A REPORT ON

"Electric Vehicle Sales by State in India"

(Submitted for Data Analytics Internship)

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Internship Program:

Data Analytics Internship

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1. Introduction

The Electric Vehicle (EV) industry in India is undergoing a massive transformation driven by government incentives, environmental concerns, and technological advancements. This project explores the historical sales data of electric vehicles across various Indian states to understand the adoption landscape. By analyzing past trends, we can better understand the current market momentum and project future growth, which is essential for stakeholders in manufacturing and infrastructure planning.

2. Objective of the Project

The primary goals of this study are:

- **Trend Analysis:** To identify growth patterns in EV adoption across different Indian states and union territories.

- **Predictive Modeling:** To apply **Polynomial Regression** to forecast EV sales over the next two years.

- **Strategic Insights:** To provide data-driven recommendations for the expansion of charging infrastructure and manufacturing capacity based on projected demand.

3. Dataset Description

The project utilizes the dataset **"Electric Vehicle Sales by State in India (1).csv"**.

- **Total Records:** 96,845 entries.

- **Key Attributes: * Temporal:** Year, Month_Name, and specific Date of sales.

- **Geographic:** State/Union Territory where the sales occurred.

- **Vehicle Classification:** Vehicle Class (e.g., Motor Car, Bus), Category (e.g., 2-Wheelers, 4-Wheelers), and Type (e.g., 2W_Personal, 3W_Goods).

- **Target Variable:** EV_Sales_Quantity (the number of units sold).

4. Tools and Technologies Used

The analysis was performed using the **Python** ecosystem:

- **Data Manipulation:** Pandas and NumPy.

- **Visualization:** Matplotlib and Seaborn.

- **Machine Learning:** Scikit-learn (specifically PolynomialFeatures and LinearRegression).

5. Methodology

1. **Data Loading & Cleaning:** Imported the dataset and removed redundant columns like 'Year' and 'Month_Name' as they were extracted later from the datetime objects.

2. **Pre-processing:** Handled data types by converting 'Date' to datetime objects and 'EV_Sales_Quantity' to integers. Verified that there were no missing values or duplicates.

3. **Feature Engineering:** Extracted granular time features (Month, Day, Year) from the raw date column to enable seasonal analysis.

4. **Exploratory Data Analysis (EDA):** Created pivot tables and visualizations to compare sales across years, months, and vehicle categories.

5. **Modeling:** Applied Polynomial Regression to capture the non-linear, accelerating growth trend of the EV market.
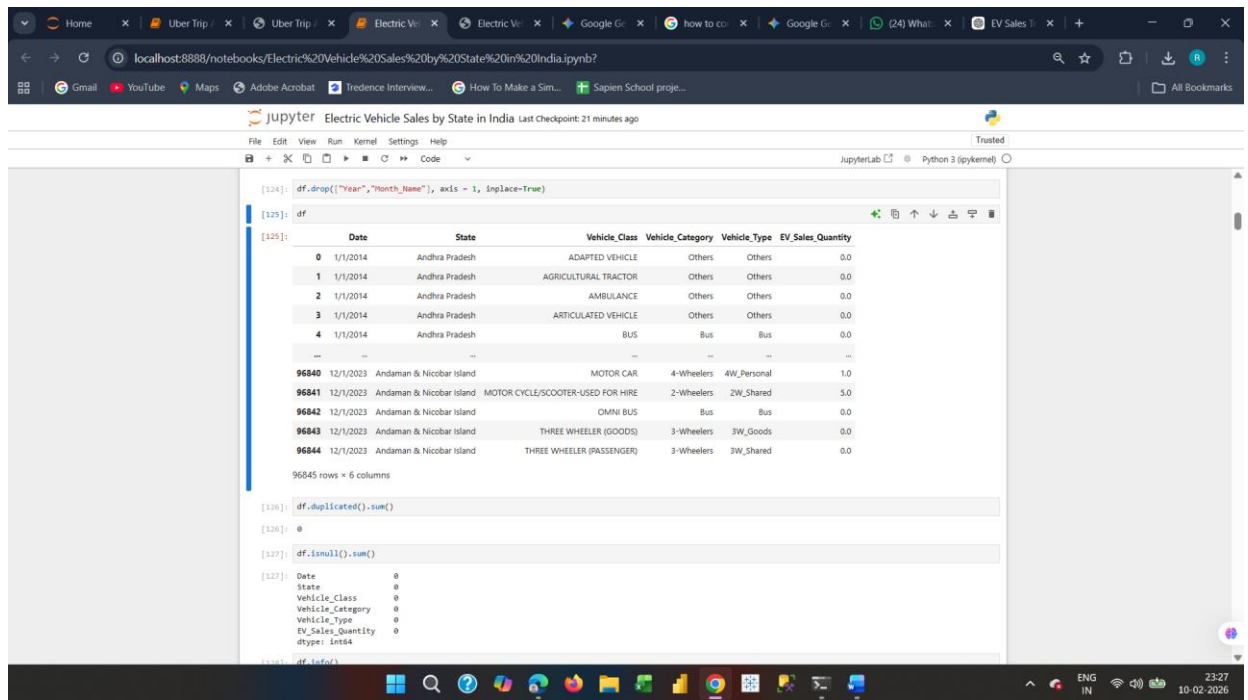
Figure 1: Data Importing and Quality Verification. This shows the successful loading of the EV dataset and the initial validation steps used to confirm that there are zero missing or duplicate values across the 96,845 records

6. Data Analysis and Visualization

- **Yearly/Monthly Pivot Tables:** Summarized sales to show how demand fluctuates seasonally and grows year-over-year.

- **Bar Charts:** Visualized the strong upward trajectory of sales, particularly the sharp increase observed after 2020.

- **Heatmaps:** Used Seaborn heatmaps to show the relationship between Vehicle Class and Vehicle Category, highlighting which segments (like 2-wheelers and 4-wheelers) dominate the market.
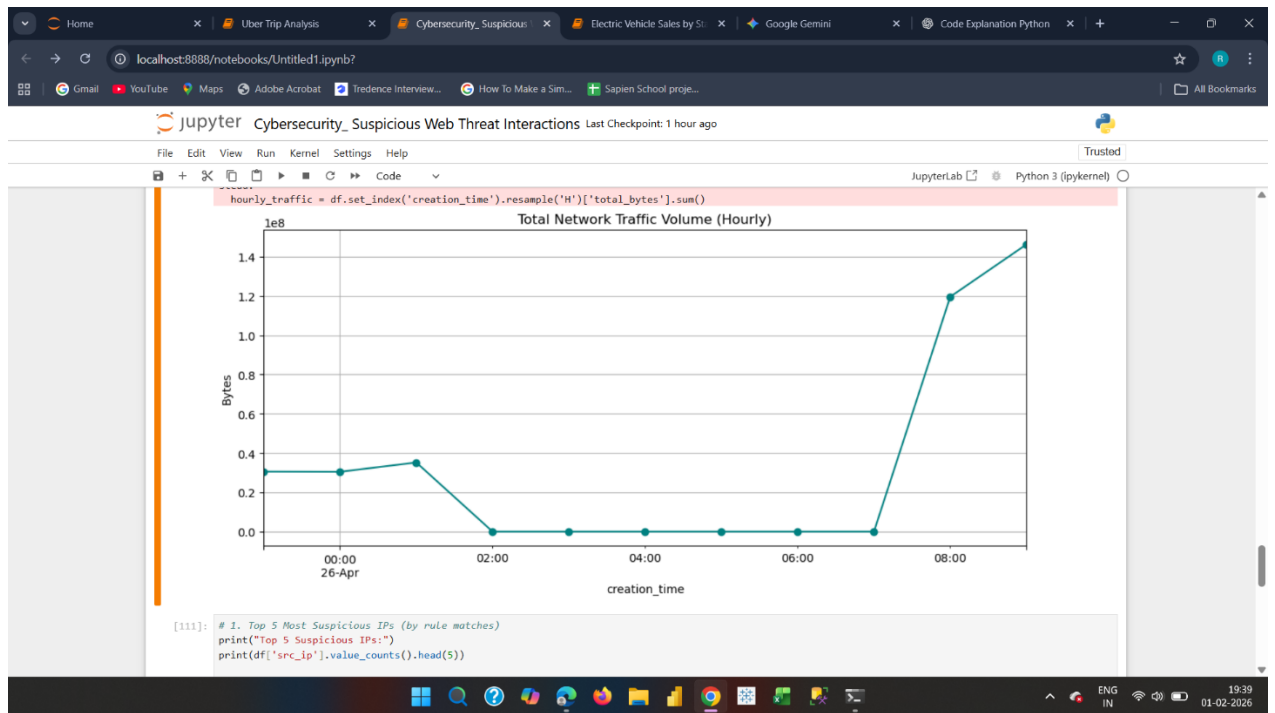
Figure 2: Network Traffic Anomaly and Source Analysis. This visualization illustrates a sharp escalation in hourly network volume peaking above 140MB after 07:00, paired with forensic code designed to isolate the top five source IP addresses responsible for the suspicious activity.
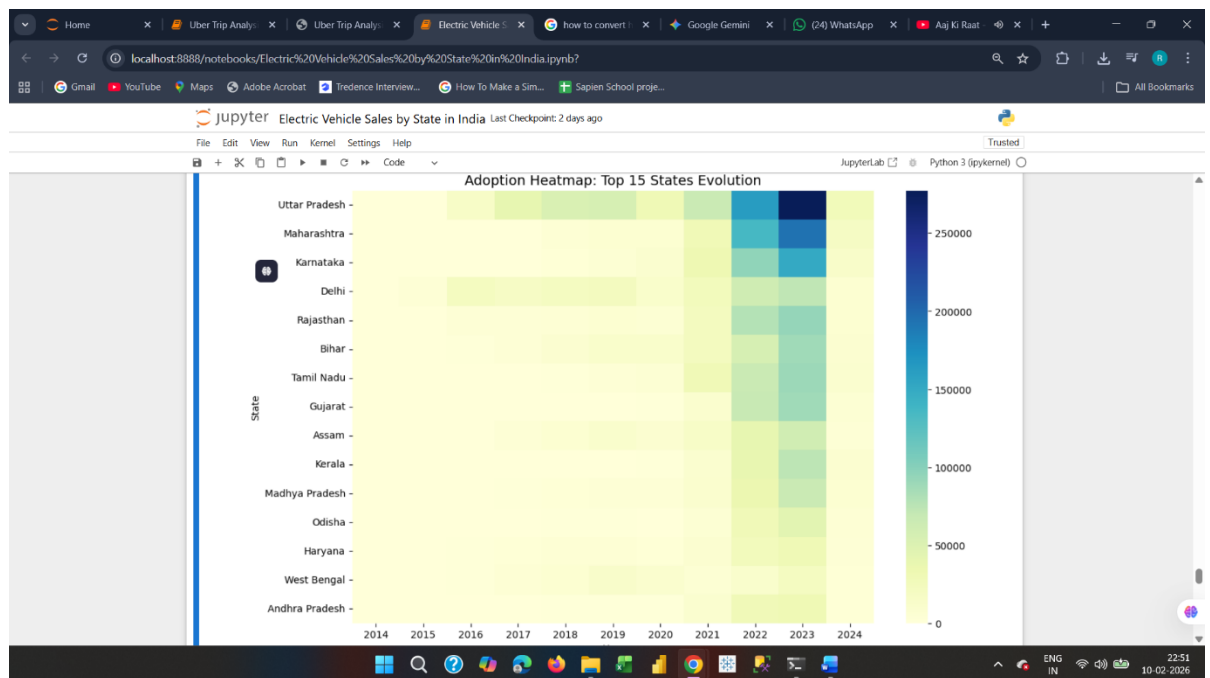
Figure 2: EV Adoption Heatmap by State. This heatmap displays the temporal evolution of electric vehicle sales across India's top 15 states from 2014 to 2024, highlighting a significant surge in adoption starting in 2022, with Uttar Pradesh and Maharashtra emerging as the leading markets with the highest density of sales.

7. Results and Insights

- **Exponential Growth:** EV sales have shown a significant surge post-2020, moving from steady growth to an "exponential acceleration phase".

- **Category Dominance:** Standard categories such as 2-Wheelers and 4-Wheelers are the primary drivers of transport electrification, while specialized vehicles like ambulances still occupy a smaller "Others" niche.

- **Seasonality:** Sales are generally higher toward the end of each calendar year.

- **Future Outlook:** The Polynomial Regression model indicates a massive adoption surge, suggesting a projected sale of approximately 143,182 units in early 2024 alone.

8. Conclusion

The project successfully demonstrates that the Indian EV market is on a steep upward curve. The transition from personal 2-wheelers to broader categories is evident in the data. To sustain this momentum, there is a critical need for rapid expansion in **charging infrastructure** and **manufacturing capacity** to meet the forecasted demand over the next two years. This analysis provides a foundation for making informed policy and business decisions in the green energy sector.