Project Documentation

# Visualization Tool for Electric Vehicle Charge and Range Analysis

## 1. Project Title

Visualization Tool for Electric Vehicle Charge and Range Analysis

## 2. Introduction

Electric Vehicles (EVs) are gaining popularity due to their environmental benefits and advancement in battery technologies. However, understanding their charging behavior and range limitations is critical for enhancing user experience, reducing range anxiety, and optimizing battery performance. This project aims to develop a visualization tool that provides interactive insights into EV charge levels, driving range, energy consumption, and related parameters.

## 3. Objectives

- Analyze the relationship between battery state-of-charge (SoC), distance traveled, and charging time.

- Visualize EV data to identify trends and optimize charging behavior.

- Offer actionable insights through an interactive dashboard for drivers, fleet managers, and researchers.

## 4. Data Requirements

- Data Sources:

- Vehicle telemetry data (sample or real-time via API)

- CSV or JSON formats

- Data Attributes:

- Timestamp

- Battery percentage (%)

- Distance traveled (km)

- Speed (km/h)

- Charging power (kW)

- Charging duration

- Optional: Temperature, GPS coordinates, cost per session

## 5. Technology Stack

- Frontend: HTML, CSS, JavaScript, React.js (or Vue.js)

- Backend (Optional): Python (Flask/Django), Node.js

- Visualization: Tableau, Power BI, Plotly.js, or D3.js

- Database (Optional): MongoDB, PostgreSQL, Firebase

- Deployment: Streamlit Cloud, GitHub Pages, or Heroku

## 6. System Design & Architecture

- Data Flow: Data Ingestion → Preprocessing → Storage → Analysis → Visualization

- Modules:

- Data Collector

- Data Processor (Cleaning, Filtering)

- Visualization Engine

- UI Dashboard

## 7. Features of the Visualization Tool

- Interactive line and bar charts:

- Battery SoC vs. Time

- Distance vs. Energy Usage

- Charging Time vs. Battery Gain

- Filtering options by:

- Trip/date/speed range

- Key Performance Indicators (KPIs):

- Average Range

- Total Distance

- Average Charging Time

- Energy Efficiency (km/kWh)

- Optional Map Visualizations:

- GPS routes with range overlays

- Charging station density heatmap

## 8. Data Analysis Techniques

- Descriptive statistics

- Correlation analysis (SoC vs Range, Speed vs Consumption)

- Time-series trend analysis

- Optional ML: Predictive modeling of range based on driving behavior

## 9. Use Cases

- Personal EV usage tracking and optimization

- Fleet monitoring for logistics companies

- City planners assessing EV infrastructure needs

- Research and development in automotive industries

## 10. Project Development Phases

1. Requirement Analysis

2. Data Collection & Cleaning

3. Visualization Design

4. Dashboard Development

5. Testing and Validation

6. Deployment and User Feedback

## 11. Timeline

- Week 1: Requirement Gathering and Data Collection

- Week 2: Data Preprocessing and Analysis

- Week 3: Visualization Development

- Week 4: Dashboard Integration

- Week 5: Testing and Documentation

- Week 6: Final Deployment

## 12. Future Enhancements

- Real-time EV data monitoring using IoT

- Predictive analytics with machine learning

- Mobile app interface

- Integration with EV navigation systems and APIs

## 13. Conclusion

The visualization tool enables a deeper understanding of electric vehicle usage patterns, aiding in better energy management, strategic planning, and enhanced user experiences. This solution supports the transition toward smarter and more sustainable transportation systems.

## 14. References

- EV datasets from Kaggle, OpenStreetMap APIs

- Plotly, D3.js Documentation

- Battery University

- Research papers on EV analytics and mobility systems