Application of Big Data Informatization in Public Utilities Response

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Abstract. With the advancement of China's market-oriented reform, the response of public utilities is developing towards diversification and normalization. The new environment has higher and higher requirements for the reliability and accuracy of public utilities response, and there is an urgent need for perfect technical support. Neural network algorithm can accurately identify the complex external environment and make the optimal decision, which can meet the relevant requirements of public utilities response. Based on this, the application of neural network algorithm technology in public utilities response is studied and discussed in this paper. Firstly, this paper combs the development process and research status of neural network algorithm, and analyzes the research status and future development needs of public utilities response problem. On this basis, the feasibility and method of applying neural network algorithm to public utility response business are discussed, which provides a reference for the of public utility response.

Keywords: Neural network algorithm · Public utilities · Demand response

1 Introduction

The construction of a socialist harmonious society must focus on solving the most concerned, direct and realistic interests of the people, and strive to develop social undertakings. Public utilities are the core content of social undertakings. The so-called public utilities are a general term for all industries that produce intangible economic value through collective selection and collective arrangement. It mainly includes three parts: social public welfare undertakings, public utilities and public resource protection. Its essence lies in its sociality. Public utilities not only include social public welfare undertakings under China's planned system, that is, the five commonly used "science, education, culture, health and sports" industries and social welfare and social relief industries, but also include new social public welfare undertakings such as environmental resource protection, greening, social security, social security and employment services and community services under the market system, as well as public utilities such as roads, transportation Protection and operation of industries such as shipping, water supply, power supply and gas supply and public resources such as forests, water sources, mountains and parks. To build a harmonious society jointly built and enjoyed by all the people, we must vigorously develop public utilities and build a public service-oriented system with Chinese characteristics [1].

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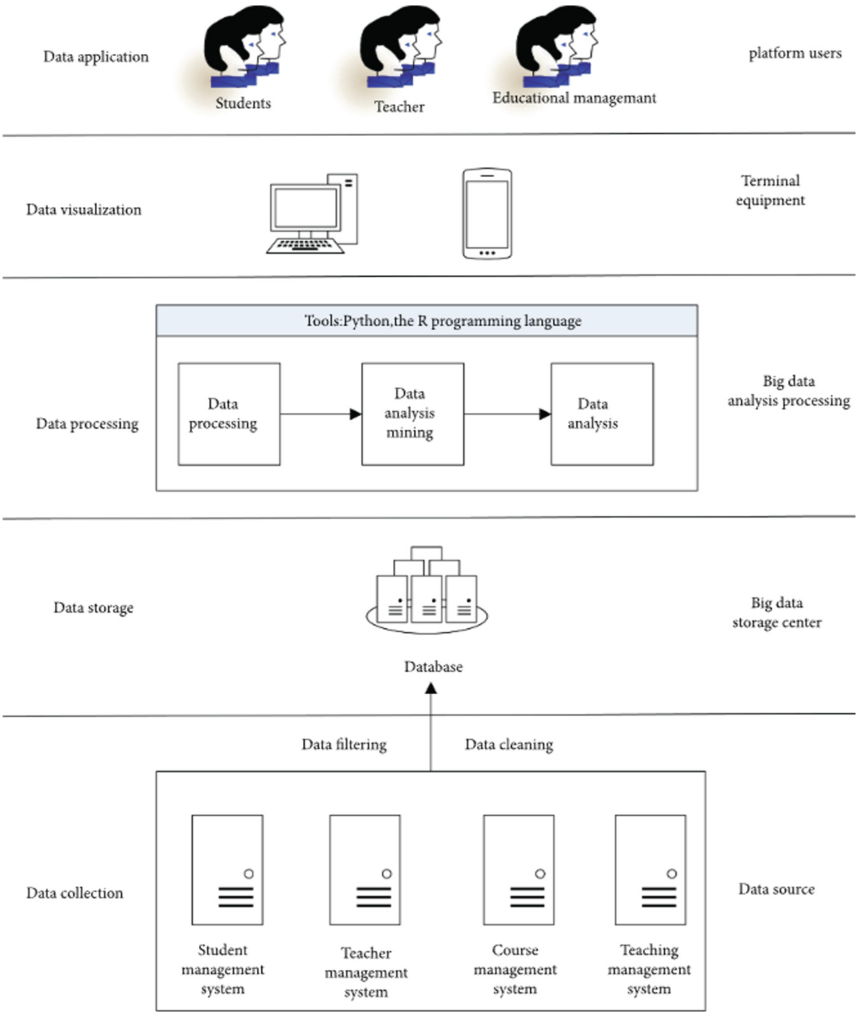

Fig. 1. The public information platform

Utilities face the continuous challenge of consistently meeting the demand for electricity. Facilities for power generation are usually well suited to supplying a constant amount of electricity. However, consumers' demand for electricity is often the opposite, because the total electricity demand changes significantly in the process of delay. One or more 'peak' demand times or periods in which the daily change leads to the greatest demand for utility companies, and the 'non peak' demand times or periods in which the demand for utility companies decreases. Therefore, this paper studies the application of neural network algorithm in public utility response problem Fig. 1.

From the perspective of China's reality and future reform trends, departments such as culture, education, social security, urban water supply, environmental protection and meteorology, and urban transportation are playing their own roles in different forms of ownership and organization. However, the obvious trend is that the state monopoly is weakened, the profit-making purpose is diluted, the degree of socialization is enhanced, and the self-discipline of management is remarkable. Their most essential feature lies in the overall interests of society and the public. They are not only closely related to the daily life of residents, but also closely related to the lifeline of national economic development. They are indispensable and have irreplaceable special functions.

1. The connotation of public utilities management and the professional characteristics of public utilities management the so-called public utilities refer to the activities and results of economic affairs that are related to the overall quality of life and common interests of all the public in the society, take social public affairs as the basic content and include the necessary social public nature.
2. Social and economic development and public utilities generally speaking, the so-called public utilities refer to various welfare and welfare facility systems that provide social security for the people between government organizations and enterprises.
3. Public utilities refer to social activities that face the society, take meeting social public needs as the basic goal, directly or indirectly provide services or create conditions for national economic and social development, and do not take profit as the main purpose.

2 Neural Network Algorithm

Based on the mathematical model with self-learning ability, neural network can analyze a large number of complex data, and complete extremely complex pattern extraction and trend analysis for human brain or other computers. The typical application of neural network is to establish classification model. Neural network regards each connection as a processing unit, trying to simulate the function of human brain neurons. Neural networks learn from experience and are often used to find the unknown relationship between a set of input data and a result. Like other methods, neural network first detects the patterns in the data, then summarizes the relationships found from the data, and then gives the prediction results. Neural network has attracted special attention because it can predict complex processes. The processing unit uses a series of mathematical functions to process the data through summary and conversion. A processing unit has limited functions, but after several processing units are connected to form a system, an intelligent model can be created. Processing units can be interconnected in many different ways. In order to more accurately fit the data for which the model needs to be established, they can be trained several times or even ten million times. The processing unit shall be connected with the input/output unit. The training of neural network is repeated according to the historical sample data. In the process of network training, the connection strength (i.e. weight) between input unit and output unit needs to be modified. The strength of a connection increases or decreases according to its importance to producing a result. The connection strength depends on the weight given to it in the process of repeated training. In the training process, a mathematical method called learning rules is used to adjust the weight. When the output results are consistent with the known results at the specified accuracy level, or meet other end criteria, the network training will not be carried out. In order to predict the outcome variables of each sample, a network should try various schemes.

$$\begin{cases} E(t)\dot{x}_k(t) = f(t, x_k(t)) + B(t)u_k(t) + d_k(t) \\ y_k(t) = C(t)x_k(t) \end{cases} \quad (1)$$

Among various neural network models, the feedforward neural network model is more applied and studied, as shown in Fig. 2 [2]. The feedforward neural network model is trained. Back propagation (BP) algorithm is a typical learning algorithm for feedforward network.

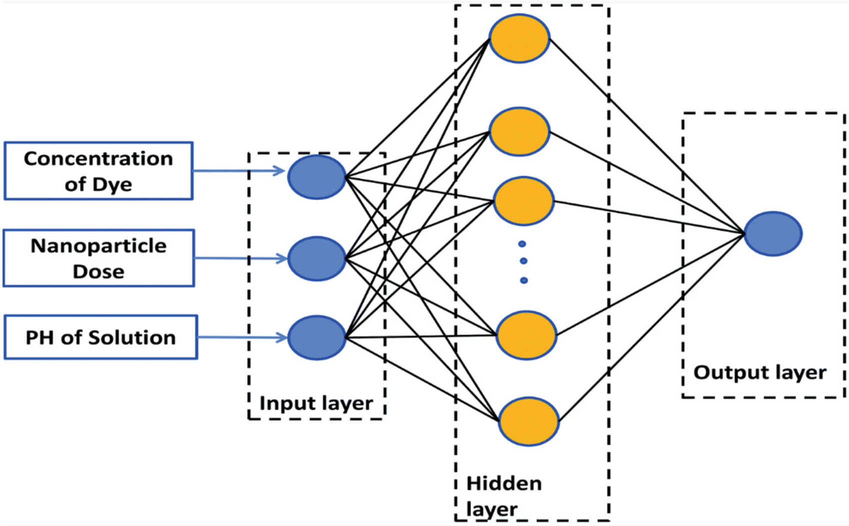

Fig. 2. Neural network model

The biggest advantage of neural network is that it can accurately predict complex problems. However, the neural network method also has some disadvantages:

First, although neural networks are useful in prediction, they are difficult to understand. However, the new neural network tools in the market have been significantly improved.

Second, neural networks are vulnerable to over training. If the neural network with strong learning function is trained with a small amount of data supporting this function, at the beginning, as we hope, the network learns the general trend in the data, but then the network continues to learn the very specific features in the training data, which is not what we want. Such networks lack generalization ability because they remember the training data. Today's commercial neural network has effectively solved this problem. The public information platform flow chart is shown in Fig. 3.

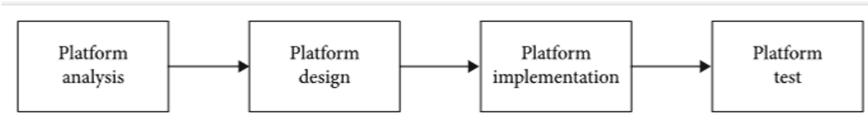

Fig. 3. The public information platform flow chart

3 Implementation Architecture of Public Utilities Response Based on Neural Network Algorithm

3.1 Implementation Architecture of Public Utility Response Based on Neural Network Algorithm

Neural network algorithm has a good application prospect in public utilities response, but how to apply it needs to build a perfect implementation architecture and implementation process. As mentioned above, public utilities have the characteristics of large number of responsive users and variable power consumption and response characteristics. At the same time, the power consumption characteristics of users are also affected by many factors [3]. A large number of users will bring huge computing pressure to e-sellers. Therefore, we can consider making full use of the computing power of the user side intelligent terminal to delegate the computing tasks perceived by single user behavior to the local, so as to reduce the computing pressure of e-sellers and improve efficiency. After collecting the data uploaded by users, e-sellers do not need to set up computing devices. They only need to build a computing model, and then purchase computing power from cloud service providers to complete the computing process. Its architecture is shown in Fig. 4.

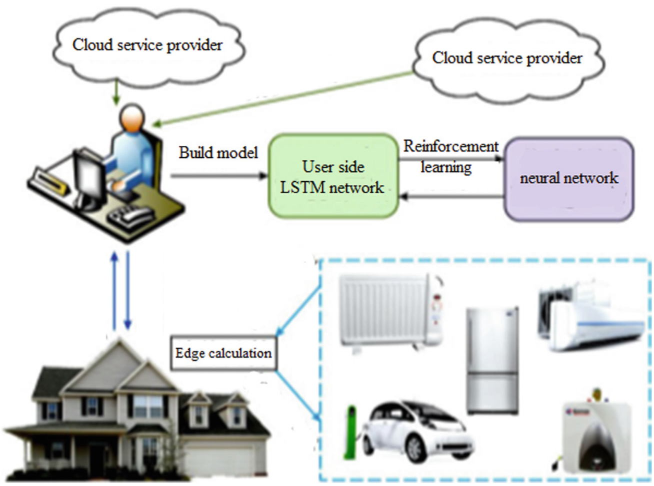

Fig. 4. Edge cloud computing architecture

On the user side, the local public utility response terminal collects the power consumption of users with different loads, establishes an LSTM network to perceive and deduce the power consumption behavior of different loads, and then when receiving the incentive signal from the incoming self-sale e-commerce, deduces the user's different responses and their response probability according to the incentive signal and external environment, and uploads them to the cloud. In the cloud, e-commerce sellers learn and integrate the power consumption behavior and response characteristics of user groups according to the response information fed back by users and combined with the real-time external environment, and select the optimal decision through the method of neural network algorithm, which is shown in Fig. 5 [4].

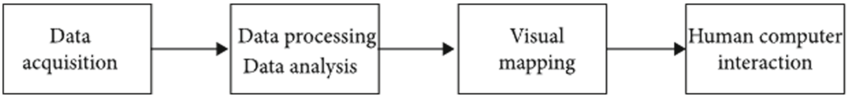

Fig. 5. System platform process.

3.2 User Virtual Response Network Based on LSTM:

The neural network algorithm trains the deep Q network by "trial and error" in the environment, and then selects the optimal strategy. In order to build a complete "trial and error" environment, it is necessary to establish a virtual environment that can simulate user response behavior to support algorithm training. According to the characteristics of users' actual response behavior and the characteristics of deep learning algorithm, a user virtual response network based on LSTM can be constructed on the user side with the support of edge intelligent devices on the user side.

The accuracy of user virtual response network for user behavior prediction will have a great impact on the training of neural network algorithm parameters, and then affect the comprehensive decision-making of e-commerce sellers. In order to verify the prediction accuracy of user virtual response network based on LSTM network, this paper preliminarily verifies the prediction accuracy of LSTM network based on the existing empirical formula. At present, some literatures have simplified the modeling of the response behavior of public utilities in response to users, and most of them use a quadratic function to approximate the user benefit function [5–7].

The existing empirical formula of user response is similar to the actual response of users to verify the learning effect of LSTM network on user response behavior. Where, a and β The normal distribution random value with 0.2 as the variance, considering that the response characteristics of users will change due to the change of environment in different periods, a and β The expected centers of normal distribution are different [8–10].

Figure 6 is a schematic diagram of the results of learning a user's response behavior using the LSTM network and then predicting its response behavior. In the figure, the response behavior of users in the next 20 public utilities response services is predicted (20 public utilities response services are distributed in different periods, and users receive

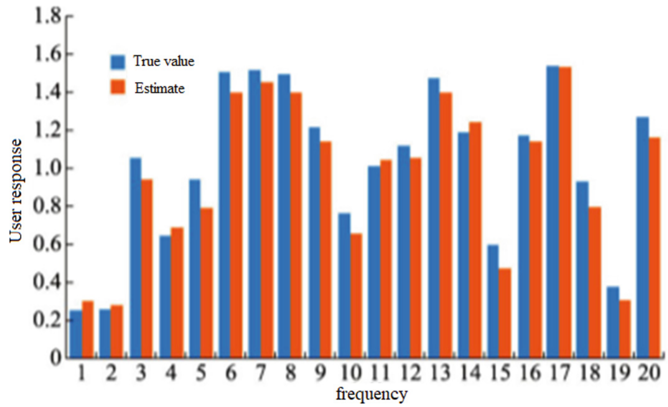

Fig. 6. Learning effect of user response behavior based on deep learning

different degrees of incentive). It can be seen that the prediction accuracy of user virtual response network based on LSTM network is high [11], and the response behavior of users can be simulated more accurately. At the same time, in the simulation process, set the training times to 200 times, and the model training time of ordinary laptop is less than 2 min. After the model training, the prediction time of the model is less than 1 s, so that the user's edge computing equipment can support the optimization of the depth model, It also shows that the user response virtual environment based on LSTM can

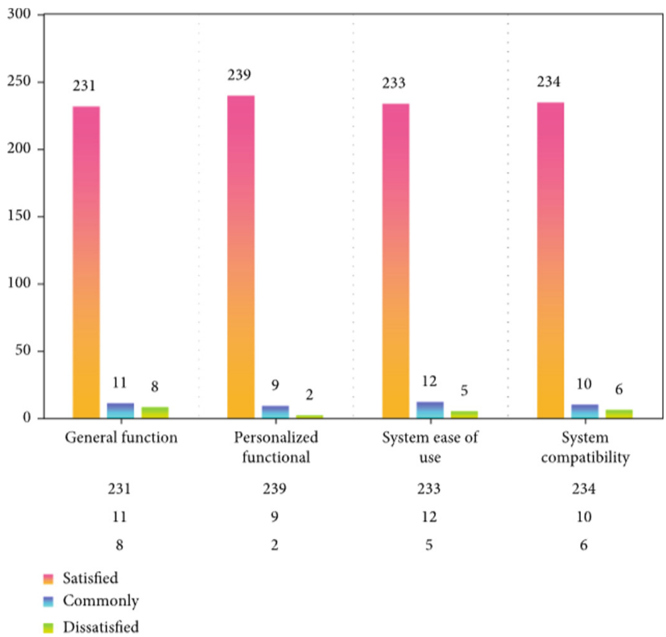

Fig. 7. The system platform testing simulation analysis result

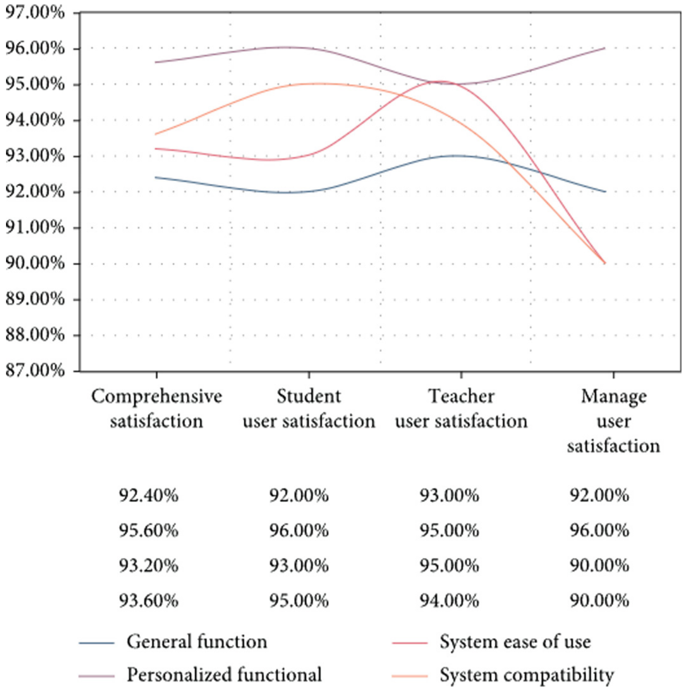

Fig. 8. Survey results of public information platform satisfaction

provide a more reliable external virtual "trial and error" environment for neural network algorithm [12–14].

The system platform testing simulation analysis is as follows which is shown in Figs. 7 and 8:

4 Conclusion

Neural network algorithm has strong information recognition and decision-making ability. With the rapid development in recent years, it has been successfully applied in many fields. With the progress of China's power market-oriented reform, the public utility response business also began to develop towards diversification and accuracy. There is an urgent need for a perfect user information identification and incentive decision-making system, and the neural network algorithm can meet this requirement. Therefore, this paper combs the development process of neural network algorithm, constructs the system architecture of neural network algorithm participating in public utility response business, and discusses the implementation process of neural network algorithm in detail. This paper only makes a rough analysis of the application and development of neural network algorithm in the field of public utility response, and the more in-depth detailed design needs to be modified and improved in the actual business development process. With the development of neural network algorithm technology and the promotion of market-oriented reform, neural network algorithm technology is bound to integrate into public utilities response business and provide strong support for business development.

It can be predicted that the equalization of basic public services in urban and rural areas has a long way to go, and cannot be achieved overnight. Looking at the gap and looking to the future, we must firmly establish the concept of caring for the people and seeking benefits for the people. We must implement the concept of building the party for the public and governing for the people in practical actions. In the magnificent new round of rural reform and development, we must always adhere to scientific development, constantly promote institutional innovation, and promote the inclination of public finance to rural areas, the extension of public facilities to rural areas, and the coverage of public services to rural areas, Make the overall level of public services in our province into the forefront of the west, and build a new pattern of equalization of public services for urban and rural residents and integration of urban and rural social and economic development.

References

1. Licheng, J., Shuyuan, Y., Fang, L., et al.: Seventy years of neural network: review and prospect. J. Comput. Sci. 39(8), 1697–1716 (2016)
2. Xuesong, C.: Yang Yimin A review of reinforcement learning research. Comput. Appl. Res. **27**(8), 2834–2838 (2010)
3. Haikun, W., Sixin, X., Wenzhong, S.: Generalization theory and generalization method of neural network. J. Automat. (06) (2001)
4. Xinghui, Y., Quantong, L.: diagnostic analysis of neural network in nonlinear dynamics. Microcomput. Inf. **01**, 179–180 (2009)
5. Paul, A., Jeyaraj, R.: Internet of things: a primer. Hum. Behav. Emerg. Technol. 1(1), 7–47 (2019). View at: Publisher Site | Google Scholar
6. Jeyaraj, R., Pugalendhi, G., Paul, A.: Big Data with Hadoop MapReduce: A Classroom Approach. Apple Academic Press, Cambridge (2020)
7. He, X., Tang, W., Liu, J., Yang, B., Wang, S.: Research on educational data mining based on big data. In: Liu, S., Sun, G., Fu, W. (eds.) eLEOT 2020. LNICSSITE, vol. 340, pp. 265–278. Springer, Cham (2020). https://doi.org/10.1007/978-3-030-63955-6_23
8. Huang, Y., Zhao, C., Zhao, G.: Intelligent technology for educational process mining: research framework, current situation and trend. E-education. Research, 41(8), 49–57 (2020). View at: Google Scholar
9. Xing, W., Wadholm, R., Petakovic, E., Goggins, S.: Group learning assessment: developing a theory-informed analytics. J. Educ. Technol. Soc. 18(2), 110–128 (2015). View at: Google Scholar
10. Liu, C., Xie, L., Han, Y., Wei, D., Yuan, X.: AutoCaption: an approach to generate natural language description from visualization automatically. In: 2020 IEEE Pacific Visualization Symposium (PacificVis), pp. 191–195, Orlando, USA, (2020).View at: Google Scholar
11. Yafeng, Z.H.E.N.G., Yaning, Z.H.A.O., Xue, B.A.I., Qian, F.U.: Survey of big data visualization in education. J. Front. Comput. Sci. Technol. 15(3), 403 (2021). View at: Google Scholar
12. Mikalef, P., Boura, M., Lekakos, G., Krogstie, J.: Big data analytics and firm performance: findings from a mixed-method approach. J. Bus. Res. 98, 261–276 (2019). View at: Publisher Site | Google Scholar
13. Tang, Z.: On study of application of big data and cloud computing technology in smart campus. IOP Conf. Ser.: Earth Environ Sci. 100(1), 012026 (2017). View at: Google Scholar
14. Cheng, S.L., Xie, K.: Why college students procrastinate in online courses: a self-regulated learning perspective. Internet Higher Educ., 50, 100807 (2021). View at: Google Scholar