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# Data standards based Mine Side Data Integration Governance Platform Research and Applications

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## Abstract

INTRODUCTION: With the advent of the mining digitalization era, the rapid growth and diversity of mine-side data make mining production management more complex. In this context, it becomes crucial to build a set of mine-side data integration and governance platforms based on data standards. The establishment of this platform aims to solve the problems of mining data fragmentation and inconsistent standards and to improve the efficiency of data management and utilization.
OBJECTIVES: The purpose of this study is to construct an efficient mine-side data integration and governance platform by studying and applying data standards to address the challenges of data heterogeneity and fragmentation. Through the development of unified data standards, the Author can realize the standardized management of mining data, improve data quality, and provide more reliable support for mining production.
METHODS: The study adopts a comprehensive approach. First, a comprehensive understanding of the problems and needs facing mining data management was obtained through a literature review and field research. Second, data standards applicable to mine-side data are developed to ensure that all types of data can be consistently understood and processed. Next, a data integration and governance platform based on these standards is established, and advanced data mining and artificial intelligence technologies are applied to realize automatic integration and cleaning of multi-source data.
RESULTS: Through experiments, this study proved that a mine-side data integration governance platform based on data standards was successfully constructed. The platform realizes efficient integration and cleaning of data and improves the consistency and quality of data. In practical application, the platform provides more accurate data support for mining production management and achieves remarkable results.
CONCLUSION: This study provides strong theoretical and practical support for the research and application of mine-side data integration and governance platforms based on data standards. Through the development of data standards, an efficient data management platform has been established, which provides practical solutions for solving mining data management challenges. In the future, the performance of the platform can be further optimized, and the updating and maintenance of data standards can be strengthened to adapt to the constant changes in the digital development of the mining industry. This research has a positive impact on promoting the construction of mining industry informatization and improving the level of production management.

**Keywords:** data standards, mine side, data integration, governance platforms

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## 1. Introduction

The rapid development of Internet technology has penetrated all fields of human activity, and the coal industry is no exception (Tang, 2022). In addition to constantly improving the computing power of computers, artificial intelligence is gradually becoming active in people's lives. This is undoubtedly a massive opportunity for the coal industry. When the "new" technology meets the "old" industry, intelligent mines are born. With the increasing demand for coal resources and the expansion of mine scale, geophysical drilling generates more and more production data. In coal geophysical drilling, mining equipment generates a variety of measurement files during operation, which are processed and analyzed by operators according to the types of these files (Hu et al., 2021). Among them, the enterprise mining files mainly consist of text and video files. Text files contain rock material in the form of display and processing curves, while video files are processed mainly in the form of rock images.

Currently, Target prefers standalone software development based on a C/S architecture that only supports the study of one file type (FAN Xue-Wei, 2023). During geophysical drilling and searching, various types of files can be created, such as XML text files, MP4 video files, SRT subtitles, and so on (Boschetti et al., 2021). The rock data contained in these files is usually relevant. The company needed mining data processing software to process and analyze mining operations documents better. Therefore, the data management of mining records is unified and can help the organization better utilize mining-based business documents by extracting data from mining records, using visual training curve data models to visualize and implement various processing methods, and comparing the results of the data analysis business document processing (Access et al., 2021). Rock Video uses deep learning techniques to identify rock types in video images to provide the company with more reference data and help staff better analyze rock data. Back in the late 1900s, some researchers used a five-year innovative mining program as an example. At that time, the mining industry was characterized by poor working conditions, high environmental impacts, low levels of automation, and complex manual operations, which showed the vast potential for automation and intelligent development in the mining industry (Kumar et al., 2022). Improving mining automation and intelligence is also an essential goal for today's leading mining companies. For example, a number of companies have built the first bright mine in Cudedri, Western Australia, focusing on automation, intelligent robotics and mining equipment to create bright mining centers with large-scale mining capabilities and low operating costs.

The relevant standards established in China focus on organizing targeted research, implementing demonstration projects, promoting concepts and technologies and developing innovative mining standards (Sharma et al., 2021). Problems encountered in China include too many subsystems, unallocated data, data inconsistencies, and data that prevent efficient and timely use of measurement data. In the oilfield, the process of building an intelligent coal mine "oilfield" has been studied in three phases: transportation, equipment, grid system, system improvement, and operational database construction (Wei & Sun, 2021). Therefore, the research process of intelligent coal mining has been adapted to the development of technology. Information systems are not able to solve complex problems in manufacturing companies, which usually require the participation of many industries and types of equipment (Zhang et al., 2021). At the same time, it is necessary to integrate company data and primary data into coal production.

According to Smart Mines' current practice, the company uses the equipment to access various mining operations documents. Measurement data often show errors that are incompatible with the actual values from two main perspectives: human error and measurement instrument error (Ally et al., 2021). Geophysical errors caused by human factors are described in detail with the help of subsidence analysis based on a mining system model. Other researchers have described the use of precision measuring equipment in the mining industry from the perspective of measuring equipment. Underground measurements may lead to errors, but the measurement methods remain the same. Therefore, it is necessary to digitize rock data curves when companies process and analyze measurements in the form of rock data curves (Cheluszka et al., 2023). This paper emphasizes measurement errors in mining operations and possible adjustment errors in bedrock curves and highlights the importance of these issues in the processing of rock materials. Predicting final mining coefficients using nonlinear multidimensional interpolation provides a practical and accurate method for predicting the relationship between the final mining coefficients of mineral resources, shale stratigraphic parameters and production capacity (J. et al. et al., 2023). Therefore, mining data processing software must provide methods for processing various rock data curves, including curve alignment and curve interpolation.

## 2. Background of the study

Video, as an intuitive way of representing data, has also been widely used in the mining industry. Some researchers have proposed a comprehensive extraction and characterization model based on deep convection neural networks, which is based on monitoring the mining environment and improves the prediction accuracy compared to the traditional left-right baseline rule (Yin et al., 2022). Regarding the detection of rock classification, other researchers combined the VGG16 lattice model with transportation science to solve the problem of coal and gear separation in coal power plants. First of all, obtaining clear and compelling rock structure images is crucial for geophysical studies. Several researchers have proposed a method to quickly integrate and merge circular images using video boreholes, converting the images into ordered images of multiple narrow-band holes and identifying and merging the images to improve the image resolution significantly (Virta et al., 2021). A pseudo-scanning radar image enhancement method was proposed to address the problems of poor radar image contrast, uneven exposure, and blurred edges, which significantly improved the quality of radar images. After that, image recognition is performed based on the preprocessing of the extracted images. In order to address the differences in rock boundary stations caused by the corresponding rock colors, quantitative characterization and automatic detection of rock properties have been proposed by several foreign research institutes to locate the rock boundaries better. For mixed materials and harsh conditions, an SSD-based rock detection method was proposed, and an SSD-VGG16 network model was developed and trained for high-precision rock detection. In conclusion, the development and implementation of rock preprocessing and video image detection functions in drilling analyzer data processing software can provide companies with similar percentages of auxiliary categories.

According to the needs of the company, the storage and management of mining geophysical data and the integrated processing of various data were developed and implemented. The software was developed based on SpringBoot and other frameworks. The geo-video analysis functionality was implemented using the VGG19 network model, which uses MySQL and MongoDB databases to store primary deposit and mining data (Bouamrane et al., 2021). The program consists of four modules: mine management, mine user management, mine analyzer output file management and mine analyzer file analysis. In the design and implementation of the mining management module, the data, workspaces, and data stored in the core data of mining operations are organized to provide the company with the organization, workspaces, and management of the core data set (Keshavarz, 2021). At the same time, the organizational structure of mining management and the implementation of user functions are maintained. This paper develops and implements a mining user management module that provides user and user access information in the underlying mining data. At the same time, it supports customized mining roles and other functions (Sheidaei et al., 2022). Based on the area management module and user management module, a mine drilling analyzer output document management module is developed and implemented, which mainly provides mine database management for the enterprise, including downloading various mine business documents and reading and storing geological data. XML files and captions are stored in an unlinked document database matching the attributes of the data structure (Stodola et al., 2021). This module also contains basic information about managing the original excavation records in the excavation activity files.

This paper is based on the Mineball Analyzer output file management module, which develops and implements the Mineball file analysis module based on geological data curves and geological videos extracted from the mine (Nadeak & Ali, 2021). In the data analysis module of Mineball Analyzer, the processing and analyzing methods of rock data mainly include moving curves, connection, filtering, equivalence, interpolation, and so on (Wong et al., 2022). First, image acquisition of rock layers is performed, and then image enhancement methods are selected to obtain images of rock layers. After that, the rock images were classified and validated using classification and image recognition techniques to enable the company to utilize better the mining site data (Roshanzamir et al., 2021). Meanwhile, a desktop model was developed and implemented to display and store stratigraphic curve data for mining operations document processing and analysis.

## 3. Research methodology

### 3.1 Framework and database

The SpringBoot framework is part of the Spring Framework, which simplifies the original design parameters in this article and eliminates the need to define model configurations during development, enabling the quick-start functionality of the project in this article. SpringBoot now has an AOP container that can be used with SpringSecurity in this article for authentication SpringBoot now has an AOP container that can be used with SpringSecurity in this article for authentication, customized dynamic access management, and simplified Maven dependency management configurations. SpringBoot has a built-in Tomcat server for project implementation that can be quickly deployed and run on company target servers. It can run jars directly with commands on Windows and Linux platforms with JRE installed. The MyBatis framework is a sustainable framework with the advantage of encapsulating a JDBC procedural database. Therefore, while developing this paper, it is necessary to focus only on SQL rather than wasting too much effort on supporting registry drivers, creating connections, configuring parameters, and other complex JDBC procedure codes to meet the requirements of the rapid development project in this paper. The MyBatis framework provides powerful dynamic SQL functionality.

A large number of SQL queries were designed and implemented in this paper. The differences between them are not significant. The use of dynamic SQL functions reduces redundancy, improves code quality, and makes writing SQL expressions more flexible and more accessible. The MyBatis framework is configured as an XML file or markup and creates the final SQL expression by combining Java objects with the SQL expression. The framework then runs the SQL and maps the results to Java objects. MySQL is a secure, multidisciplinary, and robust language that is tightly integrated with critical programming languages such as Java relational databases. It is small, fast, low-cost, and open-source to meet the development and implementation requirements of mining computing software. MySQL is also available in versions compatible with Windows and Linux for developing and deploying target operations. MySQL uses InnoDB as the default engine and supports transactional backup tables with transaction, recovery, and restoration capabilities, as well as multiple parallel controls. It provides secure data processing for mining rig analyzer data processing software. Schematic diagram of the mining rig measurement forces, as shown in Figure 1.

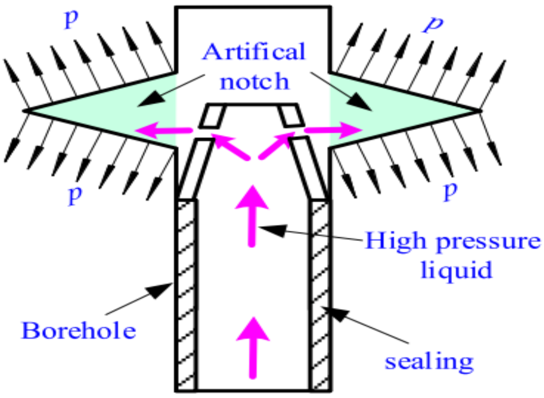


**Figure 1** Schematic diagram of mine shaft measurement forces

## 3.2 Data Remediation Processing Techniques

AlexNet uses an 8-layer convective neural network and a relay activation feature to facilitate network preparation. It also uses a backup method to reduce the complexity of overpairing and to monitor the level of fully connected models. The VGG network is an upgrade to the Alexnet network. Typically, Alexnet replaces the 7.7 and 5.5.5 spools with 3.3 smaller spools, which increases the network depth, which has a more robust structure and ensures that the increased depth is helpful in image detection. Google implemented a starter module that replaces the activation component with convection and increases the depth. The starter module provides communication and information integration between channels and improves the maintenance of flow channels to reduce model parameters. The deep convection neural network VGG represents a well-established model for image recognition.
The design is simple, and the detection factor can be improved by increasing the depth of the model. As the depth increases, the relay activation function can be used multiple times, making the convolutional neural network more isolated with better learning capability. The disadvantage of VGG is that its parameters are around 140M, and the servers provided by the company fulfill the storage conditions. Therefore, this error can be solved in the production environment where the characteristics of the VGG network meet the design requirements. Therefore, VGG is chosen as the image recognition model in this paper. In the VGG network structure diagram, the number of layers increases from 11 to 19 from left to right. The VGG3 convection core network uses 23×11 instead of 11, and the design of the 7x7 and 5x5 power cores increases the number of network layers, reduces the parameters, and increases the use of the relay activation function, overcomes the problem of gradient loss, and improves the learning speed. A 3x3 coil bar was used as the coil filter; a 3x3 continuous coil bar was used as the output connecting the entire interface layer, two 3x3 receiver fields overlapping the 3x3 coil core, and a 5x5 receiver field. The principle of convective core exchange is similar to 3x3, 11x11 and 7x7.
Histogram alignment is a method of adjusting the contrast of image processing using an image histogram. In this article, a histogram alignment technique is used to process a grayscale histogram of a rock image, which can reduce or increase exposure. A grayscale histogram describes the distribution of gray layers in an image. It can directly display the proportion of each gray layer in an image that reflects the distribution of gray layers in an image. The grayscale histogram only considers the number of pixels in each gray level and contains no information about the location of these pixels. There are four common patterns of grayscale distribution in a grayscale histogram: average gray values, dark gray values, light gray values, and half gray values. Many of the rock images in this paper have gray histograms matching dark gray, light gray, and dark gray values. Therefore, histogram equalization was chosen to solve this problem. Histogram alignment uses a cumulative distribution to adjust gray values to increase contrast and display patterns. Histogram alignment ensures that the original size ratio remains constant when displaying pixels. This means that brighter areas are brighter and darker areas are darker, which only increases the contrast of the image-processing scene in this paper. A decomposition of the mine measurement forces is shown in Figure 2.

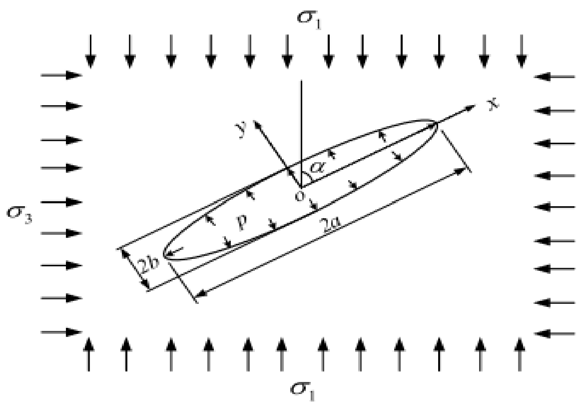


**Figure 2** Decomposition of the force on the mine measurement

The data standard's governance model for mine data integration is as follows:

$$z = W(\zeta) = R(\frac{1}{\xi} + m\xi) \quad (1)$$

Where $W$ is the analysis of the side forces on the mine.

$$\sigma_1 = q, \sigma_2 = 0, \sigma_3 = 0, X = Y = 0 \quad (2)$$

In Equation (2), $\sigma_1$ $\sigma_2$ and $\sigma_3$ are the directions of the mine forces.

$$\sigma_\theta + \sigma_\rho = q\,\mathrm{Re}\frac{\left(2e^{2ia} - m\right)\zeta^2 - 1}{m\zeta^2 - 1} \tag{3}$$

Where *Re* is a homogeneous vector decomposition of the mine-side data analysis.

$$\sigma_\theta - \sigma_p + \tau_{p\theta} = \frac{q\left(m\rho^4 + \zeta^2\right)\zeta^2}{\rho^4\left(m - \frac{\zeta^2}{\rho^4}\right)\left(m\zeta^2 - 1\right)}[2e^{2ia} - m + m\frac{1 + m\zeta^2 - 2e^{2ia}\zeta^2}{m\zeta^2 - 1}] \tag{4}$$

In Equation (4) $\zeta = \rho(\cos x + \sin x)$, the deviation of the force direction calculation is $\tau_{p\theta}$.

$$X = q\cos(N, x) = pL \tag{5}$$

Where $N$ of *cos(N, x)* is the number of cosine transformations.

$$X + iY = p(L + im) \tag{6}$$

In Equation (6), $p$ is the value of the deviation from the calculated pinch angle.

## 3.3 Software application technology

Drilling Analyzer Data Processing Software is primarily used to download, read, process and analyze mining jobs generated by the Drilling Geophysical Analyzer. Geological data in the archives of mining companies are stored mainly in text and video files. When processing and analyzing rock data, companies typically process and analyze rock data from text files, collect rock data, and reduce valid images from video files to rock images for processing and analysis. Therefore, on the basis of integrating the existing excavation data processing software, the excavation data processing program mainly processes and analyzes stone data curves and stone video images and proposes processing methods such as cutting, combining, filtering, matching, interpolating, and image enhancement. The curve detection of stone is provided to improve the flow rate.

Meanwhile, the data processing software of the drill analyzer corresponds to the processing of the company's existing mining data processing software, which provides detailed statistical graphs to present the data and help operators determine the nature of the rock. Stone is provided for quick and accurate understanding and determination. The following objectives are achieved when using Drill Analyzer data processing software:

Using Mining Analyzer's data processing software helps companies better manage information about mining organizations, mines, mining records and mine users. Mining Analyzer's data processing software enables consistent management of mining files, supports the transfer of file types generated by Mining Analyzer, and selects analyzed data to be stored in the database based on the attributes of the mining company's files. The data processing software for the drilling analyzer provides various methods for analyzing rock data curves. In response to the operator's visual activity, a custom-configured multi-channel table model is proposed that displays different rock data curves, which helps the operator to process the analysis of the mining data files more clearly. The data processing software for the borehole analyzer improves the quality of the rock video images, including improving the image quality and displaying the results by percentage similarity of rock properties. The mine logging data standard (1) is shown in Figure 3.

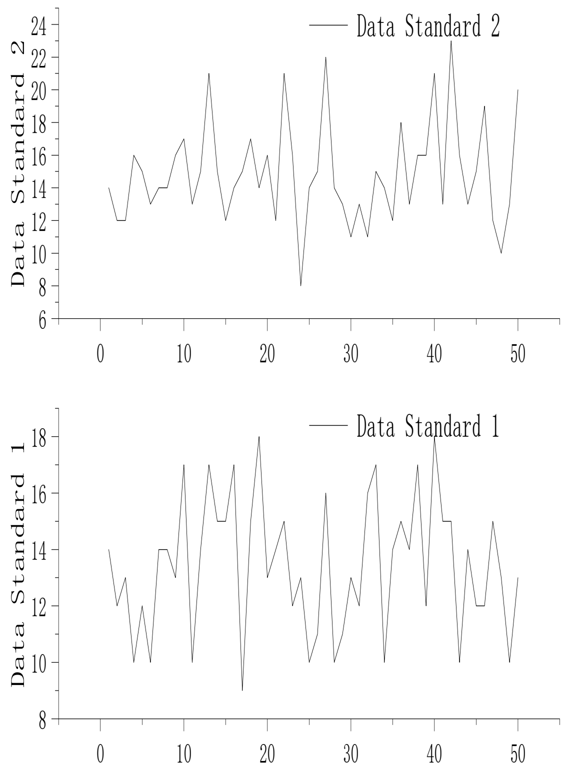


**Figure 3** Standards for mine logging data (1)

The main activity of the program is the analysis and processing of rock images and other data related to commercial document extraction. The software controls all stages of the analysis process. The basic workflow of the Mining Analyst data processing software can be deduced from the business plan: the personnel registers and downloads mining business documents produced by the Mining Analyst; the program synchronizes with the operator to process the data associated with the records during the logging process, and the logger controls the raw data of the excavation records; after the synchronization, the user processes the rock data, identifies the images based on the classifications and sends the results to the user based on the measurement data Create or update calibration interpretations.

## 4. Results and discussion

### 4.1 Mine Logging Data Processing Requirements

The functional requirements of the Drilling Analyzer data processing software were analyzed from the management, measurement and user perspectives. The management wanted the software to unify the management of the mining organization's data, mining data, mining management data and its operational files, and to manage access rights and mineral resources flexibly. Researchers wanted the software to easily upload mining files to the relevant mine logs and manage raw data to ensure accuracy in subsequent data analysis and processing. Operators expect the software will use custom configuration models, such as multi-layer structures, to process and analyze stone. Floating bars can support the visualization and processing of various stone data curves. The software can also detect rock images, show similarities to rock types, and analyze rock properties by comparing excavation files. Mine logging data standards (2), as shown in Figure 4.

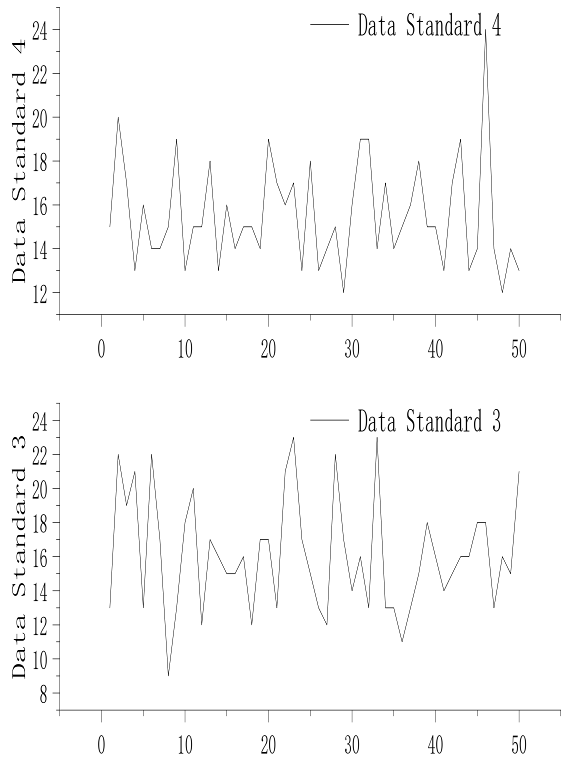


**Figure 4** Standards for mine logging data (2)

User requirements are analyzed based on additional segregation, and modules are categorized based on functional characteristics, business requirements, and usage patterns. This section analyzes the functional requirements for each functional location in detail. The software consists of four modules: mine management, mine user management, mine analyzer output file management, and mine analyzer file analysis. The Regional Mine Administration mainly provides management functions such as mine organization data, mine data, and mine registration data. Mining user management mainly provides mining user management, dynamic access management based on mining roles and utilization data access management. Explosive word analyzer output control mainly includes reading and saving various discharge work files generated by the discharge analyzer. The drilling analyzer file analysis includes platform model management, stratigraphic curve analysis, and rock analysis, which mainly includes alignment, interface, filtering, matching, interpolation, video image enhancement, and detection functions. As well as horizontal or vertical comparison of rock material curves in the platform model. Mountain management includes mine organization management, mine management and mine registration. Mining user management includes mining user management and mining permission management. Mine analyzer print file management includes mine file management and mine raw data management. Mine analyzer file analysis includes platform model management, stratigraphic curve analysis and rock analysis.

The mine management module is based on the use of well analyzers. The management divides the work into three parts: mine affairs, mine management and mine registration. Mine management includes the management of mining data and the management of mining structures. Mining management includes the management of mining data and the assignment of mining users. The submodular mining organization consists of two parts: information management of the mining organization and management of the mining organization structure. Administrators can view basic information about their organization and future organizations. When managing an organization's data mining, administrators can create sub-organizations, request organizations based on their attributes, edit primary organization data, view sub-organizations in the organization, and delete sub-organizations, workspaces, logs, users, and files that belong to the organization. The management of the mine's organizational structure focuses on questioning and changing the organizational structure of the mine. Administrators are allowed to perform unspecified queries, edits, and deletions and create sub-organizations based on the existing data in the study organization. Requesting a mining organization means presenting the organizational structure of the supervisor and its descendants based on the organizational structure, and entering the name of the mining organization can also make it ambiguous. Analyze the administrator's ability to process critical information about their organization and its descendants. Deleting a mining organization means that the administrator can delete child organizations. After deletion, the users of the research organization are transferred to the parent organization and become children of the parent organization. Creating a mine means that the administrator can create a new organization at the next level. The mine governance data (1) is shown in Figure 5.

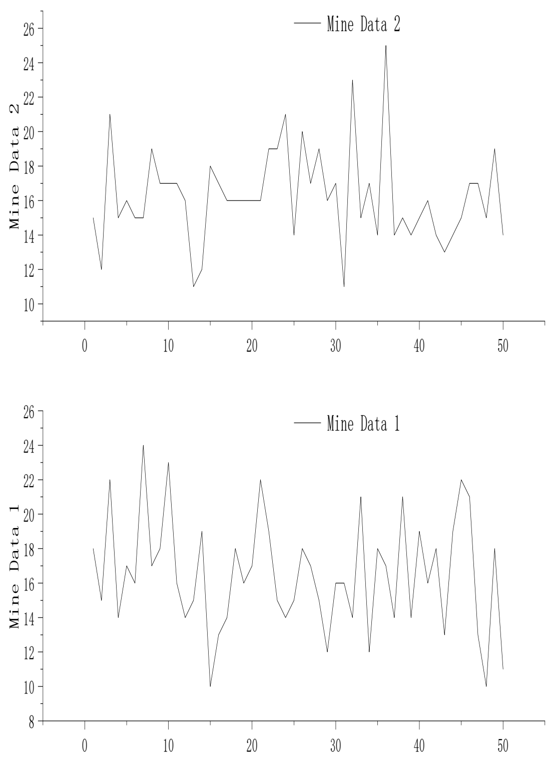


**Figure 5** Mine governance data (1)

The organization of a mine is determined by quantitative knowledge of the upper levels of the mining organization so that management can review and modify the structure of the mining organization. The mine's organizational view allows managers to view the overall organization of the mine in the form of nodes and the overall structure of many trees. The mining management sub-module consists of two parts: mining data management and mining user implementation. Administrators can view a list of mining sites and their successor sites in the organization. Query Restore Scopes is based on the administrator of the organization viewing the subset of scopes, or people can fuzzy query to restore scopes by typing in the name of the scope or selecting an organization. Changing the mine means that the administrator can change the essential information for different regions. Deleting a Search Workspace allows the administrator to delete the workspace. After the deletion process is complete, the workspace and user logs will be deleted at the next login, as well as its subfolders and all associated mining files. Creating a research site means that an administrator can create a new site at the next level of the current organization. The description of Mine Data Management is similar to the description of Mine Organization Management.

The Mining Registers section includes the management of mining register data. Administrators can view their organization and list of logs for iterative use. Mine Log Data Manager allows administrators to create subfolder logs, request logs based on log size, change logs, delete logs when they are no longer needed, and move users and log files correctly. Allows administrators to search, edit, delete and create sub-logs based on information contained in extracted logs. "Mine Logging Request" attempts to display the following entries in the log based on the organization to which the administrator belongs. Delete Activity Log means that sub-logs can be deleted, and all related activity files can be deleted after removing user logs from the next log. Creating a survey log means that the administrator can create a new log at the next level of the workspace. Mine Governance Data (2), as shown in Figure 6.

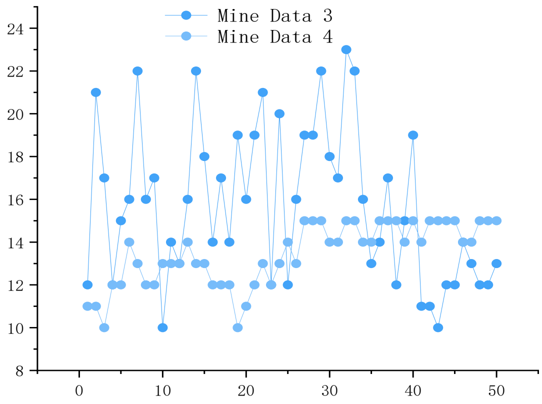


**Figure 6** Mine governance data (2)

## 4.2 Mine Management Governance Applications

The mine user management module consists of two parts: mine user management and mine rights management. Mining user management consists of two parts: managing mining user data and managing mining user status. Mining rights management consists of two parts: mine skidding data management and user role management. The mining rights management submodule consists of two parts: mining role data management and mining role definition. Administrators can view a list of mining roles. Role data management allows administrators to create new roles, edit essential roles, delete unnecessary roles, and use roles to authenticate users properly. Administrators can set up search roles. Allows administrators to edit, delete, and create new roles to retrieve their data. Mine Editor roles are essential information and role permissions that administrators can change. Deleting a mining role means that the administrator can delete the role. When the role owner logs in again after deleting the role, the role will be deleted. If the user is already registered, the role is invalid. Building new oilfield roles means that administrators can create new roles across the business. The example application of role management in a mine is the same as in a mine management organization. Only administrators are allowed to assign and use search roles in organizations, workspaces, and log spaces. Individual rollers are typically used for many blocks with significant functional differences or for localized smaller but essential blocks.

The mining user management submodule consists of two parts: mining user data management and mining user state management. In managing user mining statuses, administrators can create new statuses, change status information, change user statuses, delete statuses that are no longer in use, and correctly handle users in that status. Users can submit registration requests to the organization; administrators can send requests to, delete, and accept registration requests from multiple categories and classes of users. Registration is when a user requests without the consent of the organization's administrator, selects the organization in which they wish to participate and fills in the basic information. "Approve" is the authorization of the organization administrator to accept the registration request. Editing and retrieving user data is the ability of an administrator to edit primary data within an organization. Mine user request means that administrators in their organizations and sub-organizations display user information based on their user ID and can make unspecified requests by dialing their name, phone number, or organization. Removing a user from mine means that an administrator removes the user and their descendants from their organization. Users cannot delete themselves or users with advanced privileges. The description of the user management case in mining is similar to the description of user management in mining organizations. The mine measurement data platform is constructed as shown in Figure 7.

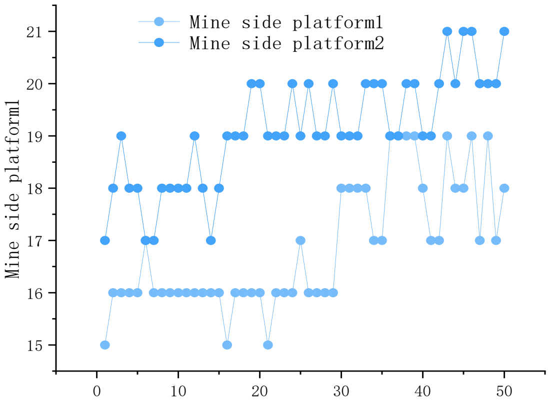


**Figure 7** Mine measurement data platform construction

Allows administrators to edit, create, or delete information about a user's status, as well as customize the user's status. State processing of mining data means that there is no conflict between the management of the mining space, the primary state data, the management of all economic activities of the state, and the economic activities of the state. Deleting a mining space means that an administrator can delete this space. When this state is deleted, users with this state will be deleted again after logging in, and this state will not be valid for registered users. Customize User Status means that the administrator can customize the user status. Users may have multiple states that cannot conflict with each other. The description of the mine user space management case is similar to the description of the mine organization management case.

Mining files are data sources used in the Mining Analyzer data processing software. Motion files contain XML files, video files, and headers. There is a relationship between individual XML output files, video files, and header files when using the Well Analyzer for geophysical surveys. XML files contain attributes such as depth-of-field detection lines, gamma values, and azimuths. The video file is a method of creating rock properties. The bridge between the XML file and the video file is the caption file. The geologic data of the caption file can be understood as geologic features that correspond per second to measured points in the video image. The integrated processing of these three types of documents makes it possible to use the company's intelligent documentation efficiently. The XML files are categorized into raw, temporary files at different stages of data processing. Raw production reports contain geologic data for multiple points in the form of measurement points. Excavation curve files store the same type of geologic data for each measurement point in the geologic data to create multiple geologic curves in ascending order of depth. Interim Excavation Files are files that record the status of the excavation data analysis process.

The Mining Analyzer's Results Documentation Management module consists of two parts: Mining Data Management and Raw Mining Data Management. Managers and surveyors have access to the protocols of their organizations and their descendants. When logging operational data, miners do not typically upload production data to a registered geophysical drilling site. Administrators can search for raw files, temporary files, video files, and similar header files using file names. Also, administrators can request and delete dig files uploaded to the dig log. Describe the use cases for requesting, changing, and deleting mining company records management, such as for mining organization management. Mining file transfers are mining company files created by the rig analyzer, including XML files, video files, stickers, and so on. After successfully downloading the XML and sticker files, the rig analyzer's data processing software analyzes the contents of the files. Then, it creates raw mine file data, mine profile file data, and sticker file data stored in a database. The mine data governance and remediation are shown in Figure 8.

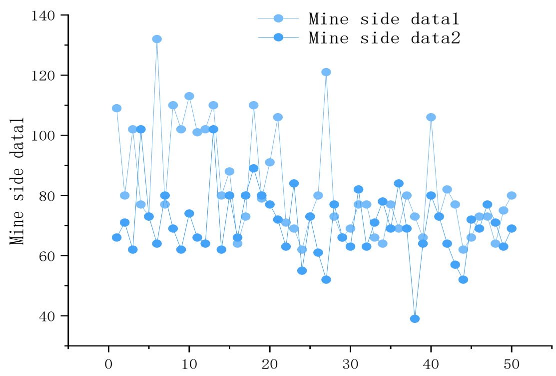


**Figure 8** Mine data governance and remediation

## 4.3 Mine-side data integration governance and analysis

The data analysis of the drilling analyzer is mainly related to the mining operation documentation. The fixed-distance geophysical survey method preserves the original mining records, but the structure of the strategic data could be more conducive to operator processing. Depending on the depth, the same type of stratigraphic data is entered into the table and displayed as stratigraphic curves for a more intuitive view of stratigraphic properties. Similarly, excavation video files created using this method can reflect rock properties as images and rock video images can help operators better evaluate rock categories. The File Analysis module of the Drill Analyzer consists of three parts: rock material curve analysis, rock analysis, and platform model management. Using a customizable desktop model, operators can view mine curve files and temporary mine files created by managing mine analyzer output files and process rock data curves and video images.

The user mainly supports and analyzes the excavated data generated by the borehole analyzer. Recovered business files include XML files, video files, subtitle files, etc. These are the main analytical targets of the Ore Drill Analyzer and the primary basis for evaluating rock properties. Once sent, the XML files are analyzed to categorize the rock data into a series of rock curves and to categorize other data into parameter data. The data was then created from the mine curve files and saved to a database. These include gamma curves, up and down offset curves, and left and right offset curves. The depth curves are called depth axes, and the curves representing rock properties are called lithology curves. Visualizing the geologic data of the Range Curve file on the interface is the first step in processing and analyzing it. Designing desktop model data helps the operator analyze different lithology data curves to display lithology data curves and properties. Traditional rock data analysis techniques allow operators to observe and process geologic data from mining files directly. Due to the large volume of floating data, it isn't easy to accurately analyze rock data based on specialized knowledge, observation, and imagination. Converting stratigraphic data from float data to desktop model-based curves improves analytical efficiency and more intuitive handling of strategic data. Data curves use multiple orbital data structures as desktop templates stored in the user interface. The floating band of the platform model is downward, corresponding to the drilling direction of the geophysical survey. It can display multiple strategic data curves simultaneously, clearly displaying multiple data metrics at the same depth and displaying strategic data curves in front of each channel. The method solves the problem of direct correlation with rock observation data.

In short, the desktop model should be designed as a flexible multi-band combinatorial model that supports the configuration of bandwidth and curve attributes. After importing the lookup curve file, the labor market table model for the data curve classes in the lookup curve file corresponds to the default curve classes displayed in each chart. If the classes are the same, they will be displayed in the template. If there are no corresponding categories, they can be displayed by adding curves to the title bar. The operator can click on the curves in the working model, select actions such as move and merge, and monitor the results of the process. The operator can also drag and drop geologic data curves between beaches, save the desktop model, and view the coastal curves the next time the survey curve file is opened. Text files are uniformly formatted text files that record equipment settings and data changes in video files in seconds.

During the drilling process of geophysical exploration, the initial and final depths of the drilling analyzer do not match the actual depths due to the equipment itself. The depths of the original and final curves of geologic data can be adjusted by performing the requirements of the actual site. A combination of geological data curves is a combination of two curves of the same name in a given depth range, which allows the continuous display of multiple measurements with duplicate certificates in the workstation model. Stone data curve filtering means filtering the measured values at 11 points on the curve (high, medium, low, medium). The corresponding rock data curve means that the operator can use existing measurement points in the assembly, refer to the calculated measurement points and manually adjust the original measurement points. Stratigraphic Data Curve Interpolation means that the operator can interpolate existing measurement points, calculate the measurement point data and compare it to the existing measurement point data. Comparison of rock data curves includes comparison of rock data curve profiles and comparison of rock cycles. By comparing geologic curve profiles, operators and surveyors can compare two types of horizontal or vertical geologic data. By comparing mine curve files, users and surveyors can compare geologic data profiles from multiple mine curve files in the same tabular model.

The output file from the Drill Analyzer is used to analyze rock properties and display them as a rocking curve. Rock analysis allows the user to overlay rock material from mine curve files and temporary mine files, select initial and final measurement depths, and manually select the appropriate rock image type for filling. Meanwhile, the video files primarily record the entire geophysical drilling process, including images of rock walls, gravel, suspended rock, soil, solid air contamination, water, and insects. The well analyzer is unstable during geophysical exploration because the diameter of some mines is much larger than the diameter measured by the well analyzer. The geophysical exploration of images also has a long period of stoppage. Artificial intelligence techniques are used to generate images in video files, classify rock properties by image recognition, and combine geologic data curves into mine curve files to obtain the corresponding geologic depth characteristics. Therefore, during the design of the video processing operations, an image processing method was developed to obtain the essential parts of the image and to reduce the interference of non-important parts in the subsequent detection process. In the field of image recognition, test results as auxiliary data for artificial stones require the selection of simple and stable structures whose accuracy is the main result of detecting objects such as carbon with a model error of 20%. Models trained in the correct production environment are used directly for image recognition. In short, visual analysis of rocks starts with converting the video into an image, then enhancing the image, and finally classifying and detecting the rocks using pre-trained lattice models for rock research work.

## 5. Conclusion

In the context of the dynamic development of "smart mining" in the coal industry, data-processing software for mining analyzers has been developed and implemented, for example, to address the underutilization of documentation by mining companies and the use of mining analyzers as data sources. This helps the company to better manage excavation operation files, improve rock curve calculations, and process rock video files using image enhancement and detection techniques for user reference. Based on the functionality of various mining data processing programs, a mining analyzer data processing software based on B/S structure was integrated, focusing on the development and implementation of functional software modules. The main results of the study are as follows: based on the existing software functions, combining business requirements, industry habits and related knowledge. Managed the mining analyzer output file and analyzed the data in the mining analyzer file. The mining business file processing process, from sending measurement data to visualizing and consuming rock data, was realized. At the same time, mining organizations, mining areas, mining registries, mining users, mining rights, etc., were completed. In the data analysis module of the drill hole analyzer, the software handles the alignment, joining, filtering, matching and interpolation of rock data curves. Among other things, curve filters are calculated over the medium and long term using the 11-point filter method and the mass method. Curve correction is performed using the least square polynomial method, which is relatively simple to compute, and the corresponding effect meets the design requirements. Interpolated curves are interpolated using Lagrangian interpolation, simple rules, and local interpolation to ensure that the interpolation function is manageable. Devices such as desktop model, vertical float tape, deep float tape and lithologic float tape were designed and implemented to provide flexibility in handling rock data curves. Also, based on the VGG19 network model, image acquisition, efficient local resolution processing and image enhancement were implemented, and rock image detection was planned and realized.

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