Data, Code & Output for

Mathematical Optimization of Electric Vehicle

Passenger Calculation

According to the survey; the peak hours of transportation in the working day are from 9.30-10.30 am and 6.00-7.00 pm. Here the no. of CNG vehicles in the peak time of 6:00-7:00 pm on different dates are shown in Table I.

Table 1 Peak hour transportation data

Date	Time	No. of CNG vehicles
02/11/2023	6.00-7.00pm	1126
06/11/2023	6.00-7.00pm	993
07/11/2023	6.00-7.00pm	1085
08/11/2023	6.00-7.00pm	960
12/11/2023	6.00-7.00pm	1120
14/11/2023	6.00-7.00pm	970
16/11/2023	6.00-7.00pm	1194
19/11/2023	6.00-7.00pm	1023
20/11/2023	6.00-7.00pm	940
21/11/2023	6.00-7.00pm	965

In the peak hour, an average of 1038 vehicles navigate the road, accommodating 5 people each, resulting in 5190 individuals commuting during this period. Beyond peak hours, characterized by reduced traffic density, the study focuses on off-peak hours during a working day (12.30-1.30 pm and 4.00-5.00 pm) [29]. During these off-peak intervals, the research scrutinizes the presence of CNG vehicles in Table-II.

Table 2 - Off-peak hour transportation data

Date	Time	No. of CNG vehicles
05/11/2023	12.30-1.30pm	742
07/11/2023	12.30-1.30pm	675
08/11/2023	12.30-1.30pm	765
09 /11/2023	12.30-1.30pm	820
12/11/2023	12.30-1.30pm	678
14/11/2023	12.30-1.30pm	788
15/11/2023	12.30-1.30pm	852
20/11/2023	12.30-1.30pm	780
21/11/2023	12.30-1.30pm	690
22/11/2023	12.30-1.30pm	815

In the off-peak hour an average 761 vehicles travels in this road resulting in 3805 people travels in this road

CODE:

```
clc
clear all
close all
% Parameters
totalPassengers = 5200;
totalDistance = 45;
efficiencyBus = 765; % Wh/km
efficiencyCab = 165; % Wh/km
capacityBus = 55;
capacityCab = 5;

% Define the objective function to minimize (total energy
cost)
fun = @(x) x(1) * efficiencyBus * totalDistance + x(2) *
efficiencyCab * totalDistance;
```

```
x0 = [1000, 1000];
lb = [13, 135];
ub = [95, 1040];
A = [];
b = [];
Aeq = [55, 5];
beq = 5200;
[x, fval, exitflag, output, lambda] = fmincon(fun, x0, A,
b, Aeq, beq,lb, ub)
```

Output:

Optimization completed because the objective function is non-decreasing in feasible directions, to within the value of the optimality tolerance,
and constraints are satisfied to within the value of the constraint tolerance.

<stopping criteria details>

x =

  82.2727 135.0000

fval =

  3.8346e+06

exitflag =

  1

output =

struct with fields:

iterations: 13
funcCount: 42
constrviolation: 9.0949e-13
stepsize: 11.4232
algorithm: 'interior-point'
firstorderopt: 0.0316
cgiterations: 5
message: '↲Local minimum found that satisfies the constraints.↲↲Optimization completed because the objective function is non-decreasing in ↲feasible directions, to within the value of the optimality tolerance,↲and constraints are satisfied to within the value of the constraint tolerance.↲↲<stopping criteria details>↲↲Optimization completed: The relative first-order optimality measure, 9.181138e-07,↲is less than options.OptimalityTolerance = 1.000000e-06, and the relative maximum constraint↲violation, 1.829767e-16, is less than options.ConstraintTolerance = 1.000000e-06.↲↲'

lambda =

struct with fields:

eqlin: -625.9097

eqnonlin: [0×1 double]

ineqlin: [0×1 double]

lower: [2×1 double]

upper: [2×1 double]

ineqnonlin: [0×1 double]