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Research Article

Urban Renewal Design Based on Integration of Database Information under Data Mining

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It is necessary to integrate the data reflecting the spatial organization and residents' behavior characteristics in design of urban space renewal. Accordingly, based on the current principles of urban space design, a design platform for urban space renewal under the background of big data is proposed in this paper. Through the analysis of platform requirements and the design of organizational structure, the information integration of urban spatial database is mainly studied, where the database features are extracted through data mining, and the information entropy detection algorithm is used to implement data clustering, so as to rationally allocate urban spatial information and schedule resources and provide new ideas for urban design.

1. Introduction

City is a complex giant system, and the urban space renewal with the city as its object inevitably needs to coordinate the relations among society, economy, culture, and material space. The corresponding management decisions and the implementation of management rules need to rely on a large number of information support [1, 2]. In addition, reasonable use of land resources can greatly improve the efficiency of urban spatial renewal and correspondingly promote the development of urban research and urban planning theory [3, 4]. At present, with the deepening of informatization of urban planning, vast quantities of urban planning data have been accumulated in the database. However, the collection, collation, and analysis of all kinds of data have not established relevant standards, which leads to the lack of standardization and makes it impossible to manage rational analysis and judgment based on valid data, thus resulting in the waste of basic data and restrictions of the further development of urban space planning and design [5–7].

Therefore, based on the principles of urban spatial design, this study focuses on the integration of urban spatial databases, puts forward the concept of a new urban spatial renewal design platform under the background of big data, and analyzes the requirements and architecture of the design platform. With the help of artificial intelligence technology, the characteristic information can be fed back to urban designers and urban planning and management departments.

2. Principles of Urban Renewal Design

2.1. Concept of Urban Renewal. As shown in Figure 1, urban renewal can be divided into three aspects [8–10]: reconstruction, renovation, and preservation.

(1) Reconstruction or redevelopment means adding new content forms to the space, broadening the scope of coverage and thus ensuring the environmental quality, and rebuilding a certain aspect of the space environment that does not meet the demand.

(2) Regulation generally refers to the inventory changes through reasonable allocation in the form of small-scale adjustment.

(3) Preservation can keep some status quo that represents the city's cultural characteristics and keep the original status unchanged.

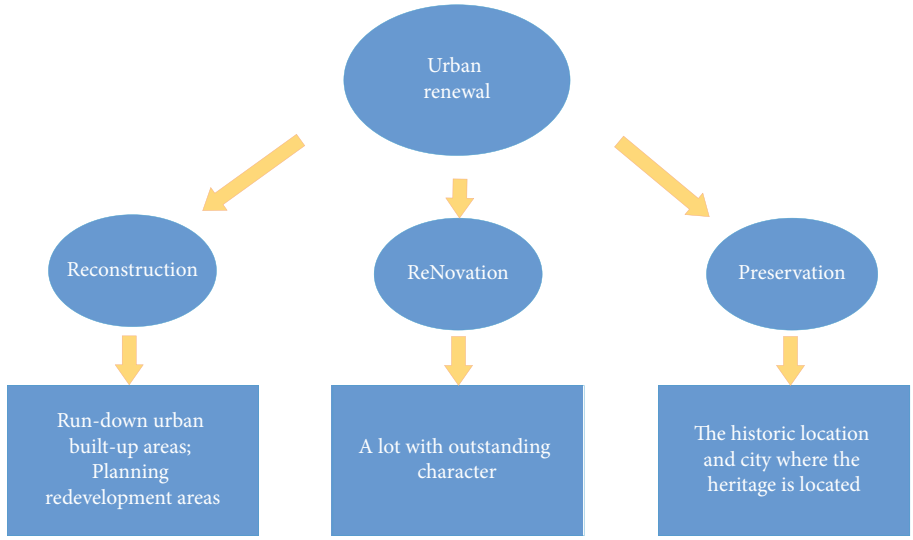

Figure 1: Content of urban renewal.

2.2. Principles of Urban Renewal Design

2.2.1. Convenient Transportation. Because the functions of urban space are relatively diversified and the attributes of public services are relatively strong, the requirements for the convenience of space use are higher [11, 12]. Therefore, when designing space, the principles of convenient transportation should be followed [13]:

(1) According to the requirements of users and the utilization rate of space, rationally aggregate space and organically integrate functions, so that the space path is the shortest and the traffic route is smooth.

(2) Consider the reasonable and convenient external connection, set up the entrance and exit reasonably, and ensure the smooth connection with urban roads.

2.2.2. Regional Principle. The principle of regionalism in the process of urban space design cannot be ignored. We should sort out the development prospect and evolution of the city, excavate its cultural value and the uniqueness of its spatial appearance, and extract the local unique regional cultural elements. Regional characteristics and regional symbols from deep-seated aspects should be expressed such as myths and legends, distinctive costumes, architectural language, and values, which will help to achieve the goal of newer urban development and provide a basis for the introduction of practical and feasible policies.

2.2.3. Forward-Looking Principle. Due to the difference of residents' age and status, the requirements of different audience groups will be different, and the corresponding needs of the same audience group will be different due to individual ideological differences and changes of time period, which is a dynamic process in general [14, 15]. The most valuable object and component of urban space is people, so their needs should be considered first in the updated design. To further update, it is necessary to fully understand residents' inner feelings and immediate needs and effectively improve the urban environment. Keep exploring the progress of people's lifestyle, study the direction of people's lifestyle change, and then provide forward-looking guidance for urban space design. Further renewal work needs to fully understand residents' inner feelings and immediate needs, effectively improve the urban environment, and guarantee residents' quality of life.

3. Urban Design Platform under Data Mining

With the support of big data, 5G technology, cloud technology, Internet of Things, and other technologies, designers of urban space can construct management platforms for big data mining and can predict the problems existing in the urban renewal process, so as to carry out the dynamic management of the whole process [16–18].

3.1. Data Mining. In the era of big data, data miners should choose data mining methods scientifically and reasonably according to the actual situation and the characteristics of objectives and requirements. Most data mining algorithms use one or several objective functions and several search methods, so as to find a point or a small area in the data volume or the data space with established distance relationship, where the best points and small areas are not important, and the data mining model built with them is the core of data mining.

As indicated by the mining techniques, information mining calculations can be isolated into educator type and non-instructor type, additionally called administered learning and unaided learning. In administered learning, given an instructor's sign, each info test in the preparation test set can be given classification imprint and arrangement cost, and the heading that lessens the general expense can be found. The system automatically forms clustering for the input samples, as shown in Figure 2. Typical methods for data analysis of massive

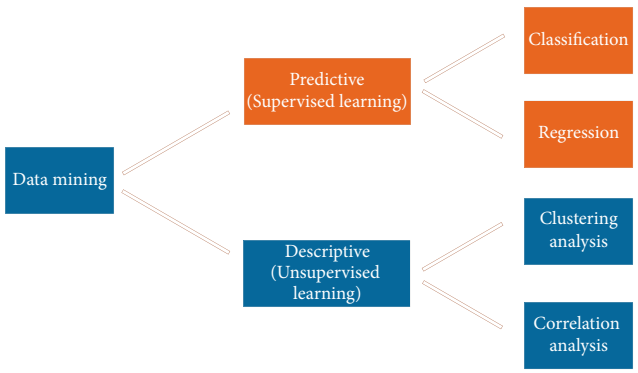

Figure 2: Classification of data mining methods.

datasets include decision tree, neural network, genetic algorithm, data visualization, and so on. For example, cluster analysis applied in the following part divides data into a series of groups that are different from each other according to a certain distance or similar size and can directly find meaningful structures or patterns without background knowledge.

3.2. Urban Renewal Design Platform

3.2.1. System Requirements. With the goal of information sharing and full use of data, the urban renewal design platform integrates the original database of urban management information system with the urban geographic information spatial database, so that data information such as people, vehicles, roads, and environment can be integrated with spatial information and finally realize the synchronous improvement of the in collaborative ability in the process of urban space design. Through comprehensive processing and analysis of various urban data, the platform can obtain data from multiple sources according to the real-time situation, manage mathematical operations to mine in-depth data, and predict the trend of urban spatial transformation. Therefore, this system needs to meet the following requirements:

(1) Collection of urban spatial information: through the traffic monitoring system, the system collects relevant city information and displays it through intuitive symbols, images, videos, charts, dynamic characters, etc. It has the functions of roaming, animation, bird's eye view, zooming, measurement, editing, etc., so that departments can make management of decision and guide practice according to real-time information.

(2) Query and forecast of urban traffic: the traffic information collected by the intersection signal and the information collection equipment on the road is stored in the central database, and the operator can make statistical inquiry and chart analysis and print out the information. Real-time detection of urban traffic conditions can optimize urban user experience by improving urban transportation system.

(3) Update the real-time information of communities: for the information of major event venues and key units such as community public facilities and medical facilities, it is necessary to indicate the specific location and surrounding road conditions, provide the information of important places such as the internal road conditions, import, and export, and automatically submit it to the internal management according to the environmental conditions entered in the system, so as to update the latest situation of these venues in time.

(4) Emergency plan: according to the changing needs of the city, the corresponding emergency plan is formulated. After the emergency information is transmitted to the system, the system can automatically select the corresponding preset plan to provide auxiliary decision making according to the specific types of emergencies and on-site conditions and build a more forward-looking urban space through the platform.

3.2.2. Organizational Structure. The urban design platform follows the urban information system platform from the overall framework, which includes the data mining algorithm tool layer, the data mining application layer, and the analysis logic layer. The logic layer is divided into four parts, namely, data layer, service layer, application layer, and business layer, and also includes a system tool set, which is shown in Figure 3.

(1) Data layer: using a large spatial database engine to store a large amount of geographic information, mainly to achieve data preservation function, can meet the TB level data management requirements, including basic vector data, image data, and business geographic data. The image data should be updated synchronously with the authoritative department providing basic data.

(2) Data mining algorithm tool layer: the tool layer of data mining algorithm is mainly based on the premise of data mining algorithm, combined with the corresponding visualization methods, and other auxiliary tools to establish a tool set of data mining algorithm. Different algorithm tools are independent, where the function of the tool layer is to gather all the algorithms and related computing tools needed for urban spatial data mining and analysis, which is a collection of independent elements.

(3) Application layer: the application layer includes the functions realized through data mining, including flow forecast of urban space traffic, community facility optimization, and other functions.

(4) System layer: the system is mainly aimed at users, and it is the connecting part between users and the system, whose main function is to meet the user's demand for calling analysis logic, and the analysis logic needed reflects the analysis ability of the application system itself.

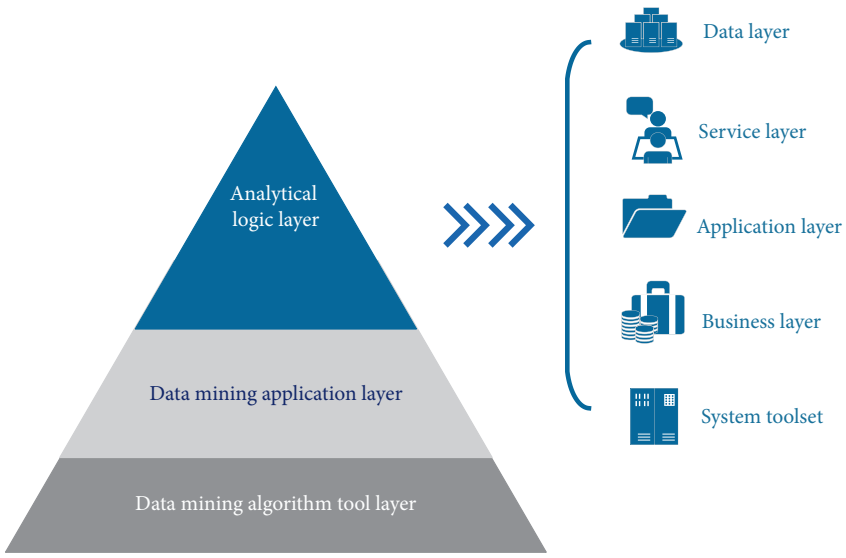

Figure 3: Organizational structure of system.

(5) GIS tool set: on the premise of combining the software tools provided by the system, such as data database building tools, symbol making tools, raster map generating tools, position comparison tools, data acquisition tools, and data analysis tools, according to the corresponding requirements, add customized and expanded related tools that can meet the requirements.

4. Urban Renewal Design Based on Database Information Integration

4.1. Establishment of Urban Spatial Database. Database is a collection of rational storage of massive spatial data. Accordingly, making an extensive analysis of them is important so that the systematic database can be designed to ensure its smooth progress and use [19, 20].

4.1.1. Security Principle. The information stored in the urban spatial database may belong to a certain region or even a certain country, so it has high confidentiality. Once this information is leaked, it will definitely pose a major threat to the security of related objects, so the design must strictly follow the security principle.

4.1.2. Standardization Principle. Both the design of the system and the design of the system database must follow certain discipline norms, and there must be rules to follow from data classification and coding to symbol design and coding, so as to improve the readability, operability, and shareability of data.

4.1.3. Practical Principles. The establishment of database must be considered according to the viewpoint of urban planning. After fully understanding the needs of users and the characteristics of planning materials, the database should be designed pertinently.

4.1.4. Maintainability Principle. With the continuous development of cities, urban planning is a dynamic process. Therefore, when designing the database, we must consider the updating of planning data and how to store the old data. In addition, the data warehouse is subject-oriented, integrated, non-updatable, and constantly changing with time, which determines that the systematic design of data warehouse cannot adopt the same design method as that of developing traditional database.

After sorting out basic data and determining the information demand of data warehouse, a theme-oriented, different-time, integrated spatial data warehouse can be established, which includes data of planning achievement; key data of urban space design in different periods; approval data of construction planning in different periods; and informatization standards and technical specifications. The whole spatial data model emphasizes that people's understanding of the geography remains first, followed closely by how to make people understand the geographical world here. Through the actual geographical world, the model realizes the world outlook within people's sight by various connections and features between the actual objects. Starting from physical characteristics, the model realizes people's understanding of the world geographical semantics by means of the operation method of interaction and connection between entities.

The information of urban spatial database comes from the information that is through integration, and then thematic data related to urban renewal are extracted. Finally, they are organized and stored from the perspective of historical development of things, so that users can conduct data analysis and assist decision support, thus providing new technical means for the scientificity, rationality, and sustainability of urban planning.

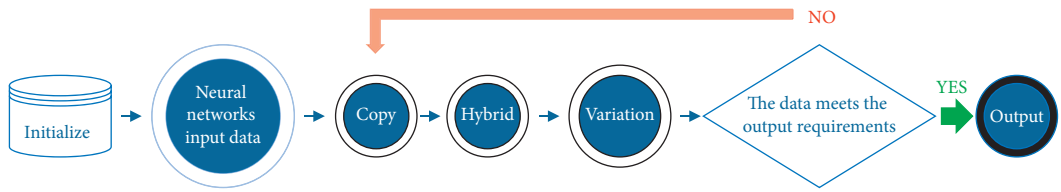

Figure 4: Schematic diagram of data mining process.

4.2. Database Information Integration. As shown in Figure 4, after the standardized processing of feature data is completed, the urban spatial feature data can be fed back to the urban designer and the urban planning management office through artificial intelligence technology, and new ideas can be provided for urban design with the help of real-time updated urban spatial data.

In order to ensure the dynamic characteristics of the big data in the database, this paper detects the characteristic data in the database under the background of data mining and uses the information entropy detection algorithm to complete the data clustering. Finally, the extracted characteristic data of urban spatial are fed back to the urban designer and the urban planning management.

The specific process of urban renewal design based on database information integration is as follows: as indicated by the characteristic element of dataset, acquire the worth element of data information, set the informational index to be mined as D, set the component of the informational collection as d, and lastly get the set W as per the information property.

Build the subspace s needed for data mining, and a data object in the subspace satisfies $o \in D$, where the nearest neighborhood (o, S) of data objects in the subspace will be unevenly distributed. From the perspective of multidimensional data attributes, the center point of the subspace is the data object o, and the formula for calculating the probability distance can be expressed as

$$d_s = \frac{1}{I_d(o, S)}, \tag{1}$$

where $I_d(o, S)$ is the outlier probability of a data object randomly selected in the subspace in the dataset and the distance is expressed as D. If the data object o is still at the center in all the datasets to be mined, the standard distance σ between data s and data o can be calculated by

$$(o, s) = \sqrt{\frac{\sum_{s \in S} d(o, s)^2}{|S|}}. \tag{2}$$

Because the local discrete data in the database present a nonuniform distribution state, the attributes of discrete information should be addressed by the rough worth between the thickness of discrete information and the standard distance:

$$\lambda = \frac{I_d}{\sigma(o, s)}. \tag{3}$$

The value of λ is obtained by formula (3). According to the above feature extraction methods, in data mining, a detection algorithm based on information entropy is adopted to obtain the information of required data. In the dataset X to be detected, the distribution of a certain item of data x is detected, and the information entropy $E(x)$ of the data x is obtained by the value probability function p:

$$E(x) = -\sum_{x \in X} p(x) \ln p(x). \tag{4}$$

After the calculation of information entropy, all the information to be distinguished in the information space is organized in plunging request. Multiple data with high information entropy were selected as the cluster center to complete the detection of the remaining data. The distance between clustering centers can be expressed as:

$$\text{dist} = \frac{|a \cap b|}{|a \cap \overline{b}| + |\overline{a} \cap b| + |a \cap b|}, \tag{5}$$

where a and b are two random clustering centers, with the clustering center as the core. After analyzing the information entropy of all data, the clustering threshold is set by average calculation. When the distance dist between cluster centers is smaller than the set threshold, other data need to be replaced as cluster centers, and the calculation of formula (5) is repeated, which cannot be terminated until all results are greater than the given threshold.

In the process of detecting datasets, the distance between the data and the cluster center is first calculated, and the data to be detected are the same kind of data objects in the nearest cluster center. After distributing the data in the database, the average value of each classification cluster is obtained. Then, based on the above calculation flow, the clustering process is completed again by using the data in the dataset. After repeating the above clustering process until no new clustering center appears, the calculation will be terminated. The database is processed according to the final clustering center, and the data without any classification clustering are called nonlocal outlier data. The existing data information is based on the feature data detected by the information entropy algorithm. To improve the accuracy of data mining, all detected data are standardized.

Considering the strong correlation of the feature information detected in this paper, some noise data inevitably exist in the detected data. In order to ensure the normal

operation of subsequent data analysis and processing, the data detected by the above operations are standardized. In addition, the dimensions of the detected data are different, which will have a certain negative impact on the mining results of the database, so it is necessary to process the detected data according to the standard format, as shown in the following formula:

$$\alpha = \frac{\alpha - \overline{\alpha}}{Y_\alpha}. \tag{6}$$

α obtained from data normalization processing needs to be calculated according to the average value α and the standard deviation Y_α of the detected data. In the process of calculation, the standard deviation is used to make the data feature more obvious to ensure the data mining accuracy. In addition, the average deviation of attribute G_α can also be used to obtain the data standardized processing results, and the calculation formula is as follows:

$$\alpha_i = \frac{\alpha - \overline{\alpha}}{G_\alpha}. \tag{7}$$

Through the above formula, the anti-interference performance of the algorithm is improved, and the formulas for calculating the mean value of data attribute α, standard deviation of data attribute Y_α, and mean deviation of data attribute G_α are as follows:

$$\begin{cases} \overline{\alpha} = \sum_m \alpha \dfrac{1}{m} \\ G_\alpha = \sum_m \dfrac{|\alpha - \overline{\alpha}|}{m} \\ Y_\alpha = \sqrt{\sum_m \dfrac{(\alpha - \overline{\alpha})^2}{m-1}} \end{cases}, \tag{8}$$

where the number of iterations is m.

5. Conclusion

This paper puts forward the concept of urban space renewal design platform under the background of big data based on the urban space design principles and analyzes the requirements of the design platform and discusses its architecture. In addition, this paper focuses on the information integration of urban spatial database, where database features are extracted through data mining, data clustering are implemented by using information entropy detection algorithm, and information of urban spatial feature is obtained, which realizes allocation of reasonable information and resource scheduling in the process of urban spatial design and provides constantly updated ideas for future urban spatial design.

Data Availability

The dataset used to support the findings of this study is available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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