival and end time for EV 1
7 8
arrival and end time for EV 2
9 10
arrival and end time for EV 7
12 13
arrival and end time for EV 3
12 14
arrival and end time for EV 4
16 17
arrival and end time for EV 5
18 19
arrival and end time for EV 9
21 22
arrival and end time for EV 8
22 23
```

## Observation:

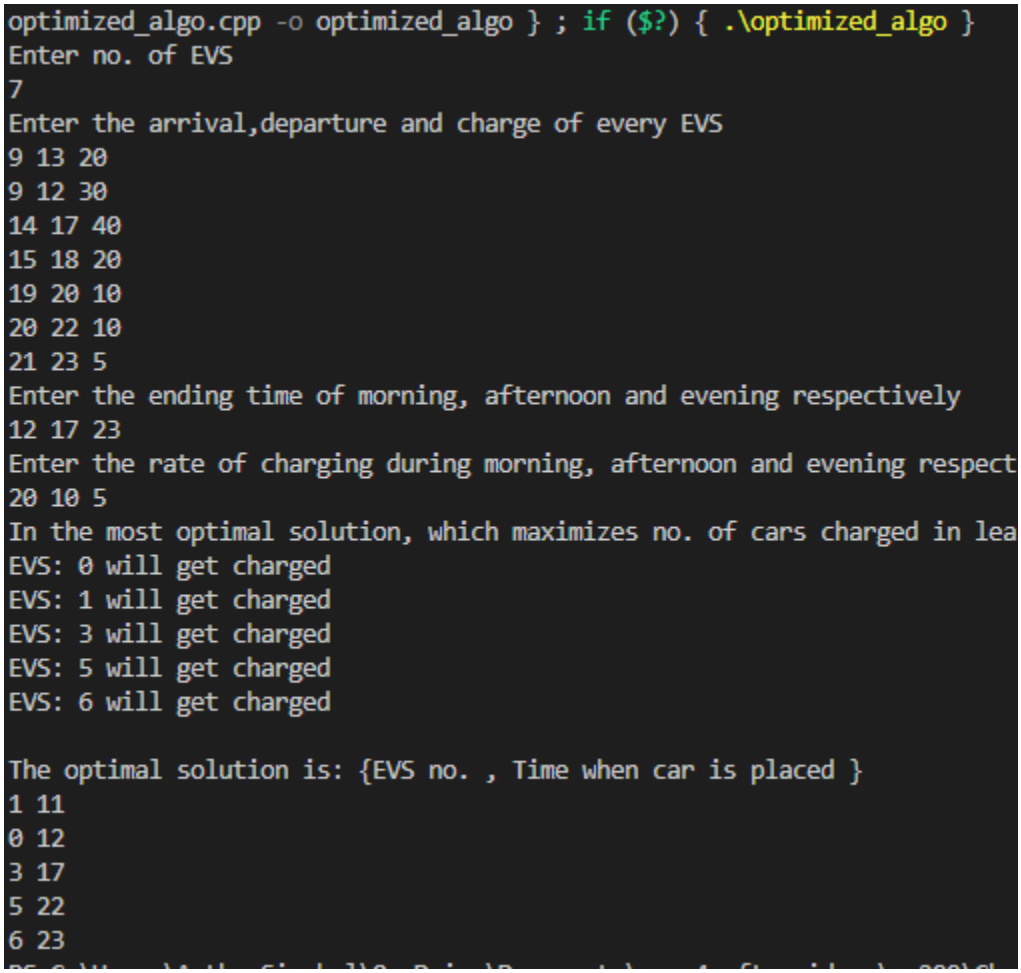
In this testcase it is observed that min charging ending time when all cars will be charged is 23 and which is same for also first come first serve, shortest job first, priority based according to deadline

But for optimized algo and priority based only one car will not be charged before the departure time of that car, and in first come first serve 2 cars will not be charged , and in shortest job first 3 cars

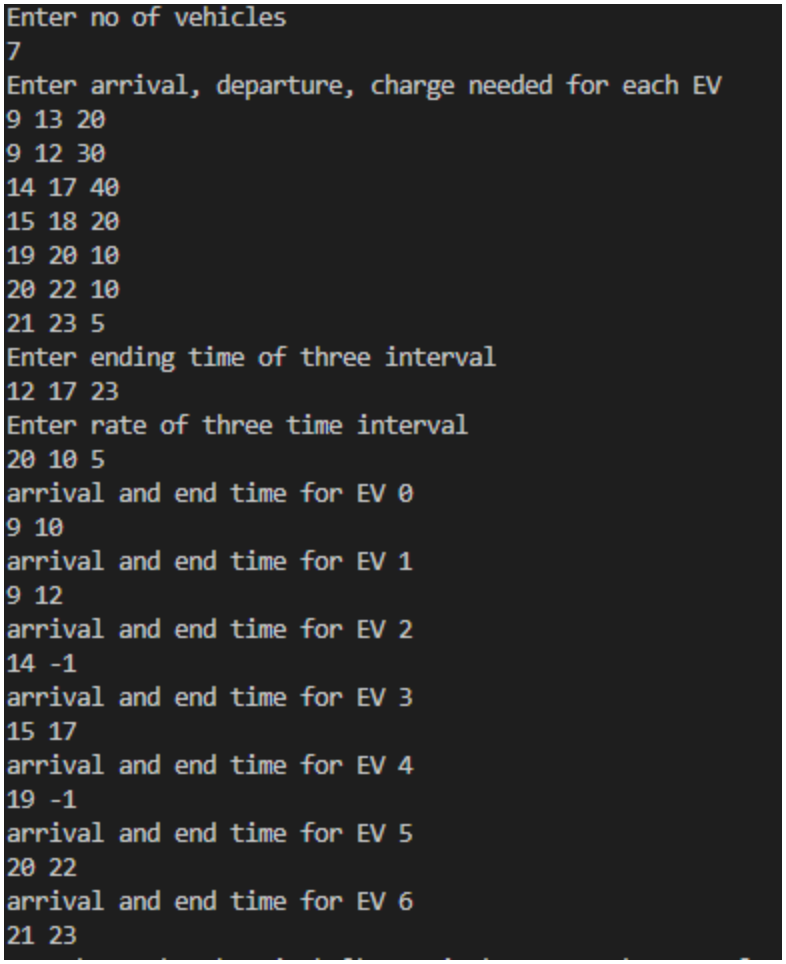
So, for this testcase optimized and priority based is the solution:

**Testcase 3:**

**Optimized :**




**FCFS:**




**Shortest Job First:**

```
Enter no of vehicles
7
Enter arrival, departure, charge needed
9 13 20
9 12 30
14 17 40
15 18 20
19 20 10
20 22 10
21 23 5
Enter ending time of three interval
12 17 23
Enter rate of three time interval
20 10 5
arrival and end time for EV 4
19 -1
arrival and end time for EV 5
20 22
arrival and end time for EV 6
21 23
arrival and end time for EV 1
9 -1
arrival and end time for EV 2
14 -1
arrival and end time for EV 3
15 17
arrival and end time for EV 0
9 -1
```

**Priority Based:**

```
priority_based_according_to_deadline.c
Enter no of vehicles
7
Enter arrival, departure, charge neede
9 13 20
9 12 30
14 17 40
15 18 20
19 20 10
20 22 10
21 23 5
Enter ending time of three interval
12 17 23
Enter rate of three time interval
20 10 5
arrival and end time for EV 1
9 11
arrival and end time for EV 0
9 12
arrival and end time for EV 2
14 -1
arrival and end time for EV 3
15 17
arrival and end time for EV 4
19 -1
arrival and end time for EV 5
20 22
arrival and end time for EV 6
21 23
```

**Observation:**

From this test case  fcfs and priority based solution is same as optimized algorithm solution but for shortest job first no of vehicle not fulfill requirement is more in this case.

## Conclusion

After applying different types of algorithm for the scheduling of Evs for different testcases  it is observed that shortest job first is not as efficient as priority based deadline if deadline same then according to first come and first serve.optimized solution will work for all testcases but due to large time complexity it will work only for

small n thus for larger n priority based according to deadline and FCFS will be the solution for the problem.here in this project main motive is to test different algorithm and minimise the total ending time and maximise to fulfill the user's requirement.

## Future Plan:

Algorithm for  Scheduling of Electric Vehicle include so many factors cost, users requirement, charging station maximize profit. in this project scheduling is done to prioritize the minimum ending time and maximize the customer's demand to fulfill. in the future should include a factor for minimum cost for users and for charging station to maximize profit. and develop a web interface live booking for scheduling of Electric Vehicle in which Ev owner can book their slot accordingly.