

Big Data Technology Applied to the Architectural Heritage Protection

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Abstract: China is a large country of world cultural heritage, with a rich number of architectural heritage(AH) of various types. With the continuous expansion of the objects of AH protection(AHP), the number of AH to be protected is also increasing, and the protection work is urgent. Under the current policy and system, conservation planning is the main means of protection, and the preparation of AH conservation planning needs to be based on detailed information, so high-precision acquisition of current information is crucial. This paper studies and analyzes the application of big data in the protection of AH, analyzes the analysis process framework of big data in the protection and management of AH, discusses the development of strategies for the protection of AH assisted by big data technology(BDT) achievements, strives to comprehensively and carefully summarize the protection strategies of AH, and discusses the feasibility, practicality and expansion of the application value of BDT in the protection planning of AH, So as to provide support for enriching the technical means for the preparation of AHP planning and enhancing its scientificity and rationality.

Keywords: Big Data Technology, Architectural Heritage, Heritage Protection, Big Data Application

1. Introduction

With the transformation of building protection concept and protection demand, traditional surveying and mapping achievements such as two-dimensional line drawing and photos can no longer fully meet the needs of protection planning work such as building accurate record, data reproduction, status analysis and multiple displays. At the same time, BDT has developed rapidly, and its technical achievements cover external spatial data acquired by air platforms and indoor and outdoor data acquired by ground equipment. BDT can meet the needs of AHP planning. A variety of new surveying and mapping results derived from new technologies enrich the content of information collection and can meet the information needs of AHP planning. At the same time, the results can be applied to the digital and information management of AH, providing technical support for the implementation and management of AHP planning.

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Many scholars at home and abroad have studied and analyzed the application of big data in the protection of AH. Caballero Rubio F J expressed the possibility of applying KDD and data mining technology to cost management and quality management in construction project management with big data [1]. ICT technology is proposed to provide data acquisition means and methods for project cost, plan, risk, safety, process supervision and quality control. Preston J et al. used the DOE building performance database to collect and establish data on building performance, so as to evaluate the building performance and estimate the energy-saving effect brought by the building reconstruction, and proposed to mine and analyze the quality inspection data to improve the quality [2].

The application of BDT in protection planning has become an inevitable trend in the development of protection planning. Based on the existing building protection theory, technical requirements for the preparation of protection planning and protection needs, this paper preliminarily discusses the application of BDT achievements in the preparation of AHP planning from the perspective of AHP. On the basis of following the relevant specifications for AHP and the relevant technical regulations for the preparation of AHP planning, consider "The advantages of big data, discussed the application of BDT and achievements in the protection planning information collection, strategy formulation, planning preparation, planning implementation supervision, etc., and analyzed and summarized the information needs of each stage of the construction heritage protection planning in the current context; based on the current BDT and construction heritage protection needs, discussed the application of big data in the construction heritage protection, sorted out the types of achievements and their achievements Advantages in obtaining and using fruits [3-4].

2. Big Data and AHP Analysis

2.1 Analysis of AHP

2.1.1 Protection of AH

The concept of "heritage" has been expanded and changed to include cultural heritage, natural heritage, etc. AH is subordinate to cultural heritage and can be seen as a sub type of cultural heritage. "Cultural heritage refers to various cultural elements created by the ancestors of various nationalities or a collection of various cultural elements, including material, spiritual, social and other aspects of culture.". In China's urban and rural planning system, according to the scope and level of protection objects, there are protection plans for historic and cultural cities, towns and villages, historic and cultural blocks and cultural relics. At present, the current legal and regulatory system related to AH in China is not perfect. In the whole cultural heritage protection system in China, protection planning plays an extremely important role. To sum up, protection planning is a plan that takes coordinated protection and construction development as the starting point, determines the protection principles, contents and priorities of historical and cultural heritage, and puts forward protection measures as the main content [5-6].

2.1.2 Information demand for AHP planning

AHP planning needs to be based on substantial basic information. The primary task of preparing AHP planning is to obtain detailed heritage information. The information demand for AH runs through every link of the protection work. Timely and effective information guarantee is extremely important for the protection work. Accurate and efficient information acquisition and sustainable information update of information sources are the basis of this guarantee. Considering the particularity of AH, its protection planning information needs have the following characteristics:

Diversity and complexity of information types: different protection objects and different types of information achievements require comprehensive support of multi-source information for current protection status and disease discovery; Different stages of protection planning lead to different information needs; The access channels are different, and the information achievements are various and complex.

Relevance and sharing of information: protection work is a circular, collaborative and sustainable work process. Information needs at different stages are interrelated. Sharing of information achievements at different stages and departments is an important basis for the formulation and implementation of protection plans [7].

Dynamic and timeliness of information: AH is not isolated from the social and natural environment. It is affected by natural conditions and human activities all the time. At the same time, according to the different preservation status of AH, its protection planning and repair projects are also implemented periodically. These factors make AH information dynamic, developmental and highly timeliness [8].

2.2 Theoretical Basis of Big Data

The definition of big data is abstract. It should be pointed out that big data is not an emerging technology, but a normal phenomenon in the digital era. Big data is not simply a large amount of data, nor is it an application of cloud computing. The application of big data is a comprehensive solution, which uses various technical methods to meet the needs of data resources in terms of collection, storage, analysis and application. The key to big data implementation is to obtain valuable information from a large amount of information [9-10].

Combine the definition of big data, summarize the characteristics of big data, and provide guidance for the application of big data. The differences between traditional data analysis and big data analysis are shown in Table 1. Through comparative analysis, big data has the following characteristics.

Table 1.The difference between traditional data analysis and big data analysis

Comparative factor	Traditional data analysis	Big data analysis
data type	Structured data, data source is strictly defined	Structured, semi-structured, unstructured
Analysis scope	Microsampling	Macro overall data
Analysis purpose	Linear causality	Correlation between things

2.3 Analysis Process Framework of Big Data of Construction Heritage Protection Management

In the protection of AH with BIM as the carrier, each uploaded quality management data contains information such as location and time. Although the data type is complex and the update speed is fast, in the BIM model based on component level, each piece of quality management data is associated with the component through ID, and the information in the design stage, construction stage, completion acceptance stage, and operation and maintenance stage is dynamically collected, modified, and optimized, With strong timeliness and traceability, it is easy to form massive data[11].

Through the description of quality problems in the process of AH management, the value mining is carried out to find common and individual problems, providing a data basis for the prior control and post improvement of quality management. The construction simulation is realized through BIM. From the perspective of 4M1E, the quality influencing factors are strictly controlled, and the quality control and quality assurance are strengthened, so as to reduce the quality problems of AH and ultimately improve the protection effect of AH.

In the process of building heritage protection based on big data, the description of quality behaviors that do not meet the requirements of standards and specifications and the quality problems they cause is linked to the BIM model with unstructured text documents. Such data has no definite format and it is difficult for computers to understand its semantics. To realize its value utilization, text mining technology should be used to realize the value mining of unstructured text data. In text mining, the data source is an unstructured text document in the text collection. It needs to preprocess the text document data, and then realize the core mining such as pattern discovery, trend discovery, and finally realize the use of knowledge to reorganize information. The application process of text mining in AHP is shown in Figure 1.



Figure 1. General process of text mining

Through text clustering and semantic network analysis, keywords and the relationship between keywords are extracted to achieve text dimension reduction and text representation, and data is presented in a visual form using tools [12].

3. The Application of Big Data in the Protection of AH

3.1 Quality Text Data Preprocessing

The data formed in the process of building heritage protection are mostly stored in the form of text documents, and unstructured data expressed in natural language. In view of this feature, it is necessary to standardize the initial data in the text set.

3.1.1 Text data cleaning

Data warehouse is a collection of data in different forms from different databases, which are all real data records described in natural language and have the same characteristics as traditional databases. Through data cleaning, duplicate data, entry errors, missing values, and meaningless values are processed, and data exceptions are detected and adjusted as early as possible to provide high-quality and standardized data resources for text mining. Data cleaning mainly adopts the following measures to achieve data standardization:

3.1.2 Text segmentation

Words such as "existence", "local", "first floor", "part", "individual", "serious", "phenomenon" and other words marked with text properties shall be filtered out. For words that have no significant impact on the text content, words with frequency of 50 times, These phrases are abbreviations of common quality problems in the process of AHP.

3.2 Text Data Clustering

The text data after text data cleaning and text segmentation shall be used to establish its corpus. TF-IDF calculation shall be carried out for each feature phrase in the text representation to obtain its weight. TDM matrix shall be established to realize the structural transformation of unstructured data. The clustering analysis of text data shall be realized by clustering the matrix.

Cluster analysis discusses the similarity of text data of construction project quality problems in description by explaining the clustering results, providing reference for the standardized description of the text; Secondly, the establishment of data index and correlation analysis are conducive to the comprehensive management of specific issues; Furthermore, the clustering analysis method is used to achieve data preprocessing, and on this basis, the text structured representation, semantic network analysis and other applications are carried out to greatly improve the accuracy and mining efficiency. Figure 2 is the text clustering flow chart.

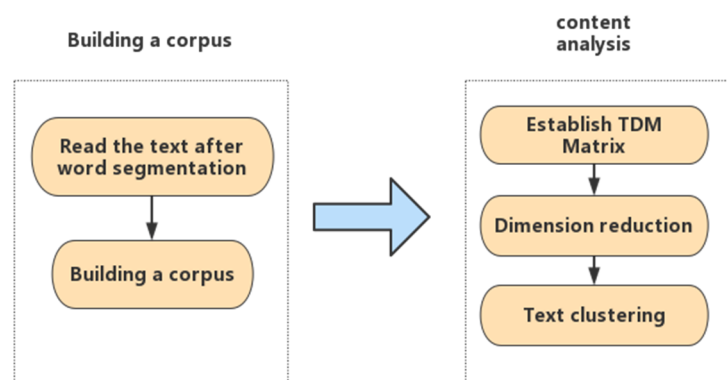


Figure 2. Text clustering flow chart

Transforming the text content into a matrix and giving each phrase a corresponding weight is the basis of the clustering algorithm. The mathematical representation of TF-IDF is:

$$TF = \frac{t}{d} \quad (1)$$

$$IDF = \log\left(\frac{n}{m}\right) \quad (2)$$

$$TF * IDF = \frac{t}{d} * \log\left(\frac{n}{m}\right) \quad (3)$$

4. BDT Aided Analysis of AHP Strategy

4.1 BDT Achievements Support the Formulation of AHP Strategies

In the development stage of protection strategy, space control, building protection and renovation technology intervention, landscape and environment control and display education are mainly considered. Under current conditions, the methods for protection strategy development are relatively mature, and the specific information use and operation are relatively scientific and perfect. On the basis of the existing background conditions, the application of BDT is a rich supplement to the existing methods and means, Strive to improve the strategy formulation method at the current technical level stage.

4.1.1 Development of auxiliary space control strategy - division of protection scope

The delimitation of protection zoning is one of the most important tasks in the planning of AHP, and is the fundamental measure to achieve the goal of heritage protection, which directly affects the success rate and operability of the planning. Because the protection zoning itself has important legal significance, it has become the most important method to protect AH. The delimitation of protection zoning is one of the most important and basic technical works in the protection planning of AH, an important basis for graded protection of protected objects, and a basic method for the planning department to conduct graded management of AH. Therefore, the delimitation of protection zoning is a problem that all AHP plans need to solve.

The delimitation of protection zoning needs to comprehensively consider the self protection needs of AH and the surrounding traffic, landscape and other environmental factors. Common boundaries of protection zones include geographical boundaries, road boundaries and administrative boundaries, among which the geographical boundaries mainly include river systems, ridge lines, catchment lines and other boundaries with obvious geographical characteristics; The road boundary mainly includes the road sideline or centerline around the building; The administrative boundary refers to the existing administrative boundary involving land production areas.

4.1.2 BDT Assists the Implementation Monitoring of AH Planning

The planning of AHP is a long-term process, but also a periodic work. It is necessary to monitor the implementation of the strategies and evaluate whether they reach the planning goals. For the contents that need to be revised, corresponding planning revision procedures should be started.

Generally speaking, the supervision, monitoring and management of the implementation of the AHP plan includes three aspects: cultural relics, planning administrative departments, public opinion, and third-party neutral expert evaluation institutions. From the perspective of the management department, it mainly involves the monitoring of the land and environment around the AH and the monitoring of the AH itself. At the current detailed planning stage, the application of BDT achievements in building heritage monitoring mainly includes two aspects, as shown in Figure 3. On the one hand, it directly analyzes the information collection results of low altitude information, finds out the changes of AH and its surrounding environment, and puts forward targeted improvement strategies to achieve the purpose of monitoring and management; On the other hand, we use the flexible characteristics of UAV to monitor the AH and its environment for many times, and analyze its changes with the passage of the time axis.

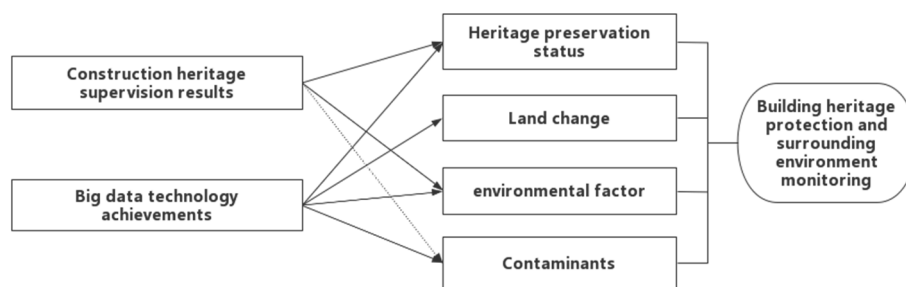


Figure 3. BDT Assisted AH Monitoring Map

4.2 Building Heritage Monitoring

The monitoring of the AH is not only the monitoring of the implementation effect of the protection plan, but also the normalization work. It is the main method for risk identification and assessment, mainly including the monitoring of the physical environment such as the building structure, building materials and the surrounding temperature and humidity. It should be carried out regularly and for a long time according to the specific situation. At present, the local monitoring of AH mainly focuses on ground manual monitoring. Low altitude UAVs are mainly used in three aspects: assisting in the monitoring of blind spots such as roofs, carrying infrared detection equipment to investigate potential diseases, and carrying a temperature and humidity meter to monitor the surrounding humid and hot environment.

In addition, with the development of wireless sensor and computer technology, the wireless sensor network technology has become quite mature. The combination of wireless sensor network technology and unmanned aerial vehicle (UAV) technology forms a UAV-WSN information system. The WSN node is used to sense, collect, store and process the analyzed

data. The UAV carries the corresponding processor to receive and collect the data in the entire area and store it, And transmit the data information to the observer for analysis. The UAV-WSN information system has a broad application prospect in the protection and monitoring of AH. Within the scope of AHP, sensors can be deployed to conduct high-density real-time monitoring of AH. With the development of wireless sensor networks and UAV technology, the information that can be monitored will become more and more abundant.

5. Conclusions

Under the new social background, the scope of protected objects of AH is constantly expanding, and the destruction of protected objects is also constantly intensifying. These changes in reality put forward new requirements and challenges for the planning of AHP. BDT has the characteristics of fast, flexible use, wide range of use, and perfect information collection. Its technical achievements are increasingly rich, which can meet the current information needs for protection. This paper analyzes the application of big data in the protection of AH, involving many fields such as architecture, planning, surveying and mapping. The intersection of disciplines makes the research more difficult, and there are some omissions: the research focus of this paper is the summary and collation of BDT achievements and the analysis and research of its application in the protection planning of AH. The research is not deep enough; There are problems in data processing and file format conversion when BDT achievements are applied to the planning process of AHP, so detailed research is needed on the office processing of data collected by BDT; The current research on information acquisition and protection planning of underwater and underground AH remains insufficient and needs further research.

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