Machine learning in coal and gas outburst prediction

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ABSTRACT: Artificial intelligence is flourishing, and its research achievements are being extensively applied across various industries. In the field of predicting coal and gas outbursts, methods such as machine learning and deep learning have been widely explored, resulting in accurate prediction accuracy and excellent predictive effects. This has significantly improved the safety of coal mine underground operations.

KEYWORDS: machine learning; coal and gas outburst prediction; deep learning; artificial intelligence; application

1. Introduction and observation

During the stage of establishing an indicator system for predicting coal and gas outburst, Wu *et al*.[1] have employed machine learning methods such as decision trees and random forests to identify and select the influencing factors of coal and gas outbursts. They evaluate the importance of each factor and choose more effective predictive indicators based on their importance, using these scientific algorithms from the beginning to move towards accurate predictions.

Furthermore, in the process of handling the collected raw data for coal and gas outburst indicators, scientific machine learning methods are also applied. Methods such as Seasonal and Trend decomposition using Loess (STL) and wavelet denoising are utilized for regularity processing of time series data and noise reduction, achieving preprocessing and in-depth processing of the data. For example, Zhang *et al*.[2] use wavelet denoising to denoise the collected coal mine gas raw data. Such processing enables researchers to observe potential hazards through the regularity exhibited by the data, thereby preparing for further prediction work.

On this basis, some machine learning models that are consistent with the prediction needs of coal and gas outbursts are gradually being explored in coal and gas outburst prediction research[3], such as Back Propagation neural network (BP), Support Vector Machine algorithm (SVM), Long Short-Term Memory network (LSTM), Bi-directional Long Short-Term Memory network (Bi-LSTM), and Artificial Immune Algorithm (AIA)[4], etc. At the same time, based on the practical needs of coal and gas outburst prediction, these methods have been optimized accordingly, such as Xue *et al*.[5] using a genetic algorithm to optimize support vector machine, and Peng *et al*.[6] using particle swarm optimization algorithm to optimize the immune algorithm. Two or more models have complementary performance, forming some combination models, which significantly improve prediction accuracy and prediction effectiveness[7].

Through active exploration of the application of machine learning methods in coal and gas outburst prediction, coal mine safety technology has also been developed and iterated in the prevention and control of coal and gas outburst[8,9]. It has demonstrated beneficial effects and improved the

level of coal mine safety. With the current trend of mining automation and intelligence, more machine learning-based coal and gas outburst prediction methods with better performance can be explored.

Acknowledgments

Conflict of interest

The authors declare no conflict of interest.

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