Developing a Smart Charging Algorithm for Electric Vehicles Can Minimize Charging Costs in Parking Lots

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Introduction

With a rising number of electric vehicles (EVs), our demand for energy that we generate from renewable sources (e.g., solar panels, windmills) are also on the rise.

During the day, there is a timeframe that's referred to as "peak hours", where the demand for electricity is at the highest, therefore electricity prices are also very high.

When electric vehicles charge during peak hours, users pay for expensive prices, and electric companies may run out of renewable energy, forcing them to switch to carbon-emitting power plants.

Project Goals

Our goal for this project is to develop a smart charging algorithm for electric vehicles so that we can minimize EV charging during peak hours. This will result to a decrease in charging fees and a better management for renewable energy.

Materials and Methods

We are using Python and Jupyter Notebook to analyze EV charging data from the SLAC National Accelerator Laboratory parking lot at San Mateo, CA.

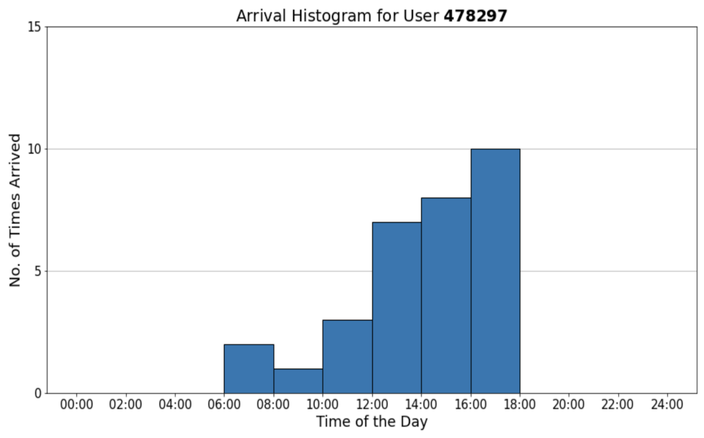
First, we identify a User ID once the charger is plugged in to a vehicle

Then, we filter the data and gather the necessary historical information (e.g., charging times)

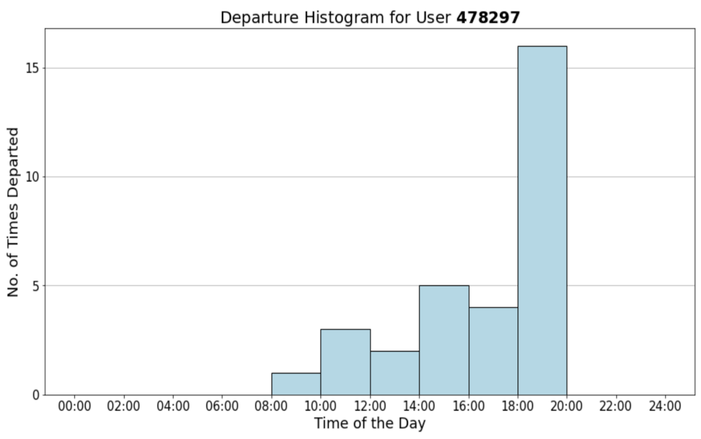
We calculate average charging times

We create an optimized charging schedule for the vehicle

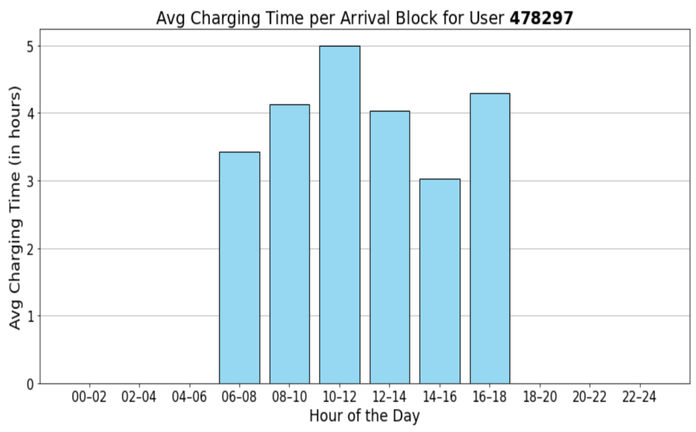
Data Representation



An arrival histogram is generated to show how many times a user arrived at the parking lot in 2-hour windows of time in a day. This helps us determine when a user will most likely arrive at the parking lot and use the charger.



Departure histograms are also generated to show us how many times a user has left the parking lot in 2-hour windows as well. This will help us determine how long a user may stay in the parking lot to charge their EV.



One of the most important graphs is seeing how long on average does a user stay at the parking lot to charge their vehicles. Again, they are separated into 2-hour blocks of time for consistency with previous graphs.

By having this data, we can calculate how much energy was being delivered to the vehicle. Then we use that amount to inform our algorithm about an energy threshold it must satisfy to create an optimized charging schedule.

Initial Optimization Test Results

```
Matrix for optimized charging is

[[0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 1. 1. 1. 1. 1. 1. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
  1. 1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 1. 1. 0. 0. 0. 0. 0. 0. 0. 0.]]
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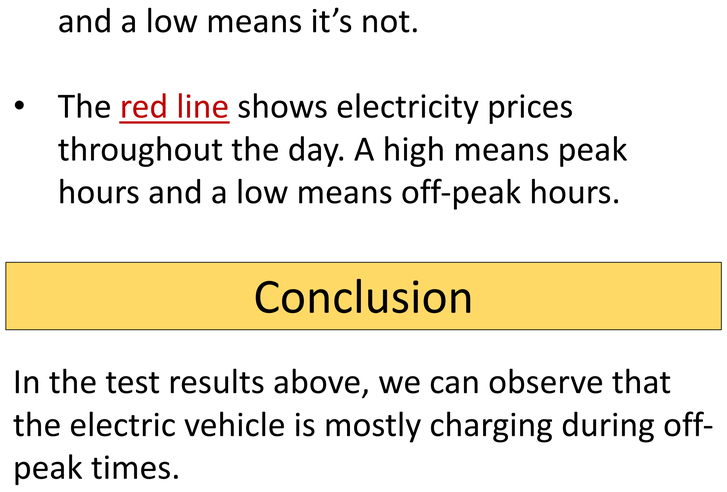


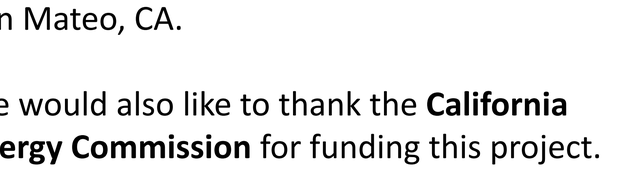
In our optimization testing above:

- the green line shows when the vehicle is plugged in. A high when it's plugged in and a low when it's not.
- the blue line is the visual representation of the charging matrix and shows when the EV is being charged. A high means it's charging and a low means it's not.
- The red line shows electricity prices throughout the day. A high means peak hours and a low means off-peak hours.

Conclusion

In the test results above, we can observe that the electric vehicle is mostly charging during off-peak times.

Judging from that data, we can expect our smart charging algorithm to make EV owners pay less for charging and allow better management for renewable energy.



Acknowledgments

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