**Identifying Charging Station Malfunctions**

**Problem Statement**

**Motivation**

- **Charging Station Ownership**: Public charging stations used by GM Electric Vehicle (EV) drivers are owned and operated by third party providers called Charging Point Operators (CPOs).
- **Limited Station Visibility**: GM is reliant on the CPOs for all maintenance, and CPOs are limited to reactive and often delayed repairs. Additionally, GM lacks awareness of real-time station status.
- **High Failure Incidence**: GM suspects high failure incidence across EV charging stations, bringing negative implications for driver experience.

**Objective**

Develop a modeling methodology to evaluate charging station health by promptly identifying charging stations that have failed or are exhibiting deficiencies.

**Scope**

We focused our study on data from 121 EV charging stations in California. This includes 49 Direct Current Fast Charge (DCFC) and 72 Level 2 stations from various CPOs.

**Analytical Approach**

We developed a unique modeling approach for each of three distinct charging failure types:

**Charge Does Not Start**

We used ARIMA models to forecast the number of charging events and residual analysis to flag days where our forecast consistently exceeded the observed values.

**Charge is Slow**

We used DBSCAN clustering to identify anomalous slow charging events, considering charge power, start battery level, end battery level, and vehicle model.

**Charge Terminates Prematurely**

We used DBSCAN clustering to identify anomalous charging events with low end battery levels and short charging durations.

For all three failure types, we calculated a measure of confidence for each failure identified. This confidence is based on the deviation of the anomalies from "normal behavior," scaled by the maximum possible deviation. We adjusted confidence based on the length of the failure and the concentration of anomalies within the failure window.

**Results and Impact**

**Results**

- **24.0%** Failure Incidence Among All Failure Types
  - 10.1% Does Not Start
  - 15.3% Slow
  - 0.7% Terminates Prematurely

Delivered dashboard showing summary statistics and actionable insights by CPO provider:

**Impact**

- **Facilitates Relationships and Data Sharing with CPOs**: Improved visibility into CPO performance enables GM to have better informed partnerships with CPOs.
- **Improves Driver Experience**: Direct notification of potential charging station failures eliminates driver frustration.
- **Accelerates EV Adoption**: Higher reliability and uptime of charging stations promotes EV adoption, enabling GM's all-electric, zero-emissions future.

**Future Work**

- Incorporate additional charging stations
- Apply models to real-time with driver notifications
- Leverage station visitation data