Open Pit Mining Process Optimization Decision System Based on Artificial Intelligence Technology

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Abstract: The traditional open-pit mining method has some defects, such as insufficient utilization of resources, high dilution rate, low production, high cost and unsafe. In order to solve this problem, it is more and more popular to combine modern intelligent technology with traditional mining scheme, but the scheme is still not perfect. Therefore, this paper puts forward an optimization method based on artificial intelligence technology for open-pit mining technology decision-making system. Through the optimization operation of this paper, the traditional open-pit mining technology decision-making system greatly improves the decision-making efficiency and comprehensive performance. In the study of this paper, through the re-analysis of the requirements of the open-pit mining technology for the decision-making system, the optimization feasibility scheme is established according to these requirements. The scheme covers the optimization calculation method, simplified calculation steps and so on. In the experimental test, the average broadband performance of the system in this paper reaches more than 10m / s, the average CPU load is less than 70%, and the GIS map response time is less than 3 seconds. The results show that the system in this paper has a higher comprehensive performance, compared with the traditional decision-making system; the performance has been greatly improved. Through the analysis, the research in this paper has achieved ideal results and made a contribution to the field of open-pit mining technology decision-making system.

Keywords: Artificial Intelligence, Mining Technology, Decision System, Optimization Research

1. Introduction

Artificial intelligence is a science and technology based on computer science, biology, psychology, neuroscience, mathematics and philosophy. Artificial intelligence is a key technology to simulate human brain intelligence and realize the automation of mental work [1-3]. At present, artificial intelligence focuses more on improving the ability of machines to predict complex patterns. With the
continuous development of artificial intelligence technology, electronic information technology has been widely used in various fields of open-pit mining process decision-making system. From deposit exploration, geological model establishment to mine design, from mine production management, process scheduling to equipment fault monitoring, computer has become an indispensable tool in open-pit mining [4-6].

In order to improve their own competitiveness, many mining enterprises introduce artificial intelligence into the mining process decision-making system, which makes the decision-making system intelligent. Compared with other mining industries in China, there are still some gaps, especially in the application of open-pit mining technology decision-making system in small and medium-sized mining enterprises. Many mining enterprises are in the mining decision-making system The use of artificial intelligence technology is still relatively unfamiliar [7-8]. With the advent of the intelligent era, the open-pit mining industry must introduce modern technology if it wants to continue to develop. This is not only in line with the development of the times, but also the inevitable way of the development of open-pit mining technology. Therefore, relevant technical personnel and researchers should improve their understanding of artificial intelligence technology and constantly enhance their professional ability, so as to better promote the effective application of artificial intelligence technology in mining process decision-making system [9-10].

Based on the actual situation of the application of artificial intelligence technology in decision-making system of small and medium-sized mining enterprises in China, this paper analyzes the evidence collection and finds that there is still a lack of technology promotion and technical support with developed countries. Therefore, this paper establishes the research on the application of artificial intelligence technology in the open-pit mining technology decision-making system. In the research, according to the actual situation of China's mining enterprises, the introduction of artificial intelligence technology, the combination of the two can improve work efficiency, scientific and technological strength and core competitiveness. Based on the analysis of the investigation results, this paper considers that the artificial intelligence technology can be used to optimize the open-pit mining process decision-making system and achieve good results.

2. Development of Artificial Intelligence Technology in Mining Industry and Intelligent Collection Process of Safety Production

2.1 Development of Artificial Intelligence Technology in Mining Industry
With the continuous improvement of science and technology, artificial intelligence has been gradually applied to mining, and its advantages are increasingly prominent. Among them, expert system as one of the main applications of artificial intelligence, now a large number of market development tools, and the development of various expert systems have been widely used in various mining companies mining operations, is a more common open-pit mine blasting system, mining facilities selection decision support system and coal mine bolt support system selection and design. However, compared with developed countries, all kinds of operation problems of mine construction in China are more complex, and lack of corresponding hardware and software, which makes the application of artificial intelligence technology in mine operation still lags behind.

2.2 Safety Production Intelligent Collection Process
Main idea of the intelligent collection model of coal mine safety hidden danger is: firstly, the matching matrix is established. Based on the vector representation and the database of keywords and synonyms, the vector composed of 0 and 1 is used to define the similarity between words by using cosine similarity calculation formula, and then the spatial position of two words is constructed into a two-dimensional structure, Similar to a plane image, after modeling with convolution neural network, feature extraction is designed and sampled at the convolution kernel layer to generate ultrafiltration. Then, through the pool layer sample, the max pool is used to reduce the dimension, and the excitation
function is used to fully establish a network connection layer based on multiple two-dimensional convolutions and pool layers. The final data is expressed as a matrix, the final input keyword and the keyword with similar semantic similarity are the most similar, and the standard database mapping of corresponding keywords is obtained.

Let convolution kernel be \((1,0,1,0,1,0,1,0,1)\), step size = 1, bias = 0, according to the formula (1), (2), then the convolution value is:

\[
\begin{aligned}
a_{0,0} &= f \left( \sum_{m=-3}^{3} \sum_{n=-3}^{3} \omega_{m,n} x_{m,n,0} + \omega_{b} \right) \\
b_{0,0} &= \text{Relu} \left( \omega_{b,0} x_{0,0} + \omega_{b,1} x_{0,1} + \ldots + \omega_{b,3} x_{3,3} \right)
\end{aligned}
\]

All the elements of the convolution layer Feature Map are calculated, and then sampled in the pooling layer \((3 * 3)\). The sampled Feature Map is obtained by using Max Pooling. Finally, the one-dimensional semantic matching similarity can be obtained after processing in the full connection layer. After comparison, the standard keywords to be retrieved are obtained by mapping the keyword ID in the database. For example: \(a_{0,0}\) the final matching degree is 0.58, \(b_{0,0}\) the final matching degree is 0.51. By comparing the two values, it can be concluded that "no helmet" is the most similar to "no helmet", then "no helmet" is used as the condition to map the standard keywords in the database for data keyword query.

3. System Performance Test Results and Analysis

In order to test the actual use performance of this system, this field performance test will take a coal company as the test object, the decision-making system of open-pit mining escape route is used in a coal company, there are more than 70 clients under the mine, the system needs to calculate the best path according to each client, and the GIS map engine has higher performance requirements for the system. In order to meet the needs of the next five years, this paper sets the minimum concurrent client of the system to be more than 500. According to the use characteristics of the mine escape route decision-making system, combined with the experience of developers, the performance requirements of the system are proposed.

This paper uses the third-party testing tool Load Runner to simulate a large number of user operating systems, and records the system response time and server load. The network average bandwidth performance test results are shown in Table 1 and Figure 1. Through the analysis of the results, the average CPU load of the server is less than 70%, and the network bandwidth is more than 10m / s.

| Number of simulated users | CPU average load (%) | Network broadband (M / s) |
|---------------------------|----------------------|--------------------------|
| 100                       | 12                   | 20.4                     |
| 200                       | 28                   | 16.8                     |
| 300                       | 41                   | 14.5                     |
| 400                       | 52                   | 13.6                     |
| 500                       | 68                   | 11.2                     |

Table 1: test results of average bandwidth performance of the system network in this paper
Figure 1: network average bandwidth performance test results

In addition, this paper further tests the system performance, the results are shown in Figure 2, through the analysis in Figure 2, under the 500 client, GIS map response time is less than 3 seconds, the average memory occupancy rate is not more than 85%. The test results of the system performance decision system show that artificial intelligence technology can not only improve the work quality, but also provide technical support for the mining process optimization decision-making system.

Figure 2: response time test results

4. Discussion
4.1 Research on Error Improvement Based on Wind resistance Algorithm

4.1.1 Algorithm ill conditioned discriminant method

For the system of linear equations $Ax = b$, if the $A$ matrix or $b$ vector has a small disturbance, causing a large error of the solution vector $x$, that is, the solution vector $x$ is highly sensitive to $A$ and $b$, and the equation system $Ax = b$ is called ill conditioned equation system. In the process of algorithm implementation, rounding error is inevitable, so the numerical solution of ill conditioned problem is extremely unstable. The limit of ill condition is fuzzy. The condition number is the index to measure the ill condition degree of the equation system. The larger the condition number is, the more serious the ill condition is, the greater the error of solution will be. In order to judge whether the error of air volume inversion algorithm is acceptable, it is necessary to set the threshold value of condition number. When the threshold value is less than the threshold value, the calculation results are consistent with the accuracy. When the accuracy requirement is high, the threshold value needs to be set smaller, and if the accuracy requirement is not high, it can be set larger. When the order of magnitude of condition number is less than $10^3$, the result is not ill conditioned. The calculation method of condition number is shown in formula (3).

$$\text{Cond}(A) = \|A\| \|A^{-1}\|$$

Where $\text{Cond}(A)$ is the condition number of matrices $A$, dimensionless; $\|A\| (\|A^{-1}\|)$ is the norm of matrix $A(A^{-1})$, none Dimension;

4.1.2 Analysis of ill conditioned algorithm

In order to improve the ill conditioned problem of wind resistance inversion algorithm, it is necessary to understand the causes of ill conditioned algorithm. The author has tried a lot, trying to analyze, summed up two main reasons.

4.1.2.1 Influence of sparse coefficient matrix on ill conditioned algorithm

For large mine ventilation system, there are usually hundreds of ventilation branches. When the anti-wind resistance equation is constructed, any branch whose wind resistance does not change and contains unknown pressure energy nodes can be used as the system equation. The node pressure energy constitutes the unknown number of a given system. The same branch can only be associated with two nodes, that is, there can be at most four unknown node pressure energy. This leads to the sparsity of the correlation coefficient matrix increases with the increase of the system size, and the uncertainty of the elements in the high-dimensional matrix often leads to the ill conditioned of the matrix. We can reduce the sparse matrix from the point of view of reducing the system size, and then improve the ill conditioned process of the algorithm.

4.1.2.2 Influence of ventilation system topology on ill conditioned algorithm

In order not to affect the actual production, the location and quantity of adjustment structure will be limited, resulting in the limitation of two sets of air volume collection means. For the parallel roadways without adjustment structure, the change proportion of air volume is approximately the same. The square coefficient of the wind ratio is very close. This will make the line vector of the system too linear correlation, and the coefficient matrix is close to the singular moment. Finally, the basic situation of the wind measurement and anti-wind algorithm is obtained through the matrix analysis. Since the overall topology of the system has been fixed, it is obviously unrealistic to adjust the topological structure of the system in order to solve the problem of wind resistance.
4.1.2.3 Ill conditioned improved algorithm for wind resistance inversion
At present, there are many methods to solve ill posed equations, such as regularization method and singular value decomposition method. But all of these methods reduce the ill conditioned degree of the algorithm by improving the condition number, which cannot fundamentally solve the ill conditioned problem of the algorithm. The actual effect is not ideal. The accuracy of the algorithm is still difficult to meet the requirements. As a result, the authors consider to reduce the pathological degree of the algorithm from the establishment of the algorithm model.

4.2 Intelligent Decision Analysis Strategy of Coal Mine Safety Hidden Danger
Coal mining enterprises through manual sinking, manual inspection, manual statistics, manual copy of mine safety hidden danger data. Through the preliminary investigation of software development, the coal mine group will produce thousands of hidden danger detection data every week, which is difficult to analyze and process in real time by manual methods. The intelligent decision system realizes the decision analysis strategy through the following five parts.

(1) The system uses intelligent semantics based on CNN precise extraction method to extract keyword retrieval, quickly collect and identify hidden danger data, and uses improved algorithm based on ACO frequency retrieval analysis method to effectively obtain the relevant provisions of coal mine safety regulations, and provide theoretical support for classification and statistical decision-making of coal mine hidden problems.

(2) The system classifies the collected hidden danger data intelligently and automatically according to the hidden danger degree, professional category, time, three violations and key concerns. For example, "a staff member does not wear safety helmet" belongs to "safety management", "general hidden danger" and "non key concern".

(3) Through the multi-attribute Internet retrieval, tracking the security risk solutions detected, real-time understanding of the rectification situation. For the solved coal mine safety hazards, the system will automatically match and eliminate the database data, and only retain the final self-inspection data; for the uncorrected hidden dangers, the system will remind repeatedly; For the problems that have not been corrected after many warnings, the system background will upgrade the coal mine hidden danger according to the evaluation formula of hidden danger degree, and issue early warning to higher management personnel to reduce the occurrence of coal mine accident hidden danger.

(4) According to the data input by the security personnel, the system will automatically calculate the number and proportion of various hidden problems according to the algorithm program, and display them in the form of pie chart and bar chart on the home page, making the data more intuitive and convenient for security personnel to view.

This system background sets the threshold according to the violation frequency of hidden rules. When a behavior violation exceeds the threshold value, the system automatically determines the feedback, selects the hidden danger data according to the query of safety researchers. After a period of time, the intelligent generation of coal mine production safety briefs the group risk issues under the coal mine, puts forward suggestions, and pays attention to the listed problems, And summed up the major concerns of all kinds of coal, so that senior managers can real-time monitoring and control, to avoid the occurrence of potential safety problems.

5. Conclusions
In the research of mining technology optimization decision system, this paper takes the introduction of artificial intelligence into decision system as the main line of research. After research, this paper considers that artificial intelligence technology has brought benefits to mining enterprises in the optimization decision system. Through the analysis of test results of different data, it is concluded that artificial intelligence technology plays an important role in optimizing decision-making system. Through intelligent mining process analysis and wind resistance morbidity improvement research,
through the optimization and improvement of open-pit mining technology decision-making system, the open-pit mining operators have been able to extricate themselves from various complicated and unstable safety factor work, and can assist people to make decisions. Therefore, the value of artificial intelligence has been recognized by enterprises. At the end of this study, the system performance is tested. In the test, a number of experiments including response time test, network average bandwidth performance test are carried out. Through the analysis of the test data, we can see that the average CPU load of the server is less than 70%, and the network bandwidth is more than 10m / s, reaching a higher level in the same industry, which can meet the production needs of enterprises. Compared with the traditional scheme, the optimized system improves the comprehensive performance and robustness. This study has achieved ideal results and provided technical support for the decision-making system of open-pit mining process optimization.

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