1. Conclusion

In my notebook analysis , Indian states are split into four distinct clusters based on EV sales and charging infrastructure:

- **Cluster 1 (Leaders):** Mature markets with very high sales (320–400 k) and dense charging infrastructure (170–320 chargers). States: Maharashtra, Karnataka.
- **Cluster 3 (Developers):** Strong growth regions with mid-range sales (80–200 k) and high charger counts (160–260). States: Andhra Pradesh, Gujarat, Madhya Pradesh, Rajasthan, Tamil Nadu, Uttar Pradesh.
- **Cluster 0 (Growth Hubs):** Moderate adoption areas with sales of 30–100 k but fewer chargers (50–140). States: Delhi, Haryana, West Bengal, Telangana.
- **Cluster 2 (Emerging):** Early-stage markets with low sales (< 20 k) and sparse infrastructure (< 40 chargers). States: Assam, Bihar, Chandigarh, Chhattisgarh, Himachal Pradesh, Kerala, Meghalaya, Odisha, Uttarakhand.

The key recommendations or actions that we could take on the states

- **Priority Charger Expansion:** Focus on ramping up charging stations in Clusters 0 and Cluster 2 to unlock sales growth.
- **Infrastructure Optimization:** In Clusters 1 and Cluster 3, maintain and upgrade existing networks to support sustained market momentum.

2. Process Overview

The overall process that i have followed to achieve market segmentation on geography variable

Data Collection & Preparation:

- Sourced publicly available EV sales and charger datasets, and supplemented with additional data scraped from reliable internet sources.
- Cleaned each dataset by standardizing state names, handling missing values, and ensuring consistency in date and metric formats.
- Merged sales and infrastructure datasets to create a unified dataset for accurate geographic segmentation.

Tools & Frameworks:

- **Language & Environment:** Python 3.10 in Jupyter Notebook.
- **Libraries:** pandas, NumPy for data manipulation; matplotlib, seaborn for visualization; scikit-learn for modeling.

Modeling:

- Employed **K-Means clustering** to segment states into distinct market groups based on EV sales metrics and charging infrastructure density.
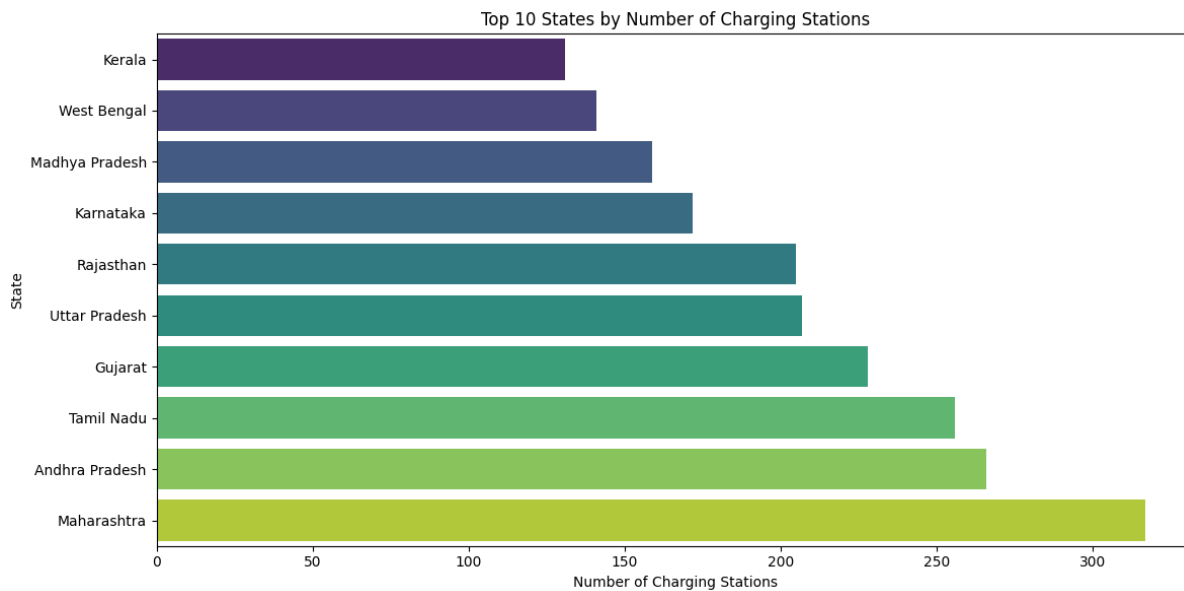
3. Graphs & Visualizations

FIG. 1 – TOP 10 STATES BY TOTAL EV SALES
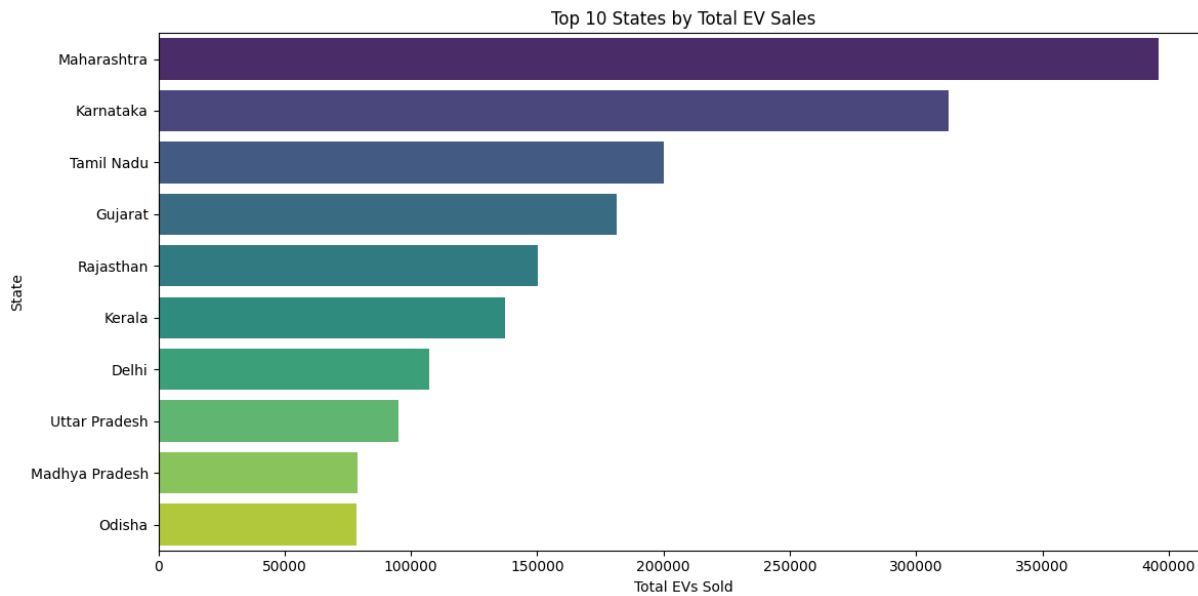
Highlights leading states in overall EV adoption. Maharashtra and Karnatak stand out as top performers.

## FIG. 2 – TOP 10 STATES HAVING CHARGING STATIONS

Highlights leading states in overall EV charger adoption. Maharashtra and Andhra Pradesh stand out as top performers.

FIG. 3 – ELBOW METHOD TO IDENTIFY OPTIMAL CLUSTERS

Elbow Method: inertia vs. number of clusters
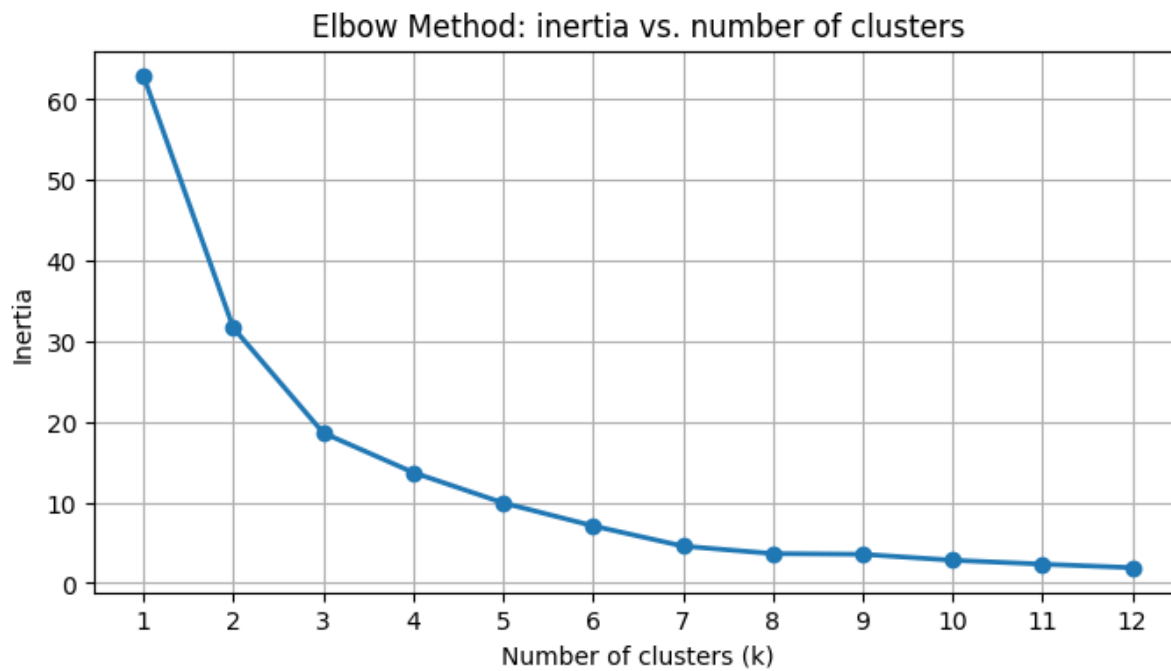
Shows that 4 is the ideal number of clusters for this dataset.

FIG. 4 – CLUSTER SCATTERPLOT ON MERGED DATASET (SALES,CHARGERS,AND CHARGING STATIONS)

EV Market Clusters (Sales vs. Chargers; size ∝ Charging Stations)
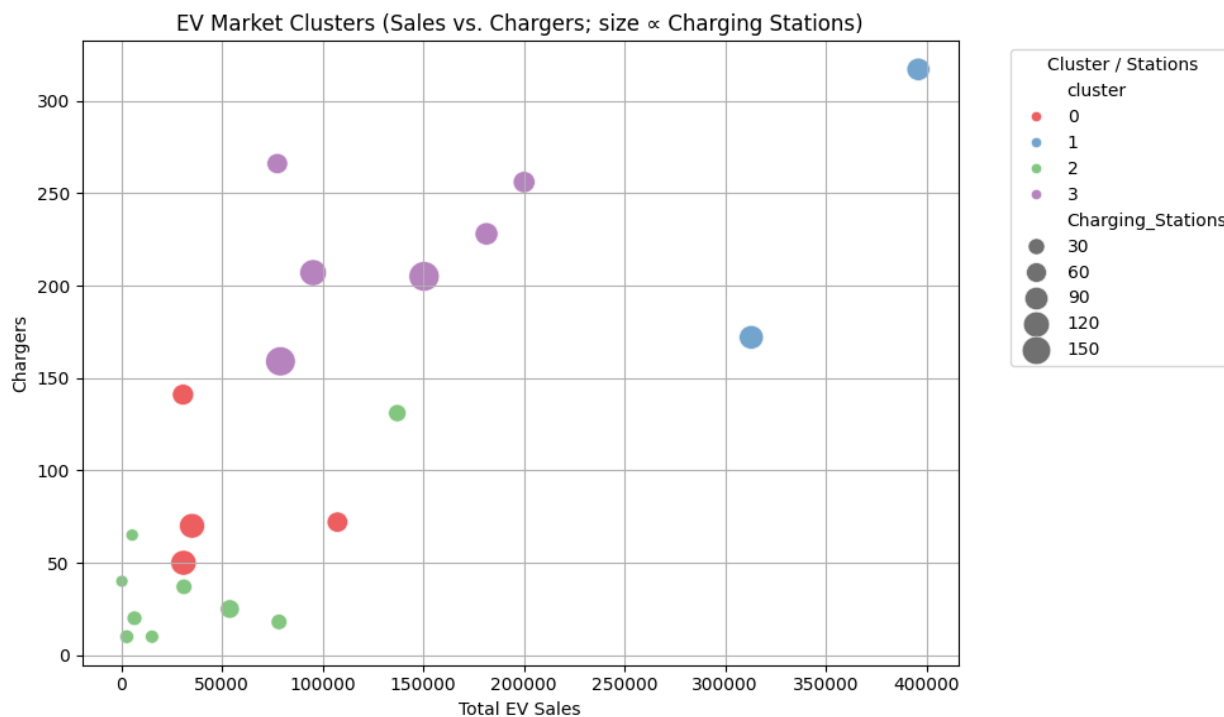
This chart shows states clustered by EV sales (x-axis) and charger counts (y-axis), with bubble size indicating station numbers—blue states lead in both, green states trail, and red/purple fall in the middle.

4. BUSINESS SOLUTION & RECOMMENDATIONS

Based on my geographic segmentation of EV sales and charging infrastructure, here are concise actions for market expansion:

1. **Focus States:**
   - **Initial Launch:** Cluster 2 (Tamil Nadu, Gujarat) for strong demand and manageable charger build-out.
   - **Scale Up:** Cluster 1 (Maharashtra, Karnataka) to tap into mature, infrastructure-rich markets.
2. **Charger Partnerships:**
   - Deploy fast chargers in Cluster 0 (Delhi, Haryana, West Bengal, Telangana) with state utilities.
   - Pilot compact charging stations in Cluster 2 and 3 on key corridors and urban hubs.
3. **Marketing & Outreach:**
   - Run digital awareness campaigns in Clusters 2 & 3, emphasizing cost savings and green benefits.
   - Partner with ride-hail and delivery fleets in Cluster 2 for bulk orders and brand visibility.
4. **Rollout Phases:**
   - **Phase 1 (0–6 months):** 50–100 chargers + pilot EVs in one Cluster 2 state.
   - **Phase 2 (6–12 months):** Expand EV portfolio and 200+ chargers in Cluster 1 metros.
   - **Phase 3 (12+ months):** Incentivize charger installs in Cluster 0 and awareness drives in Cluster 3.

These targeted steps will optimize resource use, accelerate adoption, and ensure high ROI across India's diverse EV landscape