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Application of Big Data Technology in the Heating Ventilation Air Conditioning Field

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Abstract*:* In the Internet era, people are faced with a large amount of data information in their life and work. Big data technology can help us quickly analyze the most valuable information from these massive data and reduce the classification time of cumbersome data. At present, big data technology has been widely used in all walks of life. Due to its large power, long running time and huge energy consumption, the heating ventilation air onditioning (HVAC) widely installed in modern engineering buildings is of great importance to reduce the power consumption of HVAC for the realization of building green energy saving. By adjusting the operation mode of HVAC, power consumption can be effectively reduced. The application progress of big data technology in building HVAC is briefly analyzed in order to promote the benign development of HVAC field.

Keywords Big data technology; Heating ventilation air conditioning (HVAC); Application strategy

INTRODUCTION

With the rapid development of social economy, people pay more and more attention to the quality of life, and put forward higher requirements for thermal comfort of living environment [Sun, 2020]. Building energy consumption increasing, brought huge challenges to supply, HVAC energy consumption in traditional research methods mainly include mathematical physics method, experimental method, numerical simulation method, although for building air conditioning research has brought a certain achievements, but the three methods are not considering the changing climate conditions and energy consumption of variable, and has its own specific scope of application and certain limitations [Mao, 2021]. The intelligent building system is gradually emerging, which stores a large number of building operation data and meteorological data, etc. Traditional research methods are no longer applicable, and new research methods and analysis tools are urgently needed to apply in the field of building HVAC. Big data technology is the most suitable tool for building HVAC data analysis because it can discover potential connections between data and make effective use of these data.

OVERVIEW OF BIG DATA TECHNOLOGY

Data mining is a process of automatically identifying useful knowledge and discovering the whole link from the database. It is a process of extracting and analyzing a large number of random data to make the whole data suitable for specific relational information. It is a part of the whole process of discovering in the original database. Raw data, like a source of knowledge, can be structured, such as data in a relational database, or semi-structured, such as graphics, image data, or even heterogeneous data distributed over a network. Data mining technology can be mathematical or non-mathematical, deductive or inductive. It is a wide interdisciplinary and a combination of various technologies [Gu, 2022]. Usually, computer technology is used to complete data statistical analysis and other operational objectives, and the process mainly includes 8 steps, as shown in Figure 1. At present, although data mining technology has been widely used in various fields, it is still in the preliminary exploration stage. In the future, the application of data mining technology in various fields will be further deepened.

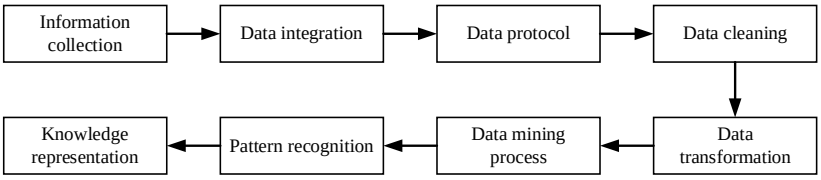

Figure 1 Figure 1 Data mining process

As shown in Figure 1, the data mining process is a repetitive process, and if each step fails to achieve the desired goal, it needs to go back to the previous step, readjust it and execute it. Of course, not every data mining effort will require each of the steps listed here, depending on the situation, such as the data integration step can be omitted when there are no more than one data source in the work.

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IDEAS OF APPLYING BIG DATA TECHNOLOGY IN HVAC FIELD

Application roadmapd

In HVAC study, in the building automatic control system for storing large data for the data base, data mining techniques as tools, can effectively find building air conditioning system internal rules, the hvac field research into a new stage, the current research in the field of data mining technology in hvac mainly includes three levels, mainly includes three aspects, see Figure 2 for details. Its application is mainly completed through the following steps:

(1) Data classification and collection: data collection and classification of fluid flow, indoor temperature and humidity, and operating power of HVAC equipment.

(2) Preprocess the collected and classified data to improve data quality and ensure data integrity.

(3) According to the characteristics of the collected data, select the corresponding analysis algorithm, construct a model to clean up the data, optimize the model parameters, and achieve the best application effect.

(4) Analyze and clarify the accuracy of the final results, find out the shortcomings in the application process of the model, and then solve the problems.

(5) Ensure the scientific nature of operation through the rational use of the construction model.

These five steps can give full play to the application advantages of data mining technology in the field of HVAC [Chen, 2019].

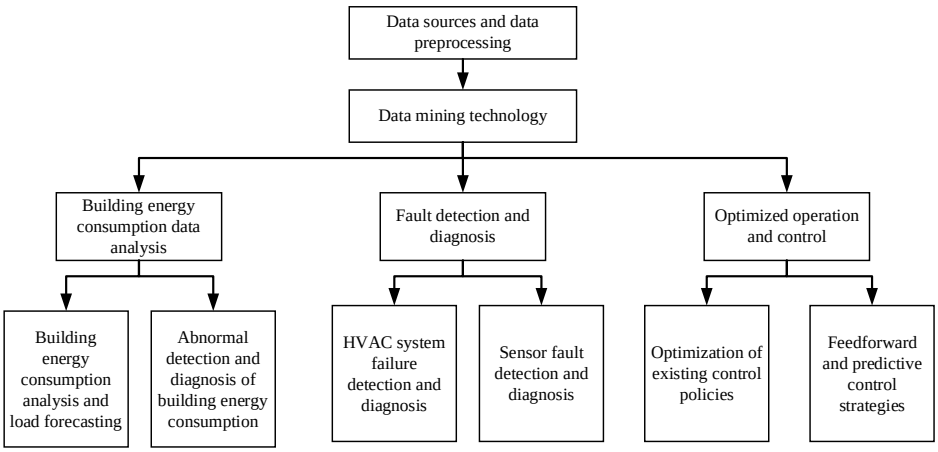

Figure 2 Application structure of data mining technology in HVAC field

Application Framework

In the process of applying data mining technology to the field of intelligent buildings, relevant researchers have proposed a general data mining framework for building automation system based on the consideration of system complexity and low data quality of building automation system, as shown in Figure 3.

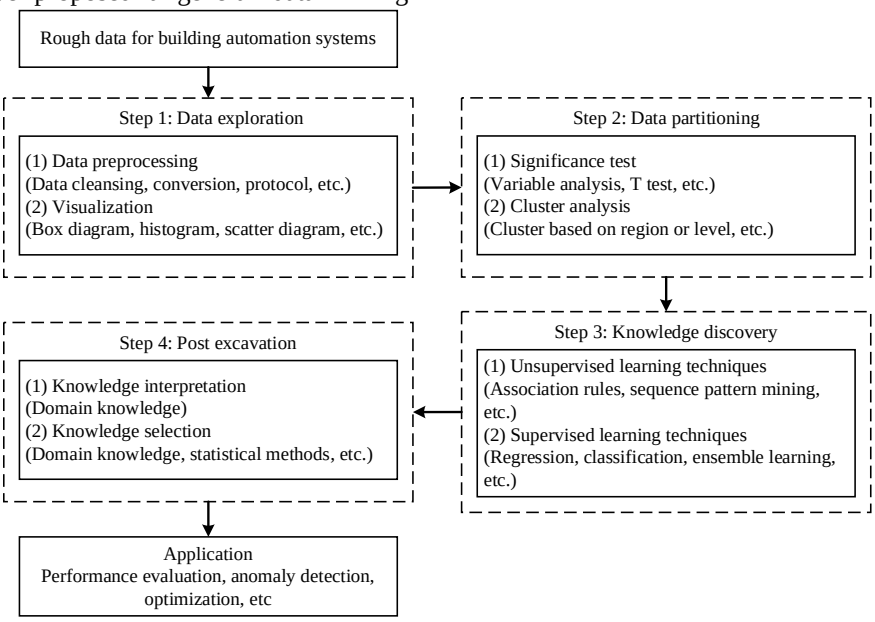

Figure 3 Data mining framework

The framework mainly includes four steps: data exploration, data partitioning, knowledge discovery and post-mining, among which data exploration mainly includes data preprocessing and visualization. This framework has been applied in the research of building automation system of the tallest building in Hong Kong, and has successfully realized the function of anomaly and fault diagnosis of building equipment system [Ma, 2021].

Other researchers put forward a data mining process based on traditional knowledge discovery in the relevant research on the occupancy pattern of office buildings, as shown in Figure 4 below. The framework includes three steps: data preprocessing, data mining and knowledge extraction. In the data mining part, decision tree, rule induction and data clustering are used to effectively mine the occupation pattern and work progress of office users based on the three-step data mining method.

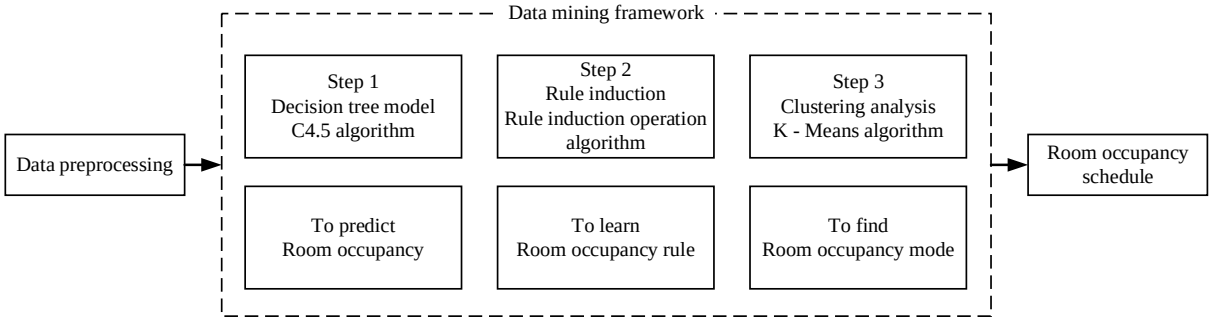

Figure 4 Mining process of building occupation pattern

THE ROLE OF BIG DATA TECHNOLOGY IN HVAC

Application roadmapd

Data mining for building hvac energy consumption data mainly includes the following five steps: (1) Collecting data sets, such as temperature and humidity, solar radiation intensity and atmospheric pressure; (2) Preprocessing the collected data set to improve the data quality and accuracy; (3) Analyze the characteristics of the collected data, determine the appropriate analysis algorithm and build the model based on the big data platform to ensure the accuracy of model parameters; (4) Analyze the results and find out the advantages and disadvantages of the model; (5) Application of the model.

In addition, some related researchers proposed a comprehensive integrated intelligent II-T method for building energy consumption analysis, which combined clustering, classification, outlier analysis algorithm, association analysis and budget algorithm [Xu, 2022]. The specific application process of the algorithm is shown in Figure 5.

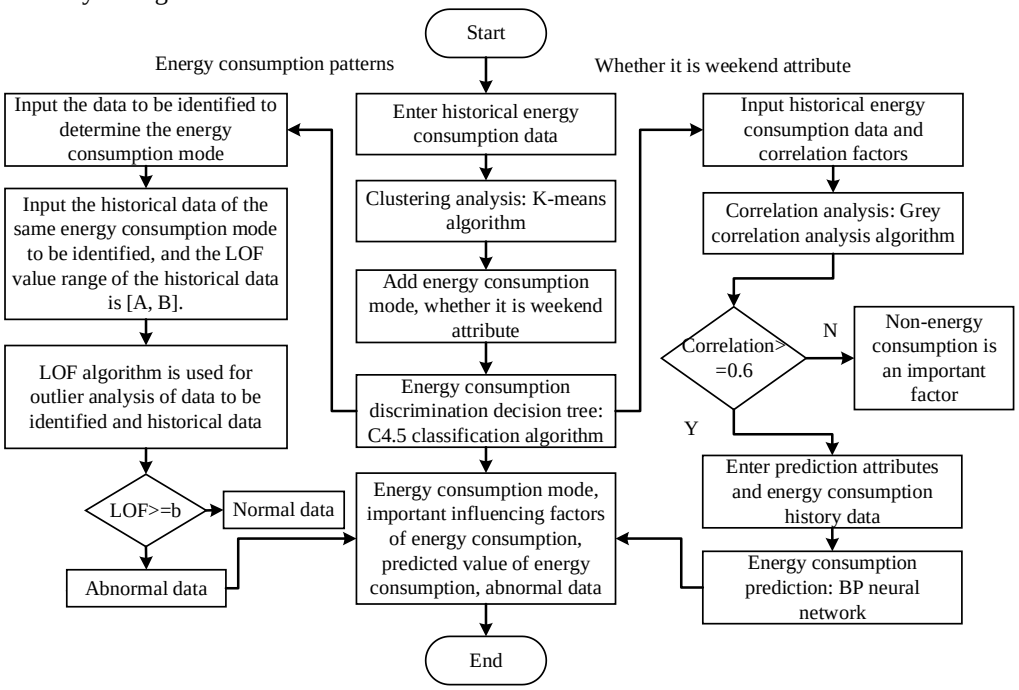

Figure 5 IIT algorithm application flow chart

In the framework of the method, the outlier analysis algorithm based on clustering algorithm mainly classifies the building energy consumption data, so as to realize the effective identification of the energy consumption pattern of the building energy consumption data. Under the same energy consumption mode, the LOF values of the data are very similar. Therefore, rational use of LOF algorithm for outlier analysis of historical building energy consumption data with the same energy consumption pattern can enhance the identification accuracy of abnormal energy consumption data to a certain extent. With the help of grey correlation analysis, the identification accuracy of factors affecting building energy consumption data can be improved, and BP neural network can predict building energy consumption more accurately based on historical energy consumption data and important factors.

Data-driven optimal control strategy

Traditional control strategy mainly adopts the method of mathematical physical model such as theory analysis, there is a certain error, and air conditioning systems are more or less simplified, so the theory and practical operation control are not always completely consistent, improper theoretical model simplified theory and actual operation may result in air conditioning system control serious deviation, increase rather than decrease energy consumption, in order to change this kind of defect, Based on the actual data, the tools of various control parameters must be optimized by using data mining algorithm, and the method of data-driven optimal control strategy should be established to make the system run optimally [Cui, 2018].

APPLICATION STRATEGY OF DATA MINING TECHNOLOGY IN HVAC FIELD

Feedforward control technology

Feedforward control technology is based on data and model algorithm, through measuring the change of disturbance and controller control, directly overcome the influence of disturbance on the controlled variable. With the rapid development of big data technology and computer technology, feedforward control technology has also been widely used in the field of HVAC control. Its application is mainly reflected in the following aspects:

(1) In the application of the hvac system control, feedforward control technology for air conditioning cold source equipment operation parameters optimization, control water chiller is one of the key equipment of cold source system, its operation energy consumption by the load and the cold water for the return water temperature and the influence of equipment running status, the researchers on this basis, the feedforward control projections for the operation of the chiller. In addition, the feedforward control technology can also adjust and control the operation parameters of the air conditioning water system. In view of the characteristics of large disturbance and large delay in the supply air temperature control loop and the return water temperature difference control loop of the HVAC system, the feedforward control technology is used to realize the air regulation of variable flow rate and variable operation.

(2) Application in indoor thermal environment: There are many factors which can affect human body comfort, such as environmental temperature, air velocity, so the suitable control algorithm was used to optimize hvac equipment, have important effects on improving the indoor thermal comfort, scholars have found that indoor air quality can be controlled through the model to estimate, indoor temperature can be controlled by the centralized and distributed model to estimate to set, A feedforward decoupling generalized predictive control algorithm based on HVAC parameter model is developed, and good thermal comfort is finally achieved.

Probabilistic neural network technology

The application of probabilistic neural network technology is mainly to formulate strategies to reduce energy consumption by analyzing and studying the HVAC model constructed. Probabilistic neural network, namely PNN, is a feedforward neural network, which is evolved from radial basis kernel function neural network. In the application of HVAC engineering, The linear learning algorithm and nonlinear learning algorithm in probabilistic neural network are mainly used to solve the problem of data classification. The input layer, mode layer, summing layer and output layer constitute the probabilistic neural network model. The structure diagram is shown in Figure 6, with simple operation and higher data accuracy.

As shown in Figure 6, the main function of the input layer is to train the transmitted HVAC data, and then transmit the input data to the next mode layer. The main function of the mode layer is to display the corresponding relationship between each module in hVAC data and the characteristic vector transmitted by the input layer. The sum layer mainly functions as computation. The number of neurons in this layer is the same as the total number of neurons in the sample layer, and the neurons are only connected with the corresponding neurons in the pattern layer. The main function of the output layer is to receive the output results of the summation layer, and then find the maximum posteriori probability density of a neuron in the output layer of all neurons. The main measures to reduce hvac energy consumption by using probabilistic neural network technology are as follows: (1) Increasing evaporation temperature, reducing condensation temperature and reducing temperature difference. (2) Reduce the pump frequency; (3) Predicting the lag of water system; (4) Dynamic adjustment of various parameters, in a specific space to adjust the air temperature, humidity,

airflow speed and cleanliness, to meet the requirements of human comfort.

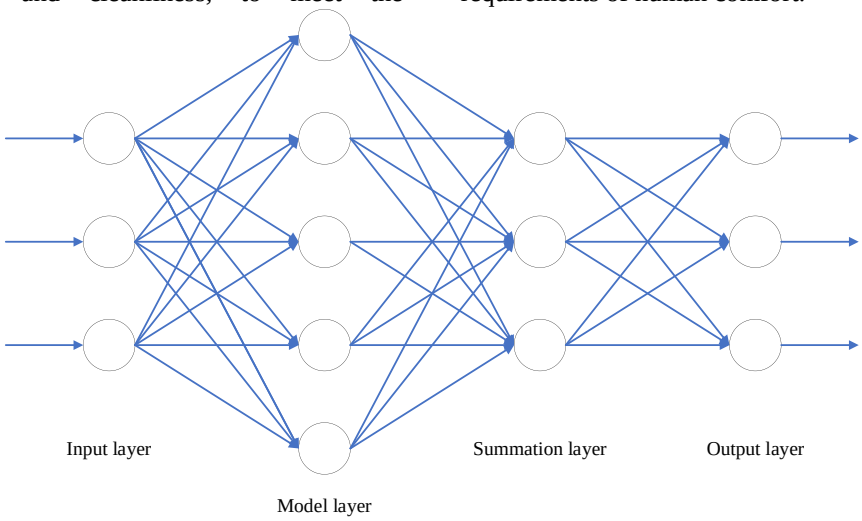

Figure 6 Basic structure diagram of probabilistic neural network technology

Expert System

Building HVAC system is a complex and huge system, which is prone to failure. In the process of system operation, the equipment is required to be cleared immediately after failure. Expert system is particularly good at dealing with this problem, so it is necessary to apply expert system to HVAC fault detection. Firstly, the expert system will find the fault location according to the occurrence of the fault by inference network, establish a diagnostic model, and judge the cause of the fault. In addition, when hvac serious fault occurs, can only stop to affect people's daily life, has the ability of personification of intelligent expert system, the main research qualitative system control and decision problems, and is beyond the scope of whole information cybernetics and in hvac fault detection and operation management plays an important role.

CONCLUSIONS

To sum up, big data are applied to the HVAC field construction, effectively promote the progress of hvac industry development, this paper briefly analyzes the HVAC big data technology application, and big data technologies, probabilistic neural network feedforward control technology in technology and concrete application in the field of expert system in HVAC, promote the development of intelligent building industry.

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