Segmenting and Clustering Tesla Superchargers in the United States

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Introduction

Electric cars are the future of ground transportation. Aside from being better for the environment, they are faster, quieter, less expensive to power, accelerate more smoothly, and are more reliable than their internal combustion engine (ICE) counterparts. There is, however, a nontrivial drawback to electric vehicles (EVs): charging time. This is a non-issue for daily commuting because charging can occur overnight at the owner's home. Charging time can be an issue for trips requiring a charge before returning home though. For example, a 700-mile trip that took me 11 hours in my ICE vehicle now takes 12.5 hours in my EV, due to the extra time it takes to charge the EV as compared to filling up the ICE vehicle's gas tank.

Taking a road trip in an EV requires a mindset shift. If completing the road trip as fast as possible is paramount, then the EV will probably leave you frustrated. If you don't mind spending a little more time traveling and are able to leverage the charging breaks as an opportunity to stretch out, grab a snack or beverage, have lunch, chat with fellow EV travelers, or check out some of the nearby shops or attractions, then you will likely find road trips more enjoyable and reach your destination more relaxed in an EV than in an ICE vehicle.

In order to mitigate the inconvenience of charging time and further encourage the adoption of electric vehicles, this project will categorize fast charging stations according to nearby locations (e.g., fast food, coffee, groceries, park, …). Such a categorization will be useful to those planning a road trip, enabling selection of routes or charging stations along the route which have amenities of interest. Further, such a categorization may be useful to entrepreneurs interested in opening a business near chargers which do not already have a similar business nearby.

Data

DC fast chargers include CCS, CHAdeMO, and Tesla Superchargers. Level 2 chargers are slower chargers, typically found in the home or at other final destinations (such as a hotel or shopping mall). A Level 2 charger typically provides 20-40 miles of range per hour of charging. This is ample for an overnight charge, but far too slow when on a road trip with the primary objective of charging the vehicle as quickly as possible. DC fast chargers, on the other hand, are able to charge up to 80% of the battery's capacity in roughly 30 minutes and would be the only feasible option for charging between the origin and final destination on a road trip. Because the intended beneficiaries of this project are EV drivers on a road trip, or potentially entrepreneurs wishing to cater to them, the data will be limited to DC fast chargers. In order to keep the project to a reasonable scope, data will be further limited to Tesla Superchargers within the United States.

Charging Station Data

I considered the following options for obtaining charging stations data:

- ChargeHub API (https://www.mogiletech.com/apiaccess)
- PlugShare API (https://recargo.freshdesk.com/support/solutions/articles/29000015750-plugshare-charging-stations-api-documentation-access)
- National Renewable Energy Laboratory (NREL) Developer Network Alternative Fuel Stations API (https://developer.nrel.gov/docs/transportation/alt-fuel-stations-v1/all/)
- Open Charge Map API (https://openchargemap.org/site/develop)

NREL and Open Charge Map are free, whereas ChargeHub and PlugShare are not, so I eliminated ChargeHub and PlugShare. Ultimately I chose NREL because it is the source of Open Charge Map data for the US and Canada and this project is limited to charging stations in the US.

The NREL API returns a total of 63 features per charging station (e.g., id, cards_accepted, open_date, station_name, station_phone, …). For this project, I will use only the following 8 features for each station (shown below with sample data from one station):

```
'id': 101972
'station_name': 'FAIRFIELD INN - Tesla Supercharger'
'latitude': 34.785416
'longitude': -86.942864
'city': 'Athens'
'state': 'AL'
'street_address': '21282 Athens-Limestone Blvd.'
'zip': '35613'
```

Location Data

The source of the location data will be the Foursquare API (https://developer.foursquare.com/). The Foursquare API returns a total of 27 features per venue (e.g., id, name, city, state, …). For this project, I will use only the following 4 features for each venue (shown below with sample data from one venue):

```
'name': 'Fairfield Inn by Marriott Athens'
'lat': 34.78587188328971
'lng': -86.9428607460327
('categories')'name': 'Hotel'
```