Optimization of Multi-Dimensional Association Rule Mining Algorithm Studies the Spatial Form of Cultural Landscape Heritage

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Abstract. The research on the spatial form of cultural landscape heritage is an important link in the protection of cultural landscape heritage. The optimization of the research by using multidimensional association rules algorithm can improve the efficiency of the research on the spatial form of cultural landscape heritage. This paper first explains the development and classification of the concept of cultural landscape and the concept and classification of data mining, and discusses the optimization of multi-dimensional association rule mining algorithm to study the spatial form of cultural landscape heritage, so as to provide readers with reference.

Keywords: Multidimensional, Algorithm, Cultural Heritage, Evaluation System

1. Introduction
Association rules mining is one of the important contents of data mining. Through the research of multidimensional association rules mining algorithm, the scale of data collection and storage can be expanded, and the useful value stored in the database can be mined. Therefore, the application of multidimensional association rule mining algorithm in the study of the spatial form of cultural landscape heritage is conducive to promoting the inheritance of cultural landscape heritage.

2. Development and classification of the concept of cultural landscape
2.1. Development of cultural landscape
From the etymological point of view, the word "landscape" comes from German, and its original meaning is to clear out the open land,

It has animals, huts, fields and fences, and it's actually an agricultural or rural landscape separated from the forest and wilderness [1]. It can be seen that "landscape" from the very beginning refers to "artificial products endowed with value by cultural processes". In 17th century Europe, especially In England, the concept of landscape was associated with landscape painting. The landscape paintings of the time were divided into two types, The Dutch realist paintings (portrait, the most original painting as a separate subject) and Claude. Claude Lorrain is the representative figure of the historical imagination painting. In Claude Lorraine's historical paintings, landscape and landscape became synonyms, representing landscape by placing characters in the natural landscape. At this time, the...
eastern world also has the same behavior, such as in China to express the artistic conception of the landscape painting. Since the Tang Dynasty (618-907CE), there have been landscapes in China that mainly express artistic conception. They are often abstract and symbolic of human emotions and beliefs [2]. The appearance of mountains and rivers has gradually become less important, and the implied spiritual world has become the theme of paintings. It can be seen that in the eastern and Western world, both landscape painting and landscape have an inevitable relationship, but the difference lies in their emphasis on the object of expression. Since the Renaissance, the European landscape painting is the reality of the landscape, while in the East, the Chinese landscape painting represented by China is the description of the ideal landscape. However, it is undeniable that both eastern and Western landscape paintings show people's subjectively yearning for idealized landscape and even landscape illusion, and they also attach great importance to the integration of characters and landscape pastoral scenery (Fig 1 European classic architectural landscape).

![Figure 1. Classic European architectural landscape.](image)

2.2. Classification of the most important cultural heritage
The Convention divides the cultural landscape into three categories: The organically evolved landscape; It began as an initial social, economic, administrative, and religious need and has evolved into its current form through connection with or adaptation to the surrounding natural environment, including:

1. A relict (or fossil) landscape is a relict (or fossil) of organic evolution; A dependent landscape environment representing a historical event, task, or activity whose evolutionary process has ended, but whose distinctive features are clearly visible and distinct from other landscapes. 

2. the organic evolution of sustainable landscape (contemning landscape): place by users through their actions shaped the landscape, it reflects the community's cultural and social characteristics, it is associated with the traditional way of life in the modern society, to maintain a positive social function, and its evolution process is still ongoing, shows at the same time in the history of its development and evolvement of material evidence [3].

3. Associative cultural landscape: It includes the elaboration and appreciation of the environment and emphasizes the universal features associated with natural factors, strong religion, art or culture rather than the main features characterized by cultural physical evidence.

3. The application of ant colony algorithm in map path finding

3.1. Basic principles of ant colony algorithm
Inspired by the collective behavior of real ant colonies in nature, Italian scholar M. Orgo first proposed a new optimization algorithm ant colony algorithm based on ant population in 1991, and solved some combinatorial optimization problems with this method. The concept of artificial ant is proposed in the ant colony algorithm. The artificial ant has two characteristics, which is an abstraction of the behavioral characteristics of real ants. The most critical part of the foraging behavior of ant colony is
given to the artificial ant. Artificial ants, like real ants, are a group of individuals who cooperate with each other to get better results. Artificial ants have the same task as real ants, which is to find the shortest path [4]. Artificial ants use pheromones for indirect communication just like real ants.

3.2. Principles of ant colony algorithm

3.2.1. Sequential operation
For sequence of multiple ant colony algorithm, is to carry out a reasonable ant colony is divided into two major components, and put two big ant colony placed in the start and end, respectively, in accordance with the order to implementation of the ant colony algorithm, can also according to the hierarchical design thought placed each ant colony in the planning of layer, each layer can hold Rows have differentiated functions. Therefore, these two design methods can realize the information exchange between populations according to the pheromone matrix.

3.2.2. Parallel operation
In the parallel operation of the multi-ant colony algorithm, each ant colony will run simultaneously, and the information exchange strategy between each ant colony is the prerequisite guarantee for the implementation of the parallel multi-ant colony optimization algorithm, which is mainly reflected in the frequency, manner, and content of the information exchange. The famous Ellabib proposed the information exchange strategy of the multi-ant colony algorithm, and further evaluated each exchange strategy accurately according to the search diversity. After the information exchange strategy of the parallel ant colony algorithm is proposed, various groups adaptively choose the information exchange objects reasonably according to themselves, and then accurately determine the actual time of information exchange according to the actual distribution of solutions.

To ensure a balance between convergence speed and diversity. After the information is exchanged, an adaptive updating strategy is adopted to carry out pheromone updating based on pheromone uniformity, to better reduce the occurrence of adverse phenomena such as early maturation of ant colony algorithm and local convergence.

3.3. Robot path planning based on improved ant colony algorithm

3.3.1. Establishment of colony pheromones
The robot's working environment is a two-dimensional known static space. Raster method is adopted to model the environment because of its simple coding and easy implementation. In order to improve the efficiency of searching optimal path and the quality of path planning of ant colony algorithm, the safety and low power consumption of robot path planning are combined. In the basic ant colony algorithm for the establishment of initial favorable pheromone matrix, the initial concentration of pheromones is uniformly distributed, leading to the possibility that the ants may choose to walk in the area opposite to the target point in the early stage of search, which leads to a longer search time and a longer found path [5]. In order to solve the blindness of the initial search algorithm and the slow convergence rate of the algorithm. The favorable information matrix is proposed to make the initial pheromone concentration distributed in a differentiated way, avoid blind search, reduce the search range, and shorten the search time. First, connect the starting point and the target point, and preplan a path. Under the influence of obstacles in the grid environment, the optimal path fluctuates near the pre-planned path, and the initial pheromone concentration takes the pre-planned path as the center and presents a Gaussian distribution to both sides.

3.3.2. Robot path planning implementation of ant colony algorithm
The steps of robot path planning for ant colony algorithm are as follows:
Step 1: Given the static two-dimensional space, establish a raster map, set the raster sequence number, and select the starting point and target point.
Step 2: Parameter initialization, set the number of ants m, the maximum number of iterations Nmax, as well as pheromone heuristic factor, expected heuristic factor, pheromone volatile factor, initial pheromone balance factor, path balance factor, and corner balance coefficient.

Step 3: Put ant M (m = 1, 2, m) at the starting position, and put the initial point into the tabu table.

Step 4: Calculate the probability of feasible node according to the transition probability formula, use roulette to find the next accessible node, add it to the tabu table, and then update the path length.

Step 5: Judge whether the ant has reached the target point E. If so, record the grid number and path length of the ant. If the target point is not reached, repeat step 4) until the target point E is found. If an ant K search is stalled, it is handled according to the ant fallback strategy. When all ants have searched, go to step 6.

Step 6: Determine if the maximum number of iterations is Nmax. If the algorithm reaches the maximum number of iterations, the shortest path length of the current ant colony search results will be output; otherwise, the tabu table will be cleared and N = N + 1 will be set. Go to Step 3 and continue the search path until the maximum number of iterations is Nmax. When the algorithm is finished, the length of the current search shortest path will be output. During the test, the parameters are set according to Table 1.

**Table 1.** Test basic parameter setting.

| The ant population                  | Basic ant colony algorithm | This paper algorithm |
|------------------------------------|---------------------------|----------------------|
| Pheromone stimulating factor       | to                        | 1                    |
| Expect stimulating factor          | 7                         |                      |
| Initialization pheromone balance   | -                         | 600                  |
| Path balance factor                | 0.3                       |                      |
| Corner balances efficient          | 1.5                       |                      |
| Global pheromone volatilization    | 0.7                       | 0.7                  |

3.3.3. Simulation and analysis
The path planning method of improved ant colony algorithm was simulated and verified by MATLAB. The raster method was used for environmental modeling, and the path planning methods of the basic ant colony algorithm and the prime factor adaptive ant colony algorithm were compared with the improved ant colony algorithm proposed in this paper under two experimental environments respectively (Table 2 shows the comparison of simulation results).

**Table 2.** Comparison of simulation results.

| Algorithm                  | Basic ant colony algorithm | This paper algorithm |
|----------------------------|----------------------------|----------------------|
| Shortest path length /cm   | 32.4                       | 29.2                 |
| System operation time /s   | 3.5                        | 1.5                  |
| Number of inflection points| 17                         | 9                    |
| The number of iterations   | 29                         | 14                   |

A 30*30 complex environment with U-shaped and H-shaped obstacles was selected to verify the applicability of the improved algorithm. To ensure the reliability of the algorithm, the number of ants was increased to 100, and the maximum number of iterations was increased to 150. U-shaped obstacle has a long search optimal path, and the algorithm is difficult to find the optimal solution. In summary, the search direction can be quickly locked in the early stage, the search efficiency is greatly improved, the number of inflection points greatly reduces the smooth search path of the algorithm, and the risk of robot operation and energy loss caused by turning can be reduced.

4. The optimization of multi-dimensional association rule mining algorithm studies

4.1. Features of digital cultural landscape heritage records
Digital cultural landscape heritage records have five characteristics: comprehensive, accurate,
dynamic, integrated and open. First of all, digital surveying and mapping methods have expanded the breadth and depth of cultural landscape heritage records, and enhanced the ability to comprehensively observe the state of artificial and natural landscape elements and grasp their interaction [6]. New digital methods can better record many hard-to-measure elements of the cultural landscape, thus providing more complete basic information of the heritage. Second, digital records will capture and represent the patterns of cultural landscape heritage more accurately.

4.2. Technical framework of digital cultural landscape heritage Record
Based on the above discussion, this paper proposes a technical framework of digital cultural landscape heritage recording, including three technical modules: multidimensional spatial data collection and processing, dynamic landscape information storage and analysis, and representation and dissemination of multiple heritage knowledge.

4.3. Multi-dimensional data acquisition and processing module
Multi-source sensor equipment is used to collect and process spatial data of cultural landscape at different scales: macro-scale landscape spatial data (100 ~ 1000km) is obtained by satellite remote sensing; Airborne photogrammetry and lidar were used to obtain mesoscale landscape spatial data (100m ~ 100km). Microscale landscape spatial data (1 ~ 100m) were obtained by ground photogrammetry and lidar. Computer 3d simulation technology can integrate the above data and intuitively simulate the pattern, shape and texture of cultural landscape. X-ray photo technology can detect the obscured landscape elements or structure, and infrared and multi-spectral imaging technology can realize the automatic classification of landscape elements and improve the efficiency of data collection and processing. The comprehensiveness, flexibility and accuracy of the technology module can make up for the defects of traditional heritage recording methods, better respond to the multi-scale characteristics of cultural landscape heritage, and more effectively capture and reflect the characteristics and combination patterns of artificial and natural elements. At the same time, this module has obvious advantages in measuring irregular landscape environment, and multi-period collection can realize the improvement of cultural landscape heritage data from three to four dimensions. The progress of technology provides a more scientific data basis for the identification of the spatial pattern of cultural landscape heritage and the identification of the interdependent relationship between man and nature.

4.4. Dynamic landscape information storage and analysis module
With geographic information system (GIS) technology as the core, supplemented by text and multimedia database, the dynamic information platform of cultural landscape heritage can be built. This module needs to first explore the landscape information model construction, highlight information integration and dynamic update functions, and gradually realize the upgrade from 2d map database to 3D spatial database. On this basis, it relies on machine learning, computer graphics, computer animation and non-photorealistic rendering techniques to identify and express the key elements, patterns and features of cultural landscape heritage. On the one hand, it can meet the needs of information integration and storage of cultural landscape heritage, on the other hand, it can accurately analyze and extract the dynamic characteristics of cultural landscape heritage based on information integration, and is transforming spatial data into landscape information that can be used for protection and management decisions.

5. Conclusion
To sum up, the application of multidimensional association rule mining algorithm in the study of the spatial form structure of cultural landscape heritage is conducive to promoting the storage and dissemination of cultural landscape heritage. Therefore, the application of multi-dimensional association rule mining algorithm should be strengthened in the future research on the spatial form structure of cultural landscape heritage, so as to realize the digital and intelligent research on cultural
landscape heritage.

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