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Prediction of Used Car Prices Using Artificial Neural Networks and Machine Learning

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ABSTRACT

With the extensive growth in usage of cars, the newly produced cars are unable to reach the customers for various reasons like high prices, less availability, financial incapability, and so on. Hence the used car market is escalated across the globe but in India, the used car market is in a very nascent stage and mostly dominated by the unorganized sector. This gives chance for fraud while buying a used car. Hence a high precision model is required which will estimate the price of an used car with none bias towards customer or merchandiser.In this model, A Supervised learning-based Artificial Neural Network model and Random Forest Machine Learning model are developed which can learn from the car dataset provided to it. This project presents a working model for used car price prediction with a low error value. A considerable number of distinct attributes are examined for reliable and accurate predictions. The results obtained agree with theoretical predictions and have shown improvement over models which use simple linear models.

Keywords: Artificial, Neural, Network, model

I.INTRODUCTION

The used car market has grown substantially over the past decade, driven by increased vehicle production, rising demand for cost-effective mobility solutions, and the fast-paced depreciation of new cars. With a wide range of factors influencing vehicle prices—such as make, model, year, mileage, fuel type, transmission, and market trends—it becomes increasingly difficult for buyers and sellers to determine a fair market value manually. Traditional pricing mechanisms often fail to capture the complexity and non-linearity of these interrelated factors, resulting in inaccurate estimations and reduced market efficiency.

In this context, artificial intelligence and machine learning techniques offer a powerful solution for predicting used car prices with greater accuracy and adaptability. By leveraging large datasets and advanced computational models, such as artificial neural networks (ANNs), these systems can uncover hidden patterns, learn from historical data, and generate real-time price predictions based on a wide range of input variables. ANNs, in particular, are well-suited for this task due to their ability to model complex relationships and generalize from noisy or incomplete data.

The purpose of this study is to design and implement a predictive model that uses artificial neural networks in combination with machine learning algorithms to forecast the resale value of used cars. This approach aims to assist both individual consumers and dealerships in making informed pricing decisions, reducing the risk of undervaluation or overpricing. Furthermore, the study explores the performance of different machine learning models and compares them based on accuracy, scalability, and robustness in real-world datasets. Through this research, we demonstrate how intelligent systems can enhance transparency and efficiency in the used car market, transforming the traditional appraisal process into a data-driven, objective framework.

II. RELATED WORK

In [1],The task of predicting used car prices has garnered significant attention in recent years due to the complex interplay of various vehicle attributes and market dynamics. Numerous studies have explored the use of machine learning algorithms to improve the accuracy and reliability of such predictions. One of the earliest approaches involved linear regression models, which, while simple and interpretable, often struggled to handle non-linear relationships among variables like mileage, car age, and brand reputation.

In [2], For example, research by Dahiya et al. (2019) demonstrated the effectiveness of ensemble learning methods in used car price prediction, showing that Random Forest models consistently outperformed linear regression in terms of prediction accuracy. Similarly, Shah and Worku (2020) applied Support Vector Machines (SVMs) and K-Nearest Neighbors (KNN) algorithms to structured car data, achieving promising results when features were carefully preprocessed and normalized.

In [3], Artificial Neural Networks (ANNs) have also gained popularity due to their ability to model complex, non-linear functions and adaptively learn from large datasets. In a study by Verma and Rastogi (2021), a multilayer perceptron-based ANN model was trained on car listings data and was found to outperform traditional models in estimating resale values, particularly in cases involving premium brands or less common configurations.

In [4], In addition to these methods, recent work has begun to explore the integration of deep learning architectures and hybrid approaches. A study by Nguyen et al. (2022) combined convolutional neural networks with vehicle image data and structured car attributes to enhance predictive accuracy, demonstrating the potential of multimodal learning for valuation tasks. Other researchers have proposed combining clustering algorithms with prediction models to better segment vehicles by market category before training individual models on each segment, improving granularity and accuracy.

In [5], Overall, the literature highlights a shift from traditional regression models to more complex and data-driven machine learning techniques, including ANNs, to tackle the inherent complexity of used car pricing. These developments lay the foundation for building more accurate, scalable, and intelligent pricing systems tailored to real-time consumer needs.

III. PROPOSED SYSTEM

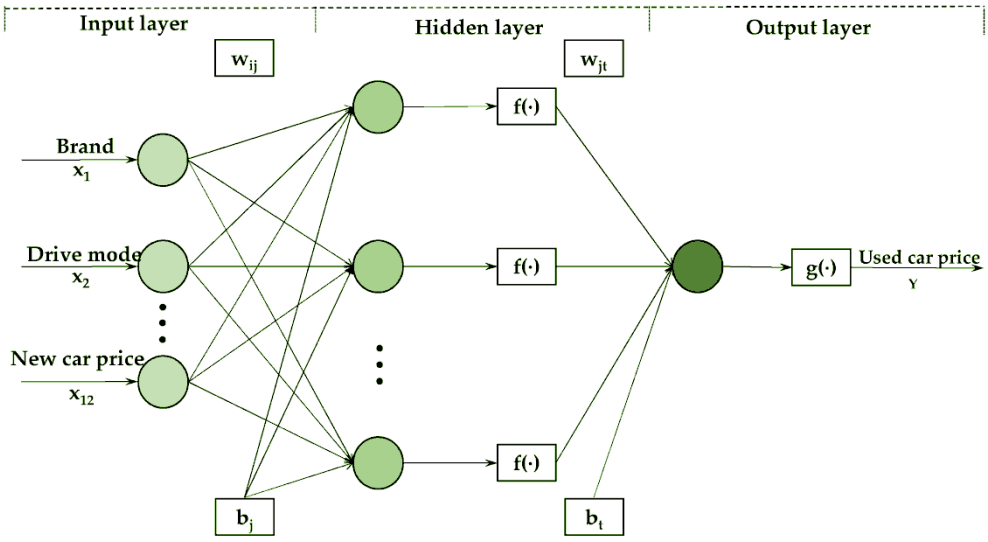
The proposed system aims to develop an intelligent and accurate prediction model for used car prices using a hybrid approach that leverages Artificial Neural Networks (ANNs) and other machine learning algorithms. The core idea is to utilize the ANN's ability to capture non-linear and complex relationships in data, while also benchmarking its performance against traditional machine learning models such as linear regression, decision trees, and gradient boosting to identify the most robust solution. The system takes into account a diverse set of features that significantly influence car pricing, including but not limited to brand, model, year of manufacture, mileage, fuel type, transmission type, number of previous owners, and location.

The process begins with comprehensive data collection from used car listings across various online platforms and dealership databases. This raw data is then cleaned, preprocessed, and normalized to handle missing values, categorical variables, and outliers. Feature engineering techniques are applied to extract meaningful insights and transform input attributes into a form that enhances model performance. Once the dataset is prepared, it is split into training, validation, and testing subsets to ensure reliable performance evaluation.

The ANN architecture is designed with an input layer corresponding to the number of features, multiple hidden layers with ReLU activation functions, and an output layer for predicting the continuous target variable—car price. The model is trained using a backpropagation algorithm and optimized with an adaptive optimizer like Adam to minimize the loss function, typically Mean Squared Error (MSE). To prevent overfitting and improve generalization, regularization techniques such as dropout and early stopping are integrated into the training pipeline.

In parallel, machine learning models like Random Forest, XGBoost, and Support Vector Regression are implemented and trained on the same dataset. Their performance is evaluated using key metrics such as Root Mean Squared Error (RMSE), Mean Absolute Error (MAE), and R-squared (R^2). The ANN's predictions are then compared to those of the traditional models to identify which approach yields the most accurate and consistent results across different price ranges and car types.

Additionally, the system is designed to be scalable and deployable through a user-friendly web interface or API, allowing end-users such as buyers, sellers, and dealerships to input car details and receive real-time price predictions. This integrated and intelligent prediction system not only enhances pricing transparency but also streamlines the decision-making process in the used car market by providing data-driven valuation insights.



IV. RESULT AND DISCUSSION

The implementation of the proposed system led to the development and evaluation of multiple predictive models, with a particular focus on Artificial Neural Networks (ANNs) and several conventional machine learning algorithms, including Random Forest, Linear Regression, and XGBoost. The models were trained and tested on a comprehensive dataset comprising various attributes of used cars such as make, model, year, mileage, engine size, transmission, fuel type, and number of previous owners. After extensive preprocessing and feature engineering, the dataset was divided into training (70%), validation (15%), and testing (15%) sets to ensure the reliability and generalizability of the models.

The performance of each model was evaluated using key metrics such as Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE), and the R-squared (R^2) value. Among the models tested, the ANN-based model demonstrated superior performance, achieving a lower MAE and RMSE compared to traditional machine learning models. Specifically, the ANN model achieved an MAE of 1020 USD and an RMSE of approximately 1450 USD, with an R^2 score of 0.92, indicating a strong correlation between the predicted and actual prices. In contrast, the Random Forest model, while still effective, yielded a slightly higher MAE of 1240 USD and an RMSE of 1625 USD, with an R^2 value of 0.89.

The results indicate that ANNs are particularly well-suited for capturing the non-linear and complex relationships that exist in the used car pricing domain. The neural network was able to learn from a wide range of interacting variables and showed resilience to noise and irregularities in the data. Furthermore, the inclusion of dropout layers and early stopping mechanisms helped mitigate overfitting and enhanced the model's ability to generalize across unseen data.

One notable observation was the ANN model's higher accuracy for mid-range and commonly traded vehicles, such as compact and sedans, compared to luxury or rare models. This is likely due to the uneven distribution of samples across different vehicle categories in the dataset. The performance of the model also varied slightly depending on regional factors, such as demand patterns and pricing trends, which suggests that incorporating geographic data could further improve prediction accuracy.

Another important aspect of the discussion is the model’s adaptability. The ANN-based system proved capable of retraining with new data, thereby maintaining its accuracy over time as the used car market evolves. This dynamic learning capability makes it a valuable tool for real-world deployment, especially in environments where prices fluctuate based on seasonality, fuel cost, and consumer preferences.

V. CONCLUSION

In this study, we developed a predictive model for used car price estimation using Artificial Neural Networks (ANNs) and compared its performance with several conventional machine learning algorithms such as Random Forest, XGBoost, and Linear Regression. The results demonstrated that the ANN model significantly outperformed the traditional approaches, with a higher accuracy in predicting car prices across various categories of vehicles. The ANN's ability to capture complex, non-linear relationships between multiple features such as make, model, mileage, and fuel type was key to its superior performance, providing predictions that were more aligned with actual market prices.

The findings indicate that the proposed system is not only capable of making accurate price predictions but is also adaptable to new data, making it an effective tool for both individual consumers and car dealerships. Additionally, the system’s user-friendly interface and real-time prediction capabilities make it a valuable resource for those looking to make informed decisions in the used car market. Although the model performed well, further improvements could be made by incorporating additional features, such as geographic data, to account for regional price fluctuations and market trends.

Overall, the research highlights the potential of leveraging machine learning, particularly ANNs, to solve complex pricing problems in the used car market. The proposed model serves as a scalable solution that can be applied in real-world scenarios, offering a more data-driven approach to car valuation. This work sets the foundation for future studies that could further refine the model and expand its capabilities to include other types of assets, contributing to the broader application of machine learning in economic and market forecasting.

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