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A Comparative Study on Car Evaluation Forecast Based on Machine Learning

Aarushi Atrey[1], Shradha[2], Yougal Joshi[3]

[1, 2, 3]Dr. Akhilesh Das Gupta Institute of Technology & Management (INDIA)

Abstract:

Cars are vital in everyday life. They play an important role as they provide us with a mostly hassle-free mode of transportation. Every car is different in terms of price, features and the level of luxury it provides. Buying a car is a major decision on the part of the buyer as they have to take several parameters into consideration. Manufacturing and business are interested to know the popular features on which buyers make their decision. Data mining algorithms can be employed in this respect. The purpose of this research is to employ three different, but vastly popular, algorithms for evaluating the dataset. This research focuses on comparing the speed, accuracy and performance of these algorithms.

Keywords:

Car acceptability, Support Vector Machine, K-Nearest Neighbors, Artificial Neural Network, Data Mining

1. Introduction:

The automotive industry is a major industrial and economic force worldwide. It makes 60 million cars and trucks a year, and they are responsible for almost half the world's consumption of oil. The industry employs 4 million people directly, and many more indirectly. Despite the fact that many large companies have problems with overcapacity and low profitability, the automotive industry retains very strong influence and importance. The industry also provides well-paying jobs with good benefits, has heavy linkages with supplier industries (which gives it an oversized role in economic development), and has a strong political influence.

The industry is more than 100 years old. It started in Germany and France, and came of age in the U.S. in the era of mass production. Vehicle volumes, efficiency, safety, features and choice have grown steadily throughout the industry's history. It is so synonymous with 20th century industrial development, and so intertwined with its twin marvels, mass production and mass consumption, that it has been called the "industry of industries."

The car valuation process can be used before buying any car. It helps car buyers to know the original value and price of any car before buying it. It is a beneficial tool and helps to quickly know the market price of any vehicle. By using this tool, the car owners can estimate the true value of any car according to its make, model, mileage and condition. The seller cannot manipulate the buyer about the prices and this would help buyer to

negotiate the price before making the final decision. In this way, by using **car valuation** the car buyers can get done with a profitable deal.

Data mining involves exploring and analyzing large blocks of information to glean meaningful patterns and trends. It can be used in a variety of ways, such as database marketing, credit risk management, fraud detection, spam Email filtering, or even to discern the sentiment or opinion of users. The data mining process breaks down into five steps. First, organizations collect data and load it into their data warehouses. Next, they store and manage the data, either on in-house servers or the cloud. Business analysts, management teams and information technology professionals access the data and determine how they want to organize it. Then, application software sorts the data based on the user's results, and finally, the end-user presents the data in an easy-to-share format, such as a graph or table.

Differentiating a decent car from an average to a terrible one is generally done physically with assistance of our neighbourly mechanics who instructs us to purchase the car. It would be nice to have a way of finding out the acceptability of the car. The focus of this research work is to compare three influential algorithms; K-Nearest Neighbours (KNN), Support Vector Machine (SVM) and Artificial Neural Network (ANN) in term of speed and accuracy they depict on the data set of cars.

2. Related Work:

One crucial step in data mining projects is to find an efficient classification algorithm so that results can be trusted upon. It also depends on the experimental design of the system. If the selection of algorithm is not made thoughtfully the outcomes of data mining task could be compromised, consequently resulting in invalid conclusions. Researchers have focused on this point and have compared various algorithms in terms of accuracy and speed. This section presents a brief overview of the essential work done in this domain.

In research work conducted by S. Makki [1] backpropagation neural network (BNN) and naïve Bayesian classifier (NB) has been employed for data mining classification for evaluation on car data set. These two algorithms are tested on data set and results show that BNN is much more accurate as compared to NB although it is difficult to implement and it runs slow. In [2] author presents a comparative study on multiple prediction algorithm for analyzing breast cancer survivability. In experiments a large data set with 10-fold cross validation has been used. Results demonstrate that decision tree is the most accurate, artificial neural networks takes third place and logistic regression method is the last in terms of accurate results. R. Russo [3] in his work has applied machine learning algorithm to dataset which describes movie. The basic aim is to create a movie recommender system for movie watchers. Neural networks, NB, simple rule classifiers and decision tree are compared. Results indicate that NB and neural networks perform better in terms of evaluating given dataset. In [4] author proposes a methodology to evaluate an adaptive tourist service of onboard cars. The system evaluated provides personalized information to tourist on cars. In the research work layered sampling strategy is employed and system suggestions to users are compared for accuracy. S. Singh [5] evaluates the performance of different classification methods. Three algorithm are studied in this research; K-Nearest Neighbors, Support Vector Machines (SVM) and Artificial Neural Networks (ANN). The results demonstrate that SVM and ANN are better predictors.

3. Dataset Description:

The dataset used in this research is a collection of the records on specific attributes of cars. The dataset is created by Marko Bohanec and donated by Marko Bohanec and Blaz Zupan in 1997. We obtained the dataset from the UCI dataset repository. The car dataset, as described on the UCI repository was derived from a simple heirarchical decision model originally developed for the demonstration of DEX, M. Bohanec, V. Rajkovic: Expert system for decision making.

Data Set Characteristics:	Multivariate	**Number of Instances:**	1728
Attribute Characteristics:	Categorical	**Number of Attributes:**	6
Associated Tasks:	Classification	**Missing Values?:**	No

Table 1: Car Evaluation Dataset

The target attribute in the dataset is "class", and it assumes the following 4 values as a combination of the deterministic features:

- Acceptable: This is denoted as 'acc'
- Good: This is denoted as 'good'
- Unacceptable: This is denoted as 'unacc'
- Very Good: This is denoted as 'vgood'

Data analysis was performed on the dataset to identify patterns within the data and present the data in tables based on the rage of the attributes and its frequencies.

Class	**Frequency**	**Relative Frequency in %**
Acc	385	22.28
Good	70	4.05
Unacc	1207	69.85
Vgood	66	3.82
Total	1728	100

Table 2: Frequency of 'class' output in dataset

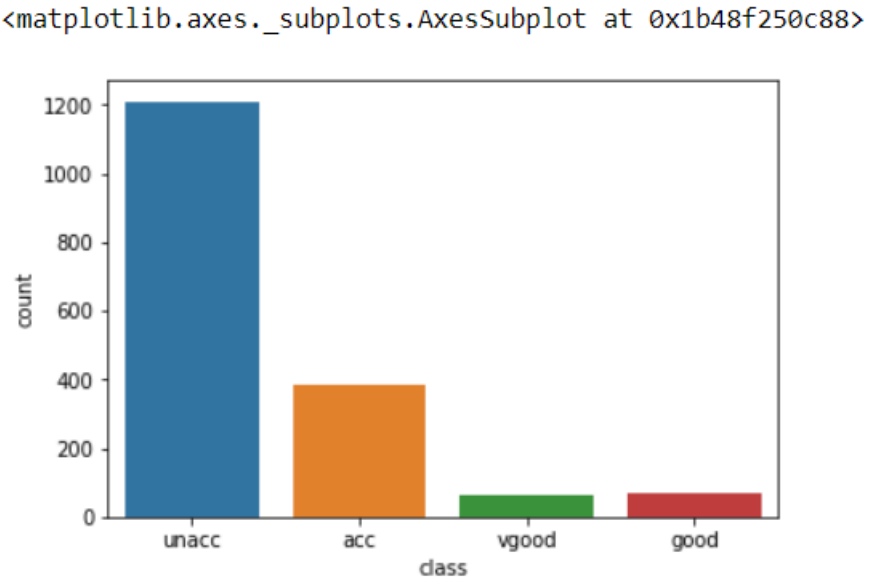

Fig 1: Frequency of 'class' output in the dataset

Table 2 and Figure 1 show the frequency of the class output which is the final outcome from the dataset. It shows that more than half of the cars evaluated were not acceptable. And the frequency of the cars falling under category 'vgood' was the least when compared to others.

4. Experiments and Results:

This section aims at demonstrating the experimental setup and the results obtained. It describes the basic working of algorithm, how data is prepared for testing and what results claim about all three of the data mining algorithms.

4.1 Classification Method:

The classification methods applied in this research are K-Nearest Neighbours (KNN), Support Vector Machine (SVM) and Artificial Neural Networks (ANN). The k-nearest neighbours algorithm (k-NN) is a non-parametric method proposed by Thomas Cover used for classification and regression. In both cases, the input consists of the k closest training examples in the feature space. In k-NN classification, the output is a class membership. An object is classified by a plurality vote of its neighbours, with the object being assigned to the class most common among its k nearest neighbours.

Support Vector Machines (SVMs) are supervised learning models with associated learning algorithms that analyze data used for classification and regression analysis. Developed at AT&T Bell Laboratories by Vapnik with colleagues (Boser et al., 1992, Guyon et al., 1993, Vapnik et al., 1997), it presents one of the most robust prediction methods, based on the statistical learning framework or VC theory proposed by Vapnik and Chervonenkis (1974) and Vapnik (1982, 1995). Given a set of training examples, each marked

as belonging to one or the other of two categories, an SVM training algorithm builds a model that assigns new examples to one category or the other, making it a non-probabilistic binary linear classifier.

Artificial neural networks (ANNs), usually simply called neural networks (NNs), are computing systems vaguely inspired by the biological neural networks that constitute animal brains. An ANN is based on a collection of connected units or nodes called artificial neurons, which loosely model the neurons in a biological brain. Each connection, like the synapses in a biological brain, can transmit a signal to other neurons. An artificial neuron that receives a signal then processes it and can signal neurons connected to it. The "signal" at a connection is a real number, and the output of each neuron is computed by some non-linear function of the sum of its inputs.

4.2 Data Cleaning:

Data cleaning is the process of preparing data for analysis by removing or modifying data that is incorrect, incomplete, irrelevant, duplicated, or improperly formatted. This data is usually not necessary or helpful when it comes to analyzing data because it may hinder the process or provide inaccurate results. There are several methods for cleaning data depending on how it is stored along with the answers being sought. Data cleaning is not simply about erasing information to make space for new data, but rather finding a way to maximize a data set's accuracy without necessarily deleting information. The dataset used in this research has also been cleaned to ensure quality for model creation. We have converted nominal attributes into numeric attributes. Table 3 shows the conversion.

Attribute	Nominal	New Numeric Value
Buying	vhigh	4
	High	3
	Med	2
	Low	1
Maintenance	Vhigh	4
	High	3
	Med	2
	Low	1
Luggage Boot	Small	3
	Med	2
	Big	1
Safety	Low	1
	Med	2
	High	3

Table 3: Nominal to Numeric Conversion

4.3Data Pre-processing:

Once the dataset has been chosen, raw input data should be pre-processed, otherwise it will negatively affect the results obtained. It is extremely crucial to the performance of neural network. The two basic pre-processing techniques are data transformation and normalization. Transformation manipulates raw data inputs creating a single input to the network, while normalization tends to distribute data evenly scaling it onto an adequate range. This can help network in learning process enhancing its ability to understand the association between given inputs and generated outputs.

4.4Dataset Split:

The pre-processed dataset is split into two shares of varying sizes for utilizing one half as training data and second half as testing or validating network. The methodology of data splitting can have considerable influence on the performance of model. Inappropriate data splitting can result in incorrect and extremely variable performance. Classifying algorithm uses training data for learning. Training model is built by comparing the attributes of dataset with class/label. After training, the model is tested on test data which is the other half of split dataset. In this research work 3 splits are being tested.

Training	Testing
90%	10%
66%	44%
50%	50%

Table 4: Training and Testing Dataset Split

4.5Results:

This section presents results of the experimentation setup. The process is as follows; it is supervised learning method. We have trained the model utilizing attributes inclusive of class attributes. As it is a supervised model, the model is built basing on the class values in correspondence to the values of attributes individually. The results achieved by various experimentation setup in KNN, SVM and ANN are elaborated in Table 5, 6 and 7 respectively. The tables show the percentage splits employed which are; 90:10, 70:30 and 50:50.

Percentage Split		Time in Seconds		KNN	
Training%	Testing%	Build	Test	Correct%	Incorrect%
90	10	0.07	0.01	89.01	10.99
70	30	0.01	0.01	90.17	9.83
50	50	0.01	0.02	88.42	11.58

Table 5: Performance of KNN

Percentage Split		Time in Seconds		SVM	
Training%	Testing%	Build	Test	Correct%	Incorrect%
90	10	0.02	0.05	94.21	5.79
70	30	0.00	0.03	91.13	8.87
50	50	0.00	0.04	83.79	16.21

Table 6: Performance of SVM

Percentage Split		Time in Seconds		ANN	
Training%	Testing%	Build	Test	Correct%	Incorrect%
90	10	7.01	0.00	90.75	9.25
66	44	7.19	0.01	96.24	3.76
50	50	6.98	0.02	81.37	18.63

Table 7: Performance of ANN

5. Conclusion:

The fundamental objective of this research work was to compare and contrast three data mining algorithms; K-Nearest Neighbours, Support Vector Machines and Artificial Neural Network in terms of accuracy they offer. Paper initiates with an introduction of the domain and talks about the previous influential work conducted. Next it leads to a detailed elaboration of the experimentation setup describing dataset, data cleaning and pre-processing. Results of all three of the algorithm are presented.

The results demonstrate that ANN provides the greatest accuracy when the train to test split ratio of the dataset is 70:30, SVM provides the greatest accuracy when the train to test split ratio of the dataset is 90:10, while KNN outperforms the other 2 when the train to test split ratio of the dataset is 50:50. Overall, the greatest accuracy is that of the Artificial Neural Network when dataset is split in a ratio of 70:30.

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