1 Introduction

The objective of this dashboard is to provide Tesla management and regional planners with actionable insights into the performance of the Supercharger network. By visualizing utilization patterns, wait-time trends, economic performance, and expansion scenarios, the dashboard empowers Operations Managers, Regional Expansion Analysts, and Strategic Decision-Makers to optimize station operations and prioritize new build-outs.

Key business questions addressed include:

- Which Supercharger stations experience the highest utilization and longest wait times?
- How do station-level revenues compare to operating costs, and which locations are most profitable?
- Where should Tesla add its next Supercharger to maximize wait-time reduction and revenue uplift?

To enable this analysis, a realistic three-year synthetic dataset was generated—covering station metadata, hourly charging sessions, local weather, special events, and traffic volumes—ensuring that the visualizations reflect plausible operational dynamics.

2 Dashboard Planning

2.1 Dashboard Structure and Tabs

This dashboard is organized into five main tabs, each addressing a critical aspect of Supercharger network performance:

1. **Utilization Map**: A geospatial view showing session counts and average wait times per station.
2. **Wait Times**: An interactive time-series chart of daily average wait times with rolling-average, anomaly flags, and event markers.
3. **Busiest Stations**: A horizontal bar chart ranking the top 10 stations by total session count.
4. **Revenue vs. Cost**: A grouped bar chart comparing total revenue against operating cost for each station.
5. **Queue & Capacity**: Boxplots illustrating the distribution of queue lengths and idle port availability across stations.

2.2 Key Metrics

The following metrics were chosen to align with the dashboard's objectives:

- **Utilization**: Number of charging sessions per station to identify demand hotspots.
- **Average Wait Time**: Daily mean wait times to surface service bottlenecks.
- **Session Frequency**: Volume ranking of stations for capacity and staffing decisions.
- **Profitability**: Station-level comparison of revenue vs. operating cost to pinpoint under/over-performers.
- **Queue & Capacity**: Distributional view of wait-queue lengths and idle port counts to optimize queuing policies.

2.3 Visualization Choices

To effectively communicate these metrics, we selected:

- **Geo-Scatter / Density Map**: Dual modes (scatter and heat) for spatial demand and wait-time intensity.
- **Interactive Line Chart**: Daily wait-time trends with slider, rolling average, and anomaly annotations.

- **Horizontal Bar Chart**: Clear ranking for busiest stations.
- **Grouped Bar Chart**: Side-by-side revenue vs. cost to highlight profitability gaps.
- **Boxplots**: Queue length and idle port distributions to reveal outliers and median performance.

By structuring the dashboard into these five focused tabs and using clear, intuitive visual forms, decision-makers can rapidly diagnose network issues, compare financial performance, and refine operational strategies.

3 Dashboard Development

The dashboard was implemented in Python using Streamlit. Data is read from Parquet files into pandas DataFrames and cached to minimize reloads. Visualizations leverage Plotly Express and Graph Objects for interactivity. The five key analytical views are organized into Streamlit tabs.

3.1 Interactive Features

- **Date Range Picker:** Filters all charts by session start date.
- **Multiselect Filters:** Charger type and region controls update each tab dynamically.
- **Range Slider:** The Wait Times chart includes a built-in Plotly range slider for zooming into specific periods.
- **Download Buttons:** Each tab offers a CSV export of the underlying data for offline analysis.

3.2 Visual Storytelling

Every tab begins with clear headings and, where appropriate, metric *cards* summarizing high-level KPIs. Explanatory captions and colored thresholds guide the user's attention.

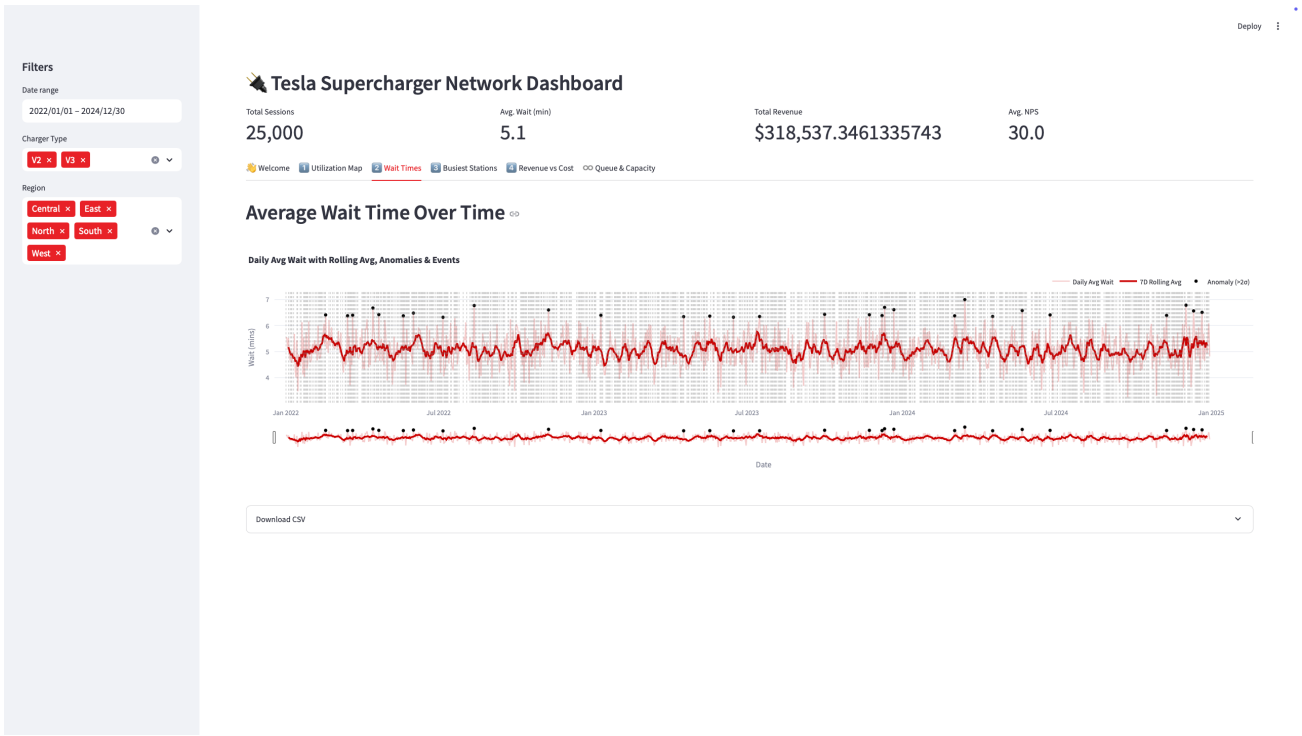

Figure 1: Wait Times Tab with 7-Day Rolling Average, Anomaly Flags, and Event Markers

4 Enhancements and Justification

4.1 Revenue vs. Cost Analysis

A grouped bar chart compares each station's total revenue against its operating cost.

- **Why this matters:** Quickly identifies which Superchargers are profitable versus those that are running at a loss.
- **Practical impact:**
  - Enables finance teams to reallocate maintenance budgets toward high-ROI stations.
  - Helps operations managers decide where to scale charger capacity or adjust pricing.
  - Accelerates break-even and margin improvements by highlighting cost-intensive outliers.

4.2 Queue & Capacity Visualization

Dual boxplots show, per station, the distribution of queue lengths and idle port availability.

- **Why this matters:** Reveals both congestion risks (long queues) and underutilization (excess idle ports) in a single view.
- **Practical impact:**
  - Operations teams can pinpoint stations needing dynamic staffing or charger rebalancing.
  - Service planners gain insight into peak-period bottlenecks, enabling preemptive scheduling of mobile chargers or temporary expansions.
  - Supports SLA monitoring by flagging stations consistently above queue-length thresholds or under target utilization.

5 Conclusion

The Tesla Supercharger Network Dashboard delivers a comprehensive, interactive platform that transforms raw charging data into actionable intelligence. By integrating geospatial utilization maps, time-series wait-time analysis, profitability comparisons, and queue-capacity diagnostics—all under a unified, filterable interface—stakeholders can:

- **Quickly identify operational hotspots and bottlenecks,** enabling targeted resource allocation to high-demand stations.
- **Evaluate station profitability** at a glance, guiding financial planning around maintenance budgets, price adjustments, and ROI maximization.
- **Detect capacity imbalances** through queue and idle-port distributions, informing dynamic staffing, charger rebalancing, and temporary expansions to meet peak demand.

The strategic enhancements—Revenue vs. Cost analysis and Queue & Capacity visualization—elevate the dashboard from descriptive reporting to prescriptive decision-support, bridging the gap between data insight and business action. Moving forward, this tool can be extended with live telemetry and automated alerting to create a real-time operations center for Tesla's Supercharger network.