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**Project 2**

**Problem Statement 1: EV Market in India using Segmentation Analysis**

**EV MARKET IN INDIA**

1. **All about Electric Vehicles in India**

The electric vehicle (EV) scene in India is buzzing with activity! Thanks to government support and growing environmental consciousness, EVs are gaining traction. Big players like Tata Motors and Mahindra & Mahindra are revving up their EV game, rolling out new models and investing in charging infrastructure.

But it's not all smooth sailing. High upfront costs still keep some buyers at bay, and finding charging stations can be a bit like finding a needle in a haystack. However, the government's FAME scheme (Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles) is zapping away some of these issues. It offers incentives and subsidies to both buyers and manufacturers, giving the EV market a much-needed boost.

With technology evolving and policies supporting the shift, India's EV market is charged up for a bright future. So, get ready to see more electric vehicles zooming around the streets, making India a key player in the global EV revolution! The market is expected to expand further with technological advancements and policy support, making India a key player in the global EV landscape.

**A.1 Data Collection**

1. [City-wise EV charging Stations](https://visualize.data.gov.in/?inst=c8158641-7283-4abb-865c-b04fb0b43933&vid=108437)
2. [state-wise current sales of ev vehicles in different segments](https://data.gov.in/resource/stateuts-wise-current-sales-electric-vehicles-ev-country-various-segments-reply-unstarred)
3. [ev-vehicles as per category-wise distribution sold in India](https://data.gov.in/resource/category-wise-details-sold-electric-vehicles-manufactures-consumers-02-08-2023)
4. [ev-charging stattions availability dataset](https://data.gov.in/resource/cityhighway-wise-electric-vehicle-ev-charging-stations-out-which-479-charging-stations)
5. **Which ML model helped me the most in this project**

The main purpose of using decision tree algorithm is its simplicity. Decision trees are easy to understand and interpret. They can even handle both numerical as well as categorical data. On top of that decision trees inherently performs feature selection and thus manual selection of certain features gets ruled out. This makes the code easier to read and faster to comprehend. Decision trees partition the feature space based on the most informative features. By examining the structure of the tree, one can identify which features play a significant role in determining the price of electric vehicles. This insight helps in understanding the factors that influence market segmentation. Decision trees partition the dataset into homogeneous segments based on similar characteristics. Each branch of the tree represents a different segment of the market. By analyzing these segments, one can gain insights into the diverse preferences and characteristics of consumers in different market segments.

By evaluating the performance of the decision tree model using one of the evaluation metrics like accuracy, one can assess how well the model captures the underlying patterns in the data. This evaluation provides confidence in the model's ability to generalize to unseen data and support decision-making processes. This further helps in segmenting the markets effectively aligning suitable customers under these segments.

1. **Final conclusion & insights gained from the research/analysis work.**

The analysis of various datasets revealed insights into market segmentation based on factors such as vehicle type (e.g., two-wheelers, three-wheelers, four-wheelers), geographical distribution, charging station availability, brand-wise distribution, and vehicle specifications (e.g., range, acceleration, top speed). This segmentation helps in understanding the diverse segmentation features that are very essential to be taken care of when it comes to formulation of various strategies for different market segments. Features such as range, acceleration, top speed, efficiency, and charging capabilities were found to influence consumers' purchase decisions. Understanding these factors can aid manufacturers in designing and marketing EVs that align with consumer preferences and requirements. Thus, the influential factors leading to purchasing decisions have been understood thoroughly. The correlation between selling price and various features, as well as the price trend analysis over time for specific models, shed light on pricing strategies and consumer willingness to pay for EVs with different specifications. This confirms that price analysis has also contributed ta major role in understanding the consumer preferences in real-life scenarios.

Overall, these above-mentioned insights can inform policymakers, manufacturers, investors, as well as consumers in making informed decisions related to EV adoption, infrastructure development, investment strategies, etc.

1. **Improvement upon the Market Segmentation Project given additional time & some budget to purchase data.**

I think the first and the foremost improvement that could have been done was to gather more specific datasets such as the datasets related to Surveys and feedback data from EV owners and potential buyers regarding their preferences, attitudes, and behaviors related to EVs. This can include reasons for choosing or not choosing EVs, satisfaction levels, perceived barriers, and future purchase intentions. Datasets that document government policies, regulations, and incentives related to EV adoption in India. This includes data on subsidies, tax benefits, and incentives provided to EV manufacturers, buyers, and charging infrastructure developers. Datasets based on the positive and negative environmental impact of EV adoption, such as reductions in greenhouse gas emissions, air pollution levels, and energy consumption patterns. The next improvement that must have been considered given additional time is understanding the implementation usages of every machine learning model as well as getting to know their limitations and the finally figuring out the most suitable building model that helps in making a more robust and accurate EV market segmentation in India. For example, in this case due to time restrictions as well as due to limited budget, I made use of decision tree algorithm, which handles missing values and so on, but it is also prone to have a bias towards features with many categories as they can create more decision nodes. This bias can result in uneven importance attribution to features, they also tend to sacrifice predictive performance for maintaining simplicity and transparency of code, etc.

1. **Estimated Market Size for the EV Market Domain**

In order to estimate the market size, we need to take consider data collection regarding the total number of electric vehicles manufactured and purchased in India across different geographical locations. After that, it is also essential to determine the current EV adoption rate in India by analyzing sales data, registration statistics over the past few years. The next thing that should be taken into consideration is segmenting EV market based on vehicle types that includes battery electric vehicles, plug-in hybrid electric vehicles, and hybrid electric vehicles. It is also very essential to consider the impact of regulatory policies and initiatives on EV market in India, encompassing emission norms, fuel efficiency standards, subsidies, tax incentives and any other government-based programs that focusses on restriction of carbon dioxide emissions and so on. It is also important to identify the constraints faced by EV market in India such as infrastructure limitations, unable to satisfy the customer needs and preferences, battery technology limitations, supply chain constraints, etc. The last but not the least step that builds the crux when it comes in determining the market size is validation. Validating the market size by comparing it with data from multiple sources such as by taking surveys, interviews with industry experts and then finally discussing and coming up with appropriate methodologies for achieving a level of consistency in the Indian EV market size for EV market domain.

1. **Top 4 Variables/features which can be used to create most optimal Market Segments for my EV market domain**

In order to create optimal market segments for this EV market domain in India, it involves identification of price, trends ongoing, consumer behavior and preferences measuring the demographic and behavioral factors. However, the 4 most optimal features are as follows:

1. **Brand/ Manufacturer Reputation:** This can be the most influential factor contributing to purchasing decisions for most of the consumers who values brand reputation and manufacturer reliability. Segmenting the market based on brand preferences and trust levels can help identify brand-conscious consumers and target them with relevant branding and messaging strategies.
2. **Level of Environmental Impact:** Environmental consciousness and sustainability concerns are increasingly influencing consumer behaviour. Segmenting the market based on eco-friendly preferences, such as carbon footprint reduction, recyclability of materials, and eco-certifications, can help target environmentally conscious consumers who prioritize sustainability in their purchasing decisions.
3. **User Experience and Convenience with continuous efforts:** Factors related to user experience and convenience, such as vehicle design, interior comfort, and after-sales services, can influence consumer satisfaction. Segmenting the market based on user experience preferences can help target consumers who prioritize seamless comfort, convenience and ownership experiences.
4. **Community and Social Factors:** Social and community influences can also impact EV purchasing decisions. Segmenting the market based on community engagement, recommendations as well as following up the current social trends related to EV adoption can help target the required groups and communities who play a significant role in shaping consumer behaviors.