PREDICTIVE ANALYSIS ON CONSUMER EXPECTATION WITH RESPECT TO ELECTRIC VEHICLES

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ABSTRACT
Electric vehicles (EVs) are a promising transportation technology for achieving a sustainable environmental welfare in the future, due to their very low to zero carbon emissions, low noise, high efficiency, and flexibility in grid operation and integration. Machine learning (ML) has proved to be vital in predicting the future of electric vehicles. The machine learning model proposed is used to predict the expectation of consumers based on mileage and price of an EV. In the case of a PHEV, the vehicle is also equipped with a socket that allows the recharge of the battery from an external source. This allows an increase in the driving range of the vehicle and a decrease in the cost of charge since the electric energy produced by the main network is cheaper than the electric energy produced on board. It runs on electricity until its battery pack is depleted, ranging from 15 kilometers to over 65 [20]. However, depending on the type of connection, it is possible to recognize three different arrangements: Series PHEV, Parallel PHEV, and Series-Parallel PHEV

Keywords - Electric vehicle (EV), machine learning (ML), internal combustion engine (ICE), PHEV

1. INTRODUCTION
The term machine learning (ML) encompasses the collection of tools and techniques for identifying patterns in data**.** EVs can be considered as a type of energy storage and utilization system. During the last few decades, environmental impacts of the petroleum-based transportation infrastructure, along with the peak oil, has led to renewed interest in an electric transportation infrastructure. Electric vehicles differ from fossil fuel-powered vehicles in that the electricity they consume can be generated from a wide range of sources, including fossil fuel, nuclear power, and renewable sources. Electric vehicles first came into existence in the mid-19th century, when electricity was among the preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time[10]. The internal combustion engine (ICE) is the dominant propulsion method for motor vehicles but electric power has become commonplace in other vehicle types, such as trains and smaller vehicles of all types.

2. OBJECTIVE
To find the current expectation of consumers regarding electric vehicles

3. RELATED WORKS
Electric vehicles had many advantages over their competitors. Changing gears on gasoline cars was the most difficult part of driving. Electric vehicles did not require gear changes. While steam-powered cars also had no gear shifting, they suffered from long start-up times of up to 45 minutes on cold mornings. The steam cars had

less range before needing water, compared to an electric car's range on a single charge. The only good roads of the period were in town, which meant that most commutes were local, a perfect situation for electric vehicles since their range was limited. The electric vehicle was the preferred choice of many because it did not require manual effort to start, as with the hand crank on gasoline vehicles, and there was no wrestling with a gear shifter[10].

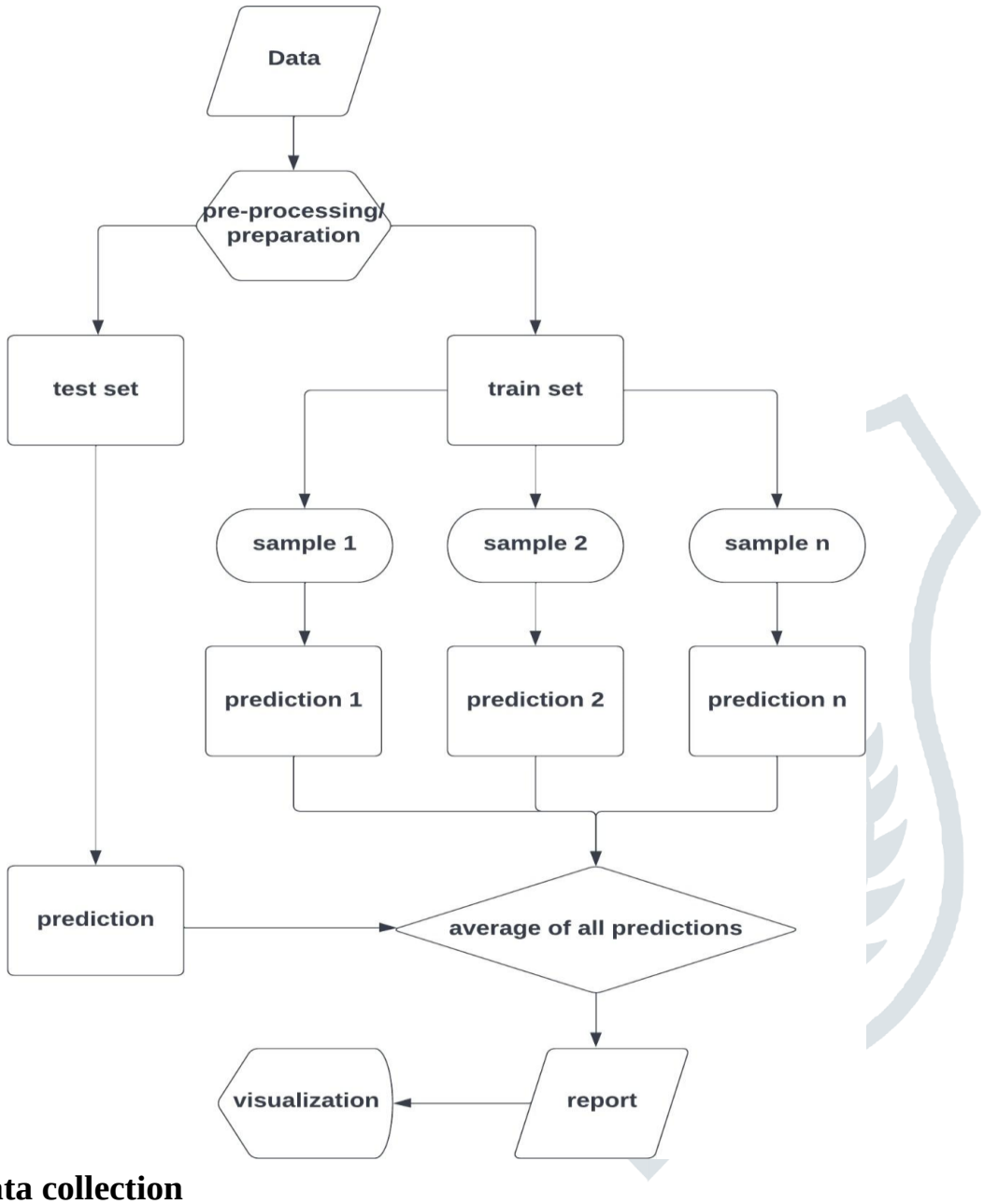
Today when the world is looking for new technology everywhere, Electric Vehicles must be the future means of transport. Pollution, growing demand for fuel, Global Warming and promoting eco-friendly means of transport are some of the reasons for promoting EV's. They are the means of transport that consume electric energy as fuel instead of traditional fuels such as petrol, diesel, and CNG. The world population is increasing drastically day by day and the demand for means of transport is also growing proportionally. Thus demand for fuel is also increasing. EV will reduce the dependency of a nation on petroleum export countries. This will reduce the import cost of petrol, diesel like fuels which will help the growing economy of the country. Cost of electric vehicles is also low when comparing the recurring expenditure on petrol and diesel used in traditional means of transport.

It is worth noting that well-to-wheel efficiency of an electric vehicle has far less to do with the vehicle itself and more to do with the method of electric production. A particular electric vehicle would instantly become twice as efficient if electricity production were switched from fossil fuel to a wind or tidal primary source of energy[11]. Because of the different method of charging possibilities the emissions reduced have been quantified in different ways. Plug-in all-electric and hybrid vehicles also have different consumption characteristics due to efficiency of electric engines as compared to combustion engines [11].

4. METHODOLOGY

A machine learning model was developed to predict the expectation of consumers based on the mileage and price of an EV. The model was used to perform a comparison of different fuel type vehicles that includes petrol, diesel, LPG, electric, and CNG. For this work, we used the vehicle database [12]**.** Random forest is a Supervised Machine Learning Algorithm that builds decision trees on different samples and takes their majority vote for classification and average in case of regression. Here the data is collected and cleaned by pre pre-processing method. Then it is splitted into training and testing datasets. Then a regressor object is created and predicted the accuracy rate. Finally it is displayed with the random forest regressor decision tree.

4.1. WORK FLOW



4.2. Data collection

The data used here is collected by issuing google forms to find the expectation of consumers regarding EV. containing 16 questions. In that 6 questions were personal and general questions and the remaining 10 were related to the study.

4.3. Data pre-processing

The vehicle dataset provides data on the vehicle model, mileage, location of sales, year of sales, fuel type, efficiency, power, brand, acceleration, range, body style, segment, price, co2 emission . The vehicle dataset was collected between 1998 and 2022 containing 1,32,396 records in total including different fuel types of transport. The extracted dataset gets into the process of data cleaning and is splitted into two different datasets, the test and train sets with the ratio of 3:7.

4.4. Machine learning algorithm

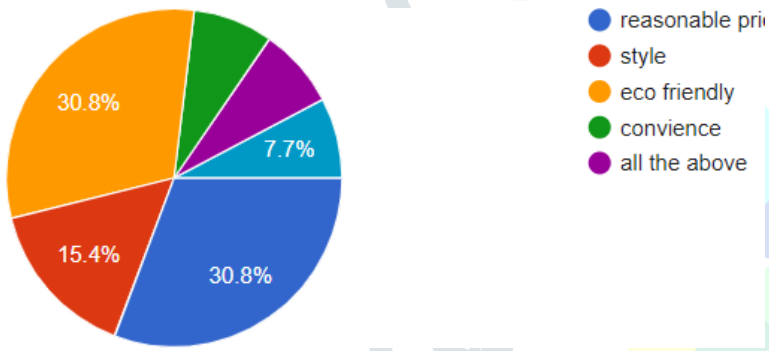
colab, an open-source machine learning tool was used to prepare the data for the machine learning algorithm and to test the machine learning algorithms. Colab is a complete cloud management source tool. The machine learning task for this study is done with the regressor problem. The algorithm used here is the Random Forest Algorithm, to predict the expectation of consumers regarding EV

5. RESULT EVALUATION

Table 1. Example data used in this work - Input

	s no	Name	Location	Year	Kilometers_Driven	Fuel_Type	Mileage	Power	Sales	Brand	...	Range	Efficiency	FastCharge	RapidCharge	PowerTrain	PlugType	BodyStyle
0	0	Maruti Wagon R LXI CNG	Mumbai	2022	72000	CNG	27.0	58.0	0	Tesla	...	450.0	161.0	940.0	Rapid charging possible	All Wheel Drive	Type 2 CCS	Sedan
1	1	Hyundai Creta 1 6 CRDi SX Option	Pune	2015	41000	Diesel	20.0	126.0	0	Volkswagen	...	270.0	167.0	250.0	Rapid charging possible	Rear Wheel Drive	Type 2 CCS	Hatchback
2	2	Honda Jazz V	Chennai	2022	46000	Electric	18.0	89.0	86.0	Polestar	...	400.0	181.0	620.0	Rapid charging possible	All Wheel Drive	Type 2 CCS	Liftback
3	3	Maruti Ertiga VDI	Chennai	2012	87000	Diesel	21.0	89.0	0	BMW	...	360.0	206.0	560.0	Rapid charging possible	Rear Wheel Drive	Type 2 CCS	SUV
4	4	Audi A4 New 2 0 TDI Multitronic	Coimbatore	2013	40670	Diesel	15.0	141.0	0	Honda	...	170.0	168.0	190.0	Rapid charging possible	Rear Wheel Drive	Type 2 CCS	Hatchback

picture 1: Result from google form



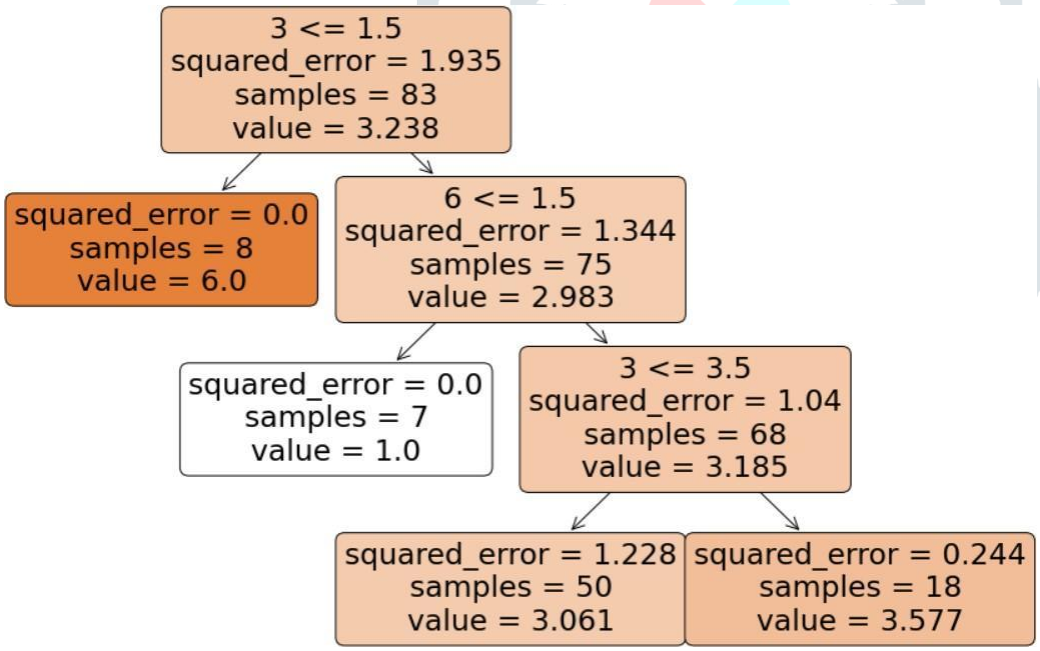
The major preferences are price, eco friendly and style. These were the features of electric vehicle that attract the people

Picture 2: Accuracy rate - output

```
[ ] #Mean Absolute Error(MAE)
    from sklearn.metrics import mean_absolute_error
    print("MAE: ",mean_absolute_error(y_test,y_pred))

    MAE:  0.7225806771222922

[ ] #Mean Squared Error(MSE)
    from sklearn.metrics import mean_squared_error
    print("MSE: ",mean_squared_error(y_test,y_pred))

    MSE:  0.9433780046768243

[ ] #Root Mean Squared Error(RMSE)
    print("RMSE: ",np.sqrt(mean_squared_error(y_test,y_pred)))

    RMSE:  0.9712764820980813
```

Here the study shows the accuracy of 97% customer expectations are based on price and style/brand of the vehicle.

Picture 3: Random forest decision tree – output



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