

Sales Forecast of New Energy Vehicles in China Based on LSTM Model

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Abstract: With the increasingly serious environmental protection problems and the rapid increase of global energy consumption, new energy vehicles, as an alternative to traditional fossil fuel vehicles, show a strong development trend in China and the global automobile market. Therefore, whether we can accurately predict the future sales of new energy vehicles is of great significance for government decision-making, enterprise investment strategy and other aspects. Through the analysis of historical sales data, market trends and related factors, we use the long-term and short-term memory (LSTM) model to predict the sales volume of new energy vehicles in China. The experimental results indicate that the model has high accuracy and reliability in predicting the sales of new energy vehicles.

Keywords: New energy vehicles, Sales forecast, LSTM model.

1. Introduction

New energy vehicles mean the vehicles that can use new energy technologies as power sources, mainly including pure electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell vehicles (FCVs) and so on. With the enhancement of environmental protection awareness and the increasingly serious energy crisis, new energy vehicles, as a clean and efficient means of transportation, have been concerned about and favored by more and more consumers. The Chinese government has been committed to promoting the development of new energy vehicles to address challenges such as environmental pollution and energy security. For example, the Chinese government has introduced a range of incentive policies, including car purchase subsidies, exemption from purchase taxes, and charging infrastructure construction, to promote the development of the new energy vehicle market. Therefore, the accurate prediction of the sales volume of new energy vehicles is of great significance for the formulation of reasonable market strategies and decisions. For this reason, I have collected nearly 500 questionnaires. Analyzing the results of the questionnaire, I find that 35.48% of people favor new energy vehicles, which is higher than that of fuel vehicles, [1] and 30.65% of people are still hovering in new energy vehicles and fuel vehicles. In the past researches, new energy vehicles' sales forecast by using statistical models and machine learning methods have achieved certain results. [2] However, as a deep learning model suitable for sequence data, LSTM model has strong memory ability and nonlinear modeling ability, and it is widely used in time series prediction tasks, so the prediction results through LSTM model may be more reliable.

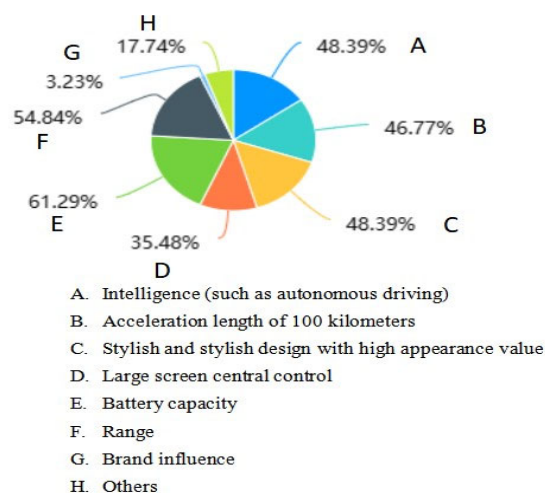


Figure 1. Proportion distribution of factors affecting the purchase decision of green vehicles

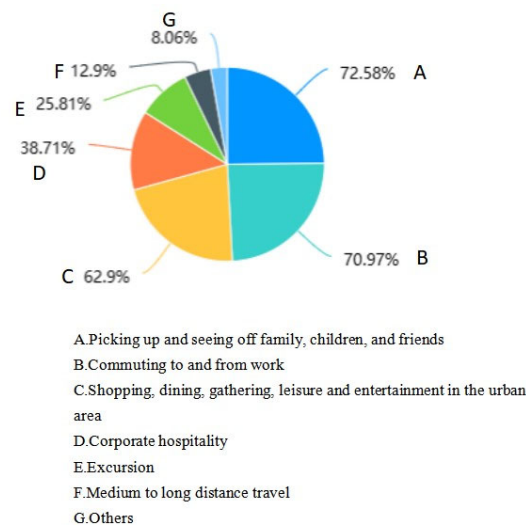


Figure 2. The proportion distribution of green vehicles

2. Introduction to the LSTM Model

The LSTM (Long Short-Term Memory) model is a

modification of a recursive neural network (RNN) dedicated to processing sequence data and long-term dependencies. Compared to the traditional RNN model, the LSTM model can better capture and remember the long-term sequence information by leading to a gating mechanism. The core idea of the LSTM model is to control the flow of information and memory updating through gating units. It consists of three key gating units:

Input gate: It decides whether to incorporate the current input information into memory. It outputs a value between 0 and 1 through a sigmoid Activation function, indicating the importance of the input information.

Forget gate: It decides whether to keep the previous memory information. It outputs a value between 0 and 1 via a sigmoid activation function, indicating the degree to which the previous memory is retained.

Output gate: It determines the output value of the current moment. It outputs a value between 0 and 1 through a sigmoid activation function, indicating the importance of the output, and also a value between -1 and 1 through a tanh activation function, representing the numerical value of the output.

Through the combination and control of these gating units, the LSTM model is able to efficiently address the long-term dependencies. It can selectively forget or remember information from the past and generate new outputs based on current input and memory states. LSTM models perform well in many sequence data processing tasks, such as language modeling, machine translation, speech recognition, etc. Its gating mechanism enables the model to better dispose of the long sequences and gradient disappearance problems, thus improving the performance and effect of the model.

3. A Simple Implementation of The New Energy Vehicle Sales Forecast in China with The LSTM Model

3.1. Sources of data

The data of this paper comes from the sales data of China's new energy vehicles in China from May 2022 to May 2023 of China Association of Automobile Manufacturers.[4]

Table 1. The sales data of China's new energy vehicles in China from May 2022 to May 2023

| Time | Sales volume of new energy vehicles (ten thousand units) |
|---------|--|
| 2022-05 | 46.6 |
| 2022-06 | 59 |
| 2022-07 | 61.7 |
| 2022-08 | 69.1 |
| 2022-09 | 75.5 |
| 2022-10 | 76.2 |
| 2022-11 | 76.8 |
| 2022-12 | 79.5 |
| 2023-01 | 42.5 |
| 2023-02 | 55.2 |
| 2023-03 | 67.4 |
| 2023-04 | 64 |
| 2023-05 | 71.3 |

3.2. Build the LSTM model

First, the input sequence needs to be encoded. The input for each time step is converted into a vector representation, usually represented using word embeddings. Then, the LSTM model predicts the output of the next time step through forward propagation and converts time series to supervised learning problems. At each time step, the model calculates the hidden state of the current time step using the input of the current time step and the hidden state of the previous time step. The hidden state contains the model's memory of past sequences. The LSTM model uses input gates to generate a candidate hidden state, which is added to the hidden state of

the previous time step. Next, retrieve training and testing data. After that, we can forecast the amount of the new energy for the next six months. Finally, the LSTM model uses the hidden state of the current time step to predict the output of the next time step. The output can be a continuous value or a discrete classification label.

The entire forecasting process is an iterative process, starting from the first time step of the input sequence and ending with the prediction of the entire sequence. The prediction results for each time step are passed as input to the next time step to produce the forecast results for the next time step. In this way, the LSTM model can predict future values based on past observations.

Table 2. The forecast values of LSTM model for China from June to November 2023

| Time | 2023-06 | 2023-07 | 2023-08 | 2023-09 | 2023-10 | 2023-11 |
|--|----------|----------|----------|----------|----------|-----------|
| Forecast value of new energy vehicles (ten thousand units) | 67.78893 | 78.06502 | 75.43263 | 73.33687 | 73.87281 | 73.377144 |

3.3. Experimental results

I used the real new energy vehicle sales data for the experiments, and compared the LSTM model with the traditional statistical model. The experimental results show that the sales forecast of new energy vehicles based on LSTM model has high accuracy and reliability. Compared with

traditional methods, the LSTM model can better capture the nonlinear relationships and sequence patterns in the data.

4. The Independent Rise of Intelligent Electric Vehicles in China

The highly anticipated 20th Shanghai International

Automobile Industry Exhibition 2023 has opened. This Shanghai Auto Show has become a feast of new energy models, especially the domestic new energy brands ushered in the landing of product technology, so that we ordinary consumers can better enjoy the convenience and science and technology in the new energy era. The Shanghai Auto Show will make consumers feel the heat of car consumption, boost consumer confidence and boost morale. The biggest highlight of this year's Shanghai Auto Show is that independent new energy has formed leading industrial advantages and technological innovation advantages, comprehensively display and promote intelligent electric new products and new technologies, and promote the rise of Chinese cars in the world. The Shanghai auto show has also boosted confidence in the global auto market and revitalized the spread of electrification. The independent brand has made a good breakthrough in the high-end aspect. In contrast to the concept of overall luxury cars, the product design, service awareness and many other highlights of the independent brand have become the products that can be compared side by side with luxury cars. Therefore, no matter in brand, service and electric vehicle design, our own brand has made a comprehensive breakthrough, and can gain a certain market position side by side with joint venture brands and international brands. Independent new energy technology lines are rising rapidly. In terms of technical lines, the independent brand is becoming increasingly mature, perfect and diversified, especially in the comprehensive breakthrough in pure electric, plug-in hybrid, extended range, ordinary hybrid and fuel version. Finally, the new energy vehicle display at the exhibition also reflects the social concern for environmental protection and sustainable development. As a clean, low-carbon way of travel, new energy vehicles have been recognized and selected by more and more consumers. The exhibition provides consumers with an opportunity to understand the new energy vehicles, compare different brands and models, and promotes the development and popularization of the new energy vehicle market.

5. Development Prospects of New Energy Vehicles

The development prospects of new energy vehicles are very broad. Here are some views on the development prospects of this industry:

Government policy support: Many countries have formulated relevant policies to support the development of new energy vehicles, such as reducing emission standards, providing car purchase subsidies, and tax incentives. These policies will help drive the growth of the new energy vehicle market. (2) Enhanced environmental awareness: With increasing attention to environmental issues, more and more consumers are choosing to purchase new energy vehicles to reduce their impact on the environment. The enhancement of environmental awareness will further drive the market demand for new energy vehicles. [5] (3) Technological

progress: The technology in the field of new energy vehicles is constantly improving, including battery technology, charging infrastructure, and driving systems. These technological advancements will improve the performance and range of new energy vehicles, making them more competitive. (4) Cost reduction: With the advancement of technology and the realization of economies of scale, the manufacturing cost of new energy vehicles is gradually decreasing. This will make new energy vehicles more cost-effective and enhance their competitiveness in the market. (5) Market growth potential: According to predictions, the new energy vehicle market will maintain rapid growth in the coming years. With the reduction of dependence on oil and the development of renewable energy, new energy vehicles are expected to gain greater market share globally.

In summary, the development prospects of new energy vehicles are very optimistic. Government support, increased environmental awareness, technological progress, cost reduction, and market growth potential will all promote the rapid development of the industry.

6. Conclusion

This paper is based on the LSTM model to predict the sales of new energy vehicles in China. The experimental results indicate that the sales prediction of new energy vehicles based on the LSTM model has high accuracy and reliability.[3] Future research can additionally optimize the structure and parameters of the model, raise the precision and stability of prediction. In addition, it is also possible to consider introducing more factors and data sources to improve the comprehensiveness and applicability of the prediction model. In addition, under the global goal of achieving "dual carbon", the development of new energy has gained more attention due to its contribution to reducing greenhouse gas emissions, addressing climate change challenges, and improving the global ecological environment.

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