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AN AI-BASED ANALYSIS FOR PREDICTION OF COST EFFECTIVE LIVING STYLE FOR PEOPLE USING ELECTRIC VEHICLES

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Abstract

With the rising use of Electric Vehicles (EV) over the society, the living standard of the people is more cost effective. As the cost of living is reduced due to less usage of diesel and petrol vehicles the expenditure in needs of the people are more saved. In this work, impact of usage of EV on cost efficient living style is studied using AI based approach. The models used for analysis are supervised ML models. A synthetic dataset with 1000 rows and 9 attributes is designed by considering a scenario on usage of EV by families. Finally, the analysis is performed using Orange data analysis tool to show the accuracy of the models in predicting the impact of usage of EV on cost efficient living as High or Low. From, the result it is found that almost all 8 supervised ML models shows an accuracy of nearly 100% in identifying the impact.

Keywords: Electric Vehicle, Petrol vehicle, Cost Efficient Living, Machine Learning, Accuracy

1. INTRODUCTION

Electric Vehicle (EV) is a vehicle that runs on the use of electricity [1-21]. The EV vehicle has a battery in it that has to be charged once using electricity for movement. It is the safest vehicle that emits less heat and carbon in the environment. The usage of vehicles powered by electricity is now slowly increasing. Mostly people use petrol vehicle (PV) for movement. However, PV is little safer to environment as it emits more heat and carbon to the environment.

The cost of using EV is lesser than those in the society those who are using PV. If a person is using EV then let, per charging the EV moves 100 Km with a cost of Rs. 16 (if 4 units needed with a cost per unit is Rs. 4). Whereas, if a person using PV, let per Litre the PV moves 50 Km with a Petrol cost of Rs. 100, then the person who use EV saves Rs. 84 that can be used in other cost of living. So, cost of living is influenced with the usage of EV

vehicles in the society. If a person is saving the money using the EV vehicle then the total income per month is influenced by it that can lead him to more savings and expends in other needs. So, there should be a prediction model that can analyse the impact of usage of EV and PV in cost efficient living. It is mainly categorized in to high impact or low impact as per our consideration. Therefore, machine learning (ML) plays an important role in predicting the impact of EV usage in cost efficient learning. ML is the branch of AI that is basically used to train the models as per the dataset and the model can predict the next output if the inputs are there. ML is basically divided into supervised and unsupervised learning. Supervised Learning means the input and output labels are there in the dataset and the prediction is made. However, in unsupervised learning only the inputs are present without any labels. In this work we consider the supervised ML models for analysis. Much research work has been done in EV as per the literature survey [1-21] that is mostly based on consumer's interest in buying EV, EV market analysis, and energy consumption estimation using ML. From the literature survey, it is found as per our knowledge that very less work is done in the area of learning the impact of usage of EV on Cost Efficient Living Style. So, it motivates us to work in this area.

The main contribution of this work is discussed as follows.

a. Impact of usage of EV on Cost Efficient Living Style is studied using AI based approach.

b. The models used for analysis are supervised ML models.

c. A synthetic dataset with 1000 rows and 9 attributes is designed by considering a scenario on usage of EV by families.

d. The analysis is done in Orange data analysis tool to show the accuracy of the models in predicting the impact as High or Low.

The rest of the work is discussed as follows. Section 2 discusses about the materials and methodology. Section 3 presents the result analysis. At last we conclude at Section 4.

2. MATERIALS AND METHODOLOGY

2.1 Example Taken

In this example, we have considered a scenario where a monthly family income is Rs. 50000. The family income is divided into three parts for living such as needs, wants and savings to live a better life. Expenditure on Needs is 50% of the family income, Expenditure on Wants is 30% of the family income and Expenditure on Savings is 20% of the family income. Many things are there that decides needs of a family like Residence, Food, Cloths, etc. Also one that can add expenditure to needs is use of vehicle for movement per month. If the amount for vehicle usage is less than this can impact the cost efficient living to be High or Low. In this case, we consider the family using two wheeler vehicles. The two wheeler vehicle is EV or PV. If a person is using EV then let, per charging the EV moves 100 Km with a cost of Rs. 16 (if 4 units needed with a cost per unit is Rs. 4). Whereas, if a person using PV, let per Litre the PV moves 50 Km with a Petrol cost of Rs 100. Here, we considered a person if using 4% (Rs. 2000 of Rs 50000 income) or below of the monthly income in movement using vehicle then it can impact the cost efficient living.

Expenditure for EV vehicle usage= (16/100) * Total Distance Covered (1)

Expenditure for PV vehicle usage= (100/50) * Total Distance Covered (2)

2.2 Dataset Considered for Cost Efficient Living

In this work, we have designed a synthetic dataset that mimics the real world scenario. The dataset consist of 1000 rows and 09 columns. The main 09 attributes of this dataset are considered per month basis of 1000 families who have a same family income. The attributes in the dataset are Income of Family (in Rs.), Expenditure on Needs (in Rs.), Expenditure on Wants (in Rs.), Expenditure on Savings (in Rs.), Usage of EV (1=using EV, 0=using PV), Distance Covered per Month (in Km), Expenditure for Vehicle Usage (in Rs.), Amount Saved on Vehicle Usage (in Rs.), and Cost Efficient Living due to EV Vehicle Usage (High/ Low).

Table 1: A small sample of dataset taken with 10 rows only

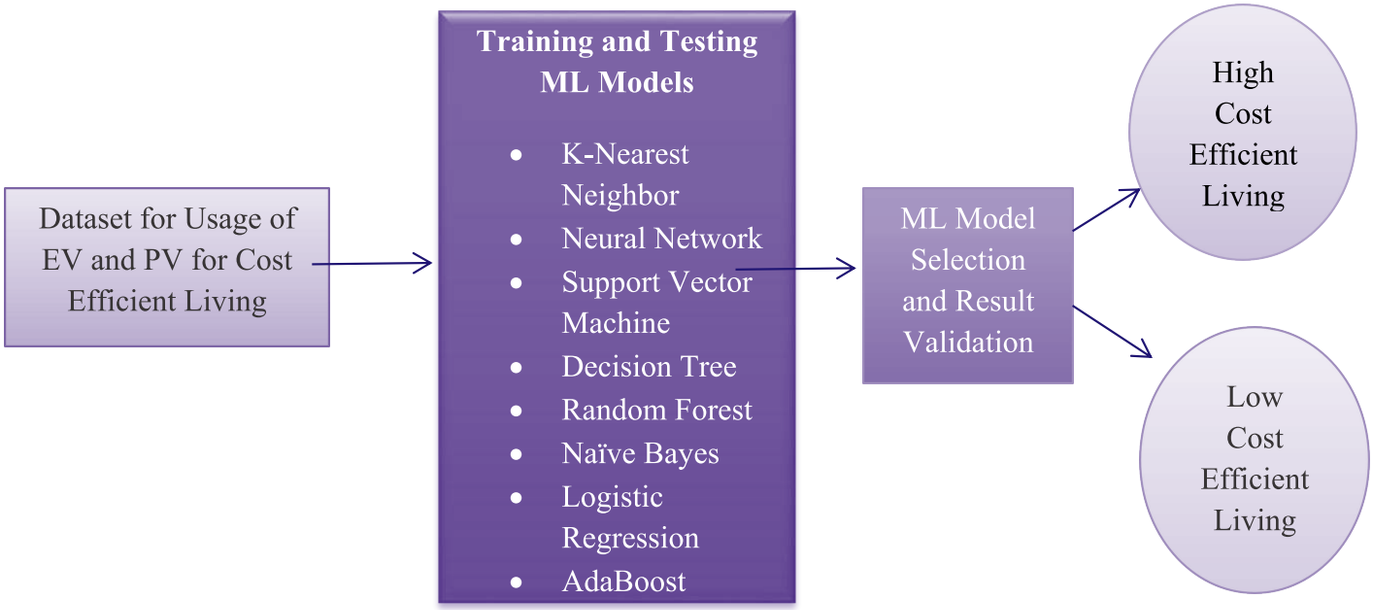
Income	Expenditure on Needs	Expenditure on Wants	Expenditure on Savings	Usage of EV (1=using EV, 0=using PV)	Distance Covered	Expenditure for Vehicle Usage	Amount Saved on Vehicle Usage	Cost Efficient Living Due to EV Usage
50000	25000	15000	10000	1	1000	160	1840	HIGH
50000	25000	15000	10000	0	1002	2004	-4	LOW

50000	25000	15000	10000	1	1004	160.64	1839.36	HIGH
50000	25000	15000	10000	0	1006	2012	-12	LOW
50000	25000	15000	10000	1	1008	161.28	1838.72	HIGH
50000	25000	15000	10000	0	1010	2020	-20	LOW
50000	25000	15000	10000	1	1012	161.92	1838.08	HIGH
50000	25000	15000	10000	1	1014	162.24	1837.76	HIGH
50000	25000	15000	10000	1	1016	162.56	1837.44	HIGH

2.3 Models Used and Methodology

The models used for prediction of the Cost Efficient Living with respect to EV and PV usage are supervised machine learning models such as K-Nearest Neighbor, Neural Network, Support Vector Machine, Decision Tree, Random Forest, Naïve Bayes, Logistic Regression, and AdaBoost. The dataset of size (1000*9) is fed into these models for training and testing with the prediction label (HIGH/LOW) as the last column of the dataset. The training and testing is performed using k-fold cross validation, where k represents the number of folds of the dataset. The results of this testing are accuracy of showing or identifying the impact of EV vehicles usage on Cost Efficient Living Style. Other parameters such as precision, recall, F1-score, and to validate the result.

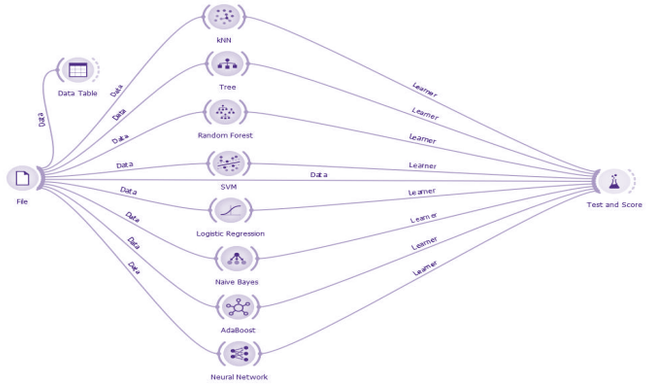
Fig. 1: Methodology process



3. RESULTS AND ANALYSIS

The simulation is performed using a machine of 8 GB RAM and core i3 processor with Windows 64 bit Operating System. The machine has a processor speed of 3.3 GHz. The tool taken for simulation and AI analysis using ML models is Orange. The Orange tool workflow for data analysis to predict the impact as High or Low of EV and PV usage on cost efficient living is shown in Fig. 2. The models used for this analysis are represented in Fig. 1. The performance metrics considered are Accuracy, Precision recall, F1-Score, and AUC.

Fig. 2: Process flow using Orange Tool for prediction of impact of usage of EV or PV on cost efficient living

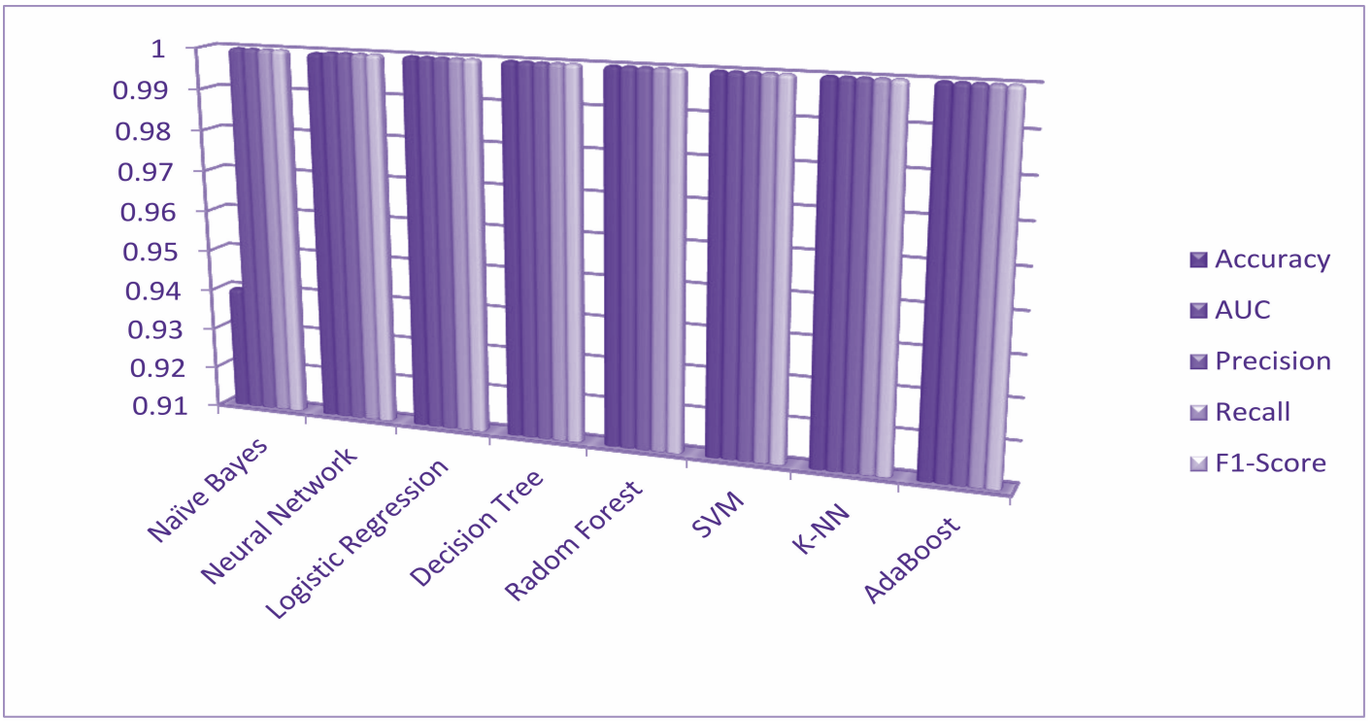


The results of the models are shown in Table 2 and Fig. 3 as follows. Form the results it is observed that the Naïve Bayes shows accuracy, AUC, precision, recall, and F1-score of 0.940, 1, 1, 1 and 1 respectively. Neural network shows accuracy, AUC, precision, recall, and F1-score of 0.999, 1,1,1, and 1 respectively. Logistic Regression shows accuracy, AUC, precision, recall, and F1-score of 1,1,1,1, and 1 respectively. Decision Tree shows accuracy, AUC, precision, recall, and F1-score of 1,1,1,1, and 1 respectively. Radom Forest shows accuracy, AUC, precision, recall, and F1-score of 1,1,1,1, and 1 respectively. SVM shows accuracy, AUC, precision, recall, and F1-score of 1,1,1,1, and 1 respectively. KNN shows accuracy, AUC, precision, recall, and F1-score of 1,1,1,1, and 1 respectively. AdaBoost shows accuracy, AUC, precision, recall, and F1-score of 1, 1,1,1, and 1 respectively. From above observation it is concluded that models are showing good accuracy of 100% or nearly 100% and we can consider these models for prediction of impact of impact as High or Low of EV and PV usage on cost efficient living.

Table 2: Results and Analysis

Sl. No.	Model	Accuracy	AUC	Precision	Recall	F1-Score
1	Naïve Bayes	0.940	1	1	1	1
2	Neural Network	0.999	1	1	1	1
3	Logistic Regression	1	1	1	1	1
4	Decision Tree	1	1	1	1	1
5	Radom Forest	1	1	1	1	1
6	SVM	1	1	1	1	1
7	K-NN	1	1	1	1	1
8	AdaBoost	1	1	1	1	1

Fig. 3: Representation of results in Graph form for parameters such as Accuracy, AUC, Precision, Recall, and F1-Score.



4. CONCLUSION AND FUTURE SCOPE

In this work, impact of usage of EV on cost efficient living is explored using AI based approach. The models used for analysis are K-Nearest Neighbor, Neural Network, Support Vector Machine, Decision Tree, Random Forest, Naïve Bayes, Logistic Regression, and AdaBoost. The analysis is done using Orange tool to show the accuracy of the models in predicting the impact of usage of EV on cost efficient living as High or Low. From, the result it is found that almost all 8 supervised ML models shows an accuracy of nearly 100% in identifying the impact. In future, new models of ML or Deep Learning (DL) can be taken for analysis of this data. Also the dataset size taken can be large and more factors can be considered for analysis.

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