Tesla Supercharger Challenge

Sahand Hadizadeh Kafash

February 6, 2023

---

1 How to compile and run the code

You should first compile the code using the command below:

```
$ g++ main.cpp network.cpp
```

Then you can run the code to find the optimal path between two stations using the example command below

```
$ ./a.out Council_Bluffs_IA Cadillac_MI
```

2 The intuition behind the code

The code is written such that the planning task is being done in two steps:

1. A^* **Search:** Here we use the $A*$ search algorithm [1], to find a path between the start station and the goal station. The algorithm is designed such that the distance between tow subsequent stations in the path is always less than 320. hence, with proper fueling/charging, the vehicle never runs out of charge.

2. **Fueling/Charging Time:** In this step, having the path as a sequence of stations between the start and goal stations, we determine the required fueling time. The logic behind this part of the code can be summarized as:

   If the current station charges faster than the next station, then fully charge the vehicle. If the next station charges faster than the current station, limit the charging to the amount required to reach the next station

3 Further thoughts

The second step in the algorithm explained above which is for determining the fueling/charging times, can be reformulated into a linear programming problem as below:

$$
\begin{cases}
\min\limits_{t_1,\ldots,t_n} \sum\limits_{i=1}^{n} t_i, \\
\text{Subject} \quad \text{to :} \\
320 - d_0 + r_1 t_1 - d_1 + \ldots r_n t_n - d_n = 0 \\
320 - d_0 + r_1 t_1 - d_1 \geq 0 \\
320 - d_0 + r_1 t_1 - d_1 + r_2 t_2 - d_2 \geq 0 \\
\vdots \\
320 - d_0 + r_1 t_1 - d_1 + \cdots + r_{n-1} t_{n-1} - d_{n-1} \geq 0 \\
r_1 t_1 - d_0 \leq 0 \\
r_1 t_1 - d_0 + r_2 t_2 - d_1 \leq 0 \\
\vdots \\
r_1 t_1 - d_0 + \cdots + r_n t_n - d_{n-1} \leq 0 \\
t_i \geq 0, \qquad i = 1, \ldots, n
\end{cases}, \tag{1}
$$

where $r_1, \ldots, r_n$ are the charging rates of n intermediate stations, $d_0, \ldots, d_n$ are the distances between the stations, and $t_1, \ldots, t_n \geq 0$ are the charging times at each station which are also our decision variables.

References

[1] Wei Zeng and Richard L Church. Finding shortest paths on real road networks: the case for a*. *International journal of geographical information science*, 23(4):531–543, 2009.