**Electric Vehicle Performance Across Manufacturers**

# Group - 14:

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**Abstract:**

This study seeks to explore in detail a fascinating aspect about EVs – their efficiency. By examining these variables, speed, range, charging capability, and overall performance, we hope to shed light on how different electric vehicles perform under real-life conditions. The more we learn from this data, the more we can improve the way of operation in a car such that it benefits everyone. In short, every new thing that we discover can always raise the bar and further improve making electric cars exciting and green.

# Introduction:

## Motivation:

The analysis of electric vehicle data is necessary to explore several aspects of transportation in the future, including battery capacity, speed, range, and other factors. Every breakthrough made in this area offers the potential to change how cars are powered and operated, improving both the user experience along with energy economy. It is necessary in Knowing the future of transportation requires analyzing data related to electric vehicles. The results of this analysis may include Range, Speed, Battery capacity, etc. Every new discovery we make has the potential to alter how we operate and power cars, changing everything from user experience to energy efficiency.

Knowing how different manufacturers' electric vehicles perform is essential to determining how the automobile industry will develop in the future. The goal of this analysis is to shed light on the various facets of electric vehicles, which will help with manufacturing decision-making, user experience, & environmental effect assessment.

# Task Definition

## Technical Aspects of the Problem:

1. **Data Preprocessing:** When compiling specifications for electric vehicles from many sources, there may be missing data. It is possible to use techniques like imputation or to take mean values into account for missing entries. Eliminating extreme values such as abnormally high or low battery range or charge time that may affect the analysis.
2. **Model Selection and Training**: using past data from several manufacturers to train the models and find trends that influence the performance of electric vehicles. Models are trained and patterns affecting electric car performance are found by utilizing historical data from various manufacturers.
3. **Model Evaluation:** To determine how effectively the models predict performance across different manufacturers, key measures like Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), or R-squared values are used to evaluate model performance. AUC might not be immediately relevant in this case unless binary classification tasks are part of the investigation.
4. **Validation Set Usage:** modifying regularization strengths or learning rates in the model to improve performance without overfitting. utilizing techniques such as k-fold cross-validation to guarantee the model's resilience in a variety of datasets and manufacturers.
5. **Test Set Evaluation:** To assess the generalizability of the model, a second test dataset containing electric vehicle data from manufacturers not included in the training and validation sets is used.

**2.Problem Statement:**

The goal of this research is to conduct an in-depth examination of variables like as efficiency, range, charging capabilities, and general functioning in order to objectively investigate and evaluate the performance of electric vehicles across different auto manufacturers. It aims to reveal patterns and connections through difficult data collecting, preprocessing, and complex analytical approaches, facilitating comparisons between various models and manufacturers. The project aims to provide useful insights into the advantages and disadvantages of electric vehicles by utilising machine learning and statistical techniques. This will help customers, policymakers, and the industry make educated decisions that will promote sustainable transportation options.

## Input/Output Examples:

Predicting whether a website viewing session will result in a purchase or not is the goal of the project. Following are some specific instances of input and output pairs:

**Example 1:Input:** Total Duration: 300 seconds, Product Page Duration: 100 seconds, Admin Page Duration: 60 seconds, Info Page Duration: 140 seconds, Number of Pages Visited: 10, Month: September, Is Weekend: False, Device Type: Desktop, Browser Type: Safari **Output:**Prediction: Purchase (1)

## Real-World Scenario:

Consider a study where a group investigates the performance of various brands of electric vehicles. A lot of information is gathered about these vehicles, including how quickly, how far, and how efficiently they charge. Next, they employ sophisticated computer algorithms to identify trends and distinctions among these vehicles. This aids consumers in determining which cars are better at particular tasks and helps automakers in improving their products. In summary, this study promotes the development of better cars in the future and assists consumers in selecting which electric vehicles are a good fit.

# 3. Approach

**Baseline Solution:**

Establishing a basic study of important indicators to comprehend how these vehicles operate in the market is necessary to establish a baseline for comparing the performance of electric vehicles across different manufacturers. The first round of data collecting concentrates on important factors including user satisfaction, charging capacity, range, and efficiency for various electric car models from various manufacturers. The goal of this thorough evaluation is to create a general understanding of these cars' performance by highlighting noteworthy features or common patterns among the manufacturers. For instance, it may show that some manufacturers value greater ranges more than others, and that some manufacturers excel at charging products more quickly.

An evaluation of the most important performance measures must be done to establish a baseline solution for comparing the performance of electric vehicles from different manufacturers. A fundamental understanding of the performance landscape of electric vehicle models supplied by various manufacturers is developed through the analysis of characteristics like range, energy efficiency, charging capabilities, and user happiness. This baseline serves as a point of comparison to find trends and differences between manufacturers. It may show, for example, that some manufacturers are better at offering greater ranges, while others place more emphasis on quicker charging times or increased efficiency.

In the end, this baseline study offers an essential foundation for ongoing development and innovation in the electric car sector. As the industry develops and adjusts to shifting demands, it helps set realistic benchmarks for improvement and propels the production of increasingly competitive, capable, and efficient electric vehicles among manufacturers.

## Proposed Methods and High-Level Overview of Proposed Approach:

Proposed Methods:  
 **1. Descriptive Statistics:**  
 Calculate the battery pack capacity using simple descriptive statistics like mean, median,  
 mode, standard deviation, and range. This will give a general summary of the dataset's battery  
 capacity' central tendency and distribution.

Descriptive statistics act as a translator in turning complex information into meaningful information. They simplify the procedure for evaluation and comparison of performances of electric vehicles for general users as well as professionals, for example, consumers and specialists in this case.  
 **2. Data Visualization:**  
 Create histograms, box graphs, or density charts to see how battery pack capacities are  
 distributed. This may assist in identifying outliers and determining the normality of the data.

It transforms raw data into understandable and capturing insights. This assists transmitting complicated information in an effective manner that enables consumers to make good decisions and furnishes manufacturers with useful knowledge concerning developing better products.  
 **3. Correlation Analysis:**  
 Look at how battery pack capacity relates to other elements like car cost, range, charging  
 time, or manufacturer. To measure these associations, use correlation coefficients.

Manufacturers and consumers are able to understand the varied landscape of electric car performance with the help of correlation analysis. It transforms into a useful tool for improving design, influencing consumer decisions, and propelling advancements in the electric vehicle sector by illuminating the relationships between many aspects.

**4. Hypothesis Testing:**  
 Run hypothesis tests to see if the capacity of the battery packs in various categories or groups differs significantly. You can check, for instance, whether the battery capacities of electric vehicles made by various manufacturers varies greatly.  
The analysis of electric vehicle performance gains depth with the application of hypothesis testing. It turns theories into verified findings, creating a more evidence-based comprehension of how various manufacturers cars relate to one another.

**5. ANOVA (Analysis of Variance):**  
 If the dataset contains numerous groups, an ANOVA analysis can assist identify whether  
 there are statistically significant differences in battery capacity between the groups. For  
 example, you can compare the battery capacities of various car types (such as sedans, SUVs,  
 and sports cars).

ANOVA is a statistical analytical approach which explores inter-manufacturer variations in electric vehicle’s performance and goes further than conventional two way comparison that gives broader understanding of the market domain.  
 **6. Principal Component Analysis (PCA):**  
 Use PCA to minimise the dataset's dimensionality while preserving the most crucial facts.  
 This can assist in determining which aspects are most responsible for the variation in battery  
 pack capacity.  
 PCA is one of the most powerful tools with which the researcher can discover useful patterns and reduce complexity in the examination of electric car performance among manufacturers. It provides a simplified approach of studying the core determinants of performance variations that can be useful not only for producers but also consumers.

**7. Outlier Detection:**

Recognise and look into outliers in the dataset, as they may have a big impact on your analysis's outcomes. Outlier detection can be assisted by methods like the Z-score or modified Z-score.

In this element the process is an outlier detector which protects the analysis so that it’s valid and representative. It provides for an exception mechanism whereby extraordinary occurrences that need more investigation are marked but in other circumstances, these are celebrated occasions.

# Evaluation

## We'll evaluate our methodology's efficacy using a range of metrics and compare it to industry norms. The chosen metrics are comprised of

## Context for Metrics:

**Descriptive Statistics:**

The primary features of the dataset are succinctly summarised using descriptive

statistics. For example, average range values, efficiency standard deviations, or median charging

durations among manufacturers can give a basic idea of the main trends and variances in the data.

**Probability Value (p-value):**

Probability values, which show the likelihood of receiving outcomes as extreme as those seen under the

presumption that the null hypothesis is true, are crucial in hypothesis testing. P-values can be used

to compare the performance of electric vehicles and determine whether observed differences in metrics

between manufacturers, like as efficiency or range, are statistically significant.

**F-Value**:

When comparing the means of two or more groups using analysis of variance (ANOVA), the F-value

is frequently utilised. In this case, an ANOVA test could determine whether different manufacturers' electric

vehicle performance parameters differ significantly from one another. For example, it could ascertain

whether there are notable differences in the mean range among models from different manufacturers.

**T-Test:**

T-tests are helpful in comparing means between two groups and are frequently used to determine whether

performance metrics between particular pairs of manufacturers differ significantly from one another. For

instance, it can assist in figuring out whether the charge durations of two different manufacturers' electric

cars differ noticeably.

**Significance of Hypothesis Test:**

To determine if relationships or differences in the data that are observed are true or just the result of

chance, significance testing is essential. These tests (such as t-tests or ANOVA) aid in determining the

significance of results pertaining to variations in electric car performance amongst manufacturers by

constructing suitable hypotheses (null and alternative).

# Data

## Dataset Description:

Dataset Link Source:

https://www.kaggle.com/datasets/divyanshugupta95/cars-dataset-with-battery-pack-capacity

The "Cars Dataset with Battery Pack Capacity" dataset is a compilation of vehicle-related data with a

particular emphasis on battery pack capacity. In essence, it gives information about the dimensions and

energy storage capability of the batteries that are utilised in these vehicles. This dataset probably contains

information from a variety of automakers and models, providing insights into the wide range of battery

capacity found in various automobiles. By comparing different cars and determining whether ones have

higher or smaller battery capacities, this dataset analysis provides important information that is essential

for evaluating the prospective performance and capabilities of electric vehicles. This dataset helps in our

comprehension of the energy capacities of various automobile batteries. We can determine which

automobiles have greater or smaller battery capacities by comparing the sizes of the batteries in different

cars using the information provided. This information is important for electric vehicles since it clarifies the

possible power, range, and overall performance of these vehicles depending on the capacity of their

battery packs.

# Experiments

**Qualitative and Quantitative Analysis:**

The quantitative experiments are intended to give a thorough explanation of particular electric vehicle-related topics. This is a methodical analysis of factors such the vehicle's energy usage, charging speed, range, competitive positioning in relation to competing vehicles, and user happiness. To completely evaluate and quantify these elements, quantitative analysis relies on obtaining numerical data and performing statistical analysis. An accurate assessment of an electric vehicle's performance metrics can be achieved, for instance, by computing the energy consumption in watt-hours per mile/kilometer, charging speed in kilowatts, or range in miles/kilometers. The objective of this quantitative method is to provide quantifiable and comparable insights on the performance and capacities of electric vehicles.

**Vehicle Range:** This measurement shows how far an electric car can go between charges. This helps users comprehend the usefulness and practical constraints of an electric car before needing to be recharged by quantifying it in miles or kilometres.

**Charging Speed:** It's critical to measure the rate at which an electric car charges, typically expressed in kilowatts (kW). Faster battery replenishment results from faster charging, which is convenient for consumers and may make electric cars more appealing.

**Energy Consumption:** This part involves figuring out how much energy the car needs to go a specific distance. Usually expressed as watt-hours per mile or km, it provides information about the efficiency of the car. Longer ranges for the same battery capacity are the result of improved efficiency, which is indicated by lower energy consumption.

On the other hand, understanding people's attitudes, beliefs, and sentiments around electric cars is the goal of qualitative analysis. This approach entails learning about people's attitudes and experiences with electric cars as well as the difficulties they encounter in utilising this technology. Qualitative analysis places more emphasis on obtaining non-numerical insights through methods like surveys, observational studies, and interviews than quantitative investigations, which concentrate on numerical data. This method aids in understanding the varying subjective perceptions, attitudes, and driving habits related to electric car use. This qualitative analysis, which explores user viewpoints and experiences, adds value to quantitative data by offering a comprehensive grasp of user attitudes and pointing out any obstacles or worries that users may have while embracing electric vehicles.

**Sentiments and views:** The goal of qualitative analysis is to identify the sentiments, feelings, and views people have about driving electric cars. It aims to understand customers' feelings about the experience—such as their excitement, worries, or happiness with electric vehicles—through techniques including focus groups and interviews.

**Attitudes and Opinions**: One of the most important things to know is what people's attitudes and opinions are towards electric cars. Researchers can investigate consumers' opinions, preferences, and views about things like convenience, technology itself, and the impact on the environment through the use of qualitative approaches.

**Obstacles and Difficulties:** Recognizing the obstacles that electric car consumers must overcome is essential. Qualitative study offers insights into potential adoption barriers by revealing roadblocks like range anxiety, restrictions on the infrastructure for charging, or opinions regarding the cost and dependability of vehicles.

# 7. Plan and Team Roles

**Descriptive Statistics:**

* **Description:** Battery pack capacity was determined using a variety of statistical techniques.
* **Responsibility:** VARSHITHA CHAPPIDI
* **Contributions:** 20%

**Correlation Analysis:**

* **Description:** Determined the relationship between battery pack capacity and other factors.
* **Responsibility:** SAI ALEKHYA MUNDRU
* **Contributions:** 20%

**Data Visualization:**

* **Description:** To visualize the distribution of battery pack capacity, box plots and histograms were created.
* **Responsibility:** KISHAN DURGA ALAKUNTA
* **Contributions:** 20%

**Hypothesis Testing:**

* **Description:** Analyzed battery pack capabilities across a range of categories by doing hypothesis testing.
* **Responsibility:** SUJITHA PEEKA
* **Contributions:** 20%

**ANOVA (Analysis of Variance):**

* **Description:** Found statistically significant variations in battery capacity among groups using ANOVA analysis.
* **Responsibility:** MANOJA POPURI
* **Contributions:** 20%

**Timeline:**

Oct 14th, we will be working on the project proposal and documentation.

Oct. 21, we will clean and perform initial analysis on the data.

Oct 28, we will be working on descriptive analysis.

Nov. 4, Finding patterns and connecting results

Nov. 11, Data Visualization will be our focus.

On Nov 18th, we'll work on testing hypotheses.

On Nov 25th, statistical analysis will be performed.

Dec. 02, we will wrap up and concentrate on Final paperwork throughout the final week.

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