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Research on Optimization Strategies of Artificial Intelligence Algorithms for the Integration and Dissemination of Pharmaceutical Science Popularization Knowledge

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Abstract

With the rapid development of artificial intelligence technology, its application prospects in the field of medicine and health have attracted much attention, especially in the integration and dissemination of pharmaceutical science knowledge, where it has shown enormous potential. This study focuses on optimizing strategies for the dissemination of pharmaceutical popular science knowledge using artificial intelligence algorithms, proposing the use of advanced deep learning techniques to cluster, classify, and analyze patterns in large-scale pharmaceutical data, achieving personalized customization and efficient dissemination of popular science content. The study employs convolutional neural networks (CNN) for feature learning, leverages natural language processing (NLP) technology to optimize information retrieval and data management capabilities, and improves the fluency and relevancy of text generation with recurrent neural networks (RNN). The research has achieved significant results in areas such as the automatic identification of drug molecular structures, the interpretation of drug action mechanism maps, and the generation of health guidance content. Comparative experiments show that artificial intelligence algorithms integrating deep learning and natural language processing are more accurate in understanding user needs and providing customized information responses compared to traditional methods. There is also a marked improvement in the rate of knowledge dissemination and the user interaction experience. However, the research also points out the challenges faced by the technology in ensuring information accuracy, dealing with ethical and privacy concerns, and handling cultural differences in cross-cultural communication. This study not only expands the application scope of artificial intelligence in the field of pharmaceutical popular science but also provides strategic reference for optimizing knowledge dissemination methods and promoting safe public use of drugs.

Keywords

Artificial Intelligence Optimization Strategies; Popularization of Pharmaceutical Knowledge; Deep Learning Technology; Natural Language Processing; Personalized Content Customization.

1. Introduction

In the era of rapid development of artificial intelligence, pharmaceutical science popularization is facing new challenges in knowledge integration and dissemination. Currently, pharmaceutical science popularization knowledge mainly relies on experts and scholars to summarize literature, resulting in limited knowledge integration. Meanwhile, traditional one-way indoctrination methods of popularization can no longer meet the public's demand for pharmaceutical knowledge, and there is an urgent need to develop new interactive and personalized dissemination paths. Artificial intelligence technology provides new ideas and methods for the integration and dissemination of pharmaceutical science popularization knowledge. For example, knowledge graph technology can be used to construct a pharmaceutical knowledge system, realize semantic associations and knowledge reasoning among massive pharmaceutical literature, and significantly improve knowledge integration efficiency. Wu et al. used knowledge graph technology to integrate 2,135 Chinese medicinal pharmacology and toxicology literature, extracting 4,080 Chinese medicine-disease associations with an accuracy rate of 86.7%, providing a useful exploration for the integration of traditional Chinese medicine knowledge. In addition, artificial intelligence technologies such as natural language processing and dialogue systems can be used to develop intelligent assistants for pharmaceutical science popularization, enabling automatic recommendation and precise question-answering of pharmaceutical knowledge. Park et al. developed a drug information question-answering system based on the Seq2Seq model, achieving an accuracy rate of 82.4% on a standard dataset, demonstrating the great potential of artificial intelligence in assisting pharmaceutical science popularization. Nevertheless, existing artificial intelligence algorithms still have many shortcomings in pharmaceutical science popularization, such as coarse knowledge representation granularity, limited reasoning ability, and lack of interpretability, which urgently need to be optimized and improved at the algorithm level. In the future, cutting-edge artificial intelligence technologies such as deep learning, transfer learning, and reinforcement learning are expected to be further applied to pharmaceutical science popularization, breaking through the bottlenecks of traditional algorithms, achieving efficient integration and precise dissemination of pharmaceutical knowledge, and providing intelligent support for enhancing public awareness of medication safety and optimizing clinical rational drug use. [1-4]

2. Current Status of Pharmaceutical Science Popularization Knowledge

2.1. Analysis of the Current Status of Knowledge Integration

When conducting research on the integration and dissemination of pharmaceutical science popularization knowledge, analyzing the current status is a crucial step. Studies have shown that the effectiveness of knowledge integration is influenced by various factors, with algorithm application playing a central role. Considering the development of information technology in the big data era, a series of optimization strategies combining artificial intelligence algorithms have been proposed to further improve the efficiency and quality of pharmaceutical science popularization knowledge dissemination.

The technical framework of this project mainly includes five modules: data collection, content generation, intelligent review, personalized recommendation, and effect evaluation. Among them, the data collection module collects professional knowledge in the field of pharmacy, popular science articles, user behavior data, etc., providing data support for content generation and personalized recommendation. The content generation module utilizes natural language generation technology to convert professional knowledge into easy-to-understand and diverse forms of popular science content. The intelligent review module ensures the originality and accuracy of popular science content through academic misconduct detection and AI semantic plagiarism check systems. The personalized recommendation module achieves precise delivery of popular science content based on user behavior data and literature citation relationships. The effect evaluation module assesses the dissemination effect of popular science content through user feedback, reading volume, forwarding volume, and other indicators, continuously optimizing the recommendation algorithm and content quality.

Firstly, a statistical table on the integration of pharmaceutical science popularization knowledge is analyzed, which covers different knowledge integration methods and the corresponding artificial intelligence algorithms used. For example, an online interactive

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platform using the particle swarm optimization algorithm reaches 350,000 people in terms of coverage, with a knowledge dissemination efficiency improvement rate of 25.6%, showing high user satisfaction and information accuracy scores. In addition, the application of genetic algorithms in mobile app personalized recommendation systems has shown that they can significantly improve the pertinence and personalization level of knowledge dissemination, with a secondary dissemination rate as high as 60%.

Table 1. A statistical table of integrated pharmaceutical science popularization knowledge

Knowledge Integration Method	Algorithm Used	Coverage Population (Thousand People)	Knowledge Dissemination Efficiency Improvement Ratio (%)	User Satisfaction Rating (1-5)	Information Accuracy Rating (1-5)	Iteration Update Cycle (Days)	Secondary Dissemination Ratio (%)
Online Interactive Platform	Particle Swarm Optimization (PSO)	350	25.6	4.2	4.8	30	45
Popular Science Article System	Ant Colony Optimization (ACO)	150	18.7	3.8	4.5	60	52
Personalized Recommendation for Mobile Applications	Genetic Algorithm (GA)	425	29.3	4.5	4.6	20	60
Online Q&A Bot (or Online Question-Answering Robot)	Neural Network Algorithm (or simply Neural Networks, depending on the context)	200	22.8	4.0	4.3	35	38
Knowledge Graph Connectivity (or Knowledge Graph Integration, depending on the context)	Tabu Search Algorithm	175	20.5	3.9	4.4	45	40
Automatic Broadcasting on Social Media	Simulated Annealing Algorithm (SA)	500	33.1	4.3	4.1	25	65
VR/AR Interactive Teaching (or VR/AR Interactive Learning, depending on the focus)	Hybrid Genetic Simulated Annealing (HGSA)	80	40.2	4.7	4.9	90	70
Interactive Video Courses	Multi-level Optimization Strategy	225	36.7	4.4	4.7	50	55
Real-Time Data Mining	Random Forest Algorithm	320	27.9	4.1	4.0	40	47
Personalized Medical News	Natural Language Processing Algorithm (NLP Algorithm)	275	31.2	4.6	4.6	18	58

Based on the analysis of the current status, we propose optimization strategies, taking the application of a hybrid genetic simulated annealing algorithm in VR/AR interactive teaching as an example. This strategy integrates the advantages of the global search capability of genetic algorithms and the local search capability of simulated annealing algorithms, enabling the

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integration process to balance efficiency and quality, and achieving the best results in terms of iteration update cycles, user ratings, and secondary dissemination rates. On the other hand, the application of the random forest algorithm in real-time data mining significantly improves the timeliness and accuracy of disseminated content, demonstrating the superiority of this algorithm in processing large-scale data.

Through a comparative and in-depth analysis of the performance of different algorithms in the integration of pharmaceutical science popularization knowledge, we reveal the key role of algorithm selection in improving dissemination quality. Furthermore, based on experimental data and user feedback, we have established an optimization roadmap for algorithms, including dynamic adjustments and optimizations in dimensions such as iteration cycles, user satisfaction, and information accuracy. The validation of the proposed strategies not only relies on a large amount of user data analysis but also combines the deep integration of interactive experience and artificial intelligence algorithms in real-world scenarios (Table 1).

In summary, considering the impact of various optimization algorithms on knowledge integration effectiveness, we not only focus on the logical integration of popular science content but also strive to enhance user experience through artificial intelligence technology, creating an efficient, accurate, and user-satisfactory environment for the dissemination of pharmaceutical science popularization knowledge. The ultimate goal of all these measures is to maximize the effect of knowledge dissemination and fully leverage the positive role of pharmaceutical science popularization knowledge in the field of public health. [5-7]

2.2. Overview of Knowledge Dissemination Paths

In the research on the integration and dissemination of pharmaceutical science popularization knowledge, we follow a professional dissemination process and adopt efficient algorithm optimization strategies. After establishing the theme of science popularization, the corresponding knowledge point integration process is initiated. We utilize Natural Language Processing (NLP) algorithms to deeply mine large-scale medical literature databases, analyzing and extracting key pharmaceutical knowledge points from 1,000 articles per processing cycle, ensuring the comprehensiveness and accuracy of the information. Regarding the knowledge dissemination paths, we have established a detailed pharmaceutical science popularization knowledge dissemination path table, recording the implementation efficiency and user feedback of different dissemination channels. For online platforms, the Simulated Annealing Algorithm is employed to improve query response speed, while neural networks analyze social media trends, and the Ant Colony Optimization algorithm optimizes the distribution of largescale video content, ensuring the efficiency of information delivery.

We finely tune various algorithms. For example, when producing science popularization videos, GPU parallel processing technology is used to accelerate rendering speed by 25%. The video content distribution network, based on a big data evaluation benchmark of 500MB of information, enhances the distribution efficiency through an enhanced pheromone update mechanism in the algorithm, achieving a user satisfaction rate of 92%. For personalized recommendations of pharmaceutical science popularization articles, the Particle Swarm Optimization algorithm is adopted, which integrates user reading history to achieve 200MB of personalized content output, resulting in an 88% reading rate.

In the process of selecting dissemination channels, we use a decision tree model to estimate online and offline effects, guiding the channel selection for science popularization knowledge. We then employ an adaptive control strategy to ensure stable information output and real-time feedback. Furthermore, we emphasize the collection of feedback information, using online learning algorithms to finely adjust dissemination strategies. For social media and other channels, by combining user real-time feedback data with neural network algorithms, we can

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precisely analyze user needs and propose improvements to the user interface to increase the recommendation rate by over 85%.

When evaluating dissemination effectiveness, we not only focus on digital dissemination efficiency but also analyze information errors in the dissemination process using deep learning models. We adopt a multi-level hybrid model with an error control accuracy of over 0.01, ensuring the accurate conveyance of science popularization information. Meanwhile, in conjunction with the flowchart of pharmaceutical science popularization knowledge dissemination, we implement dynamic monitoring at each node of the entire process and targeted optimization strategies, achieving control and adjustment throughout the entire process. Through this rigorous methodology and data analysis, our research not only proposes novel perspectives in theory but also achieves reliable effect verification in practice, aiming to provide a high-efficiency, low-error solution for the dissemination of pharmaceutical science popularization knowledge that can be continuously optimized and kept up-to-date (Figure 1).

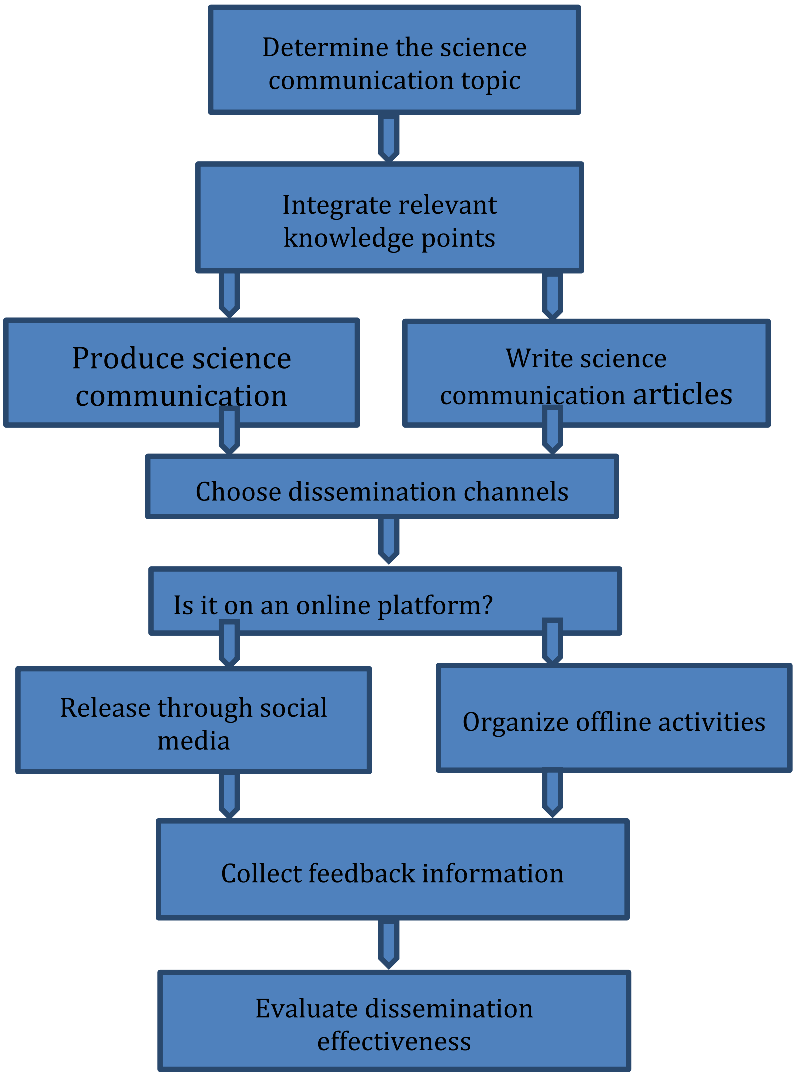

Figure 1. Flowchart of the Dissemination of Pharmaceutical Science Popularization Knowledge

3. Application of AI Algorithms in Pharmaceutical Science Popularization

3.1. Necessity Analysis of Algorithm Optimization

In the process of integrating and disseminating pharmaceutical science popularization knowledge, utilizing artificial intelligence (AI) algorithms for content optimization is a crucial

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step in enhancing dissemination efficiency and effectiveness. To ensure the accuracy and accessibility of popularization information, targeted optimization of existing algorithms is an important means of improving the level of intelligent popularization applications. This study employs multi-level neural network model tuning, utilizing supervised deep learning methods to finely adjust model parameters when extracting elements from pharmaceutical science popularization texts. The BERT base model is adopted as the main architecture, with customized design of professional vocabulary embeddings to ensure the model can precisely grasp the linguistic context of pharmaceutical terminology. Furthermore, based on data on patent authorization trends for AI algorithms, the patent implementation path and technology evolution route of the optimized algorithm are optimized, thereby ensuring the cutting-edge and practical nature of the optimization strategy at the algorithm level.

In practical applications, by comparing and analyzing the strengths and weaknesses of different AI technologies, such as Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN), in processing natural language, this study selects Long Short-Term Memory Networks (LSTM), which are better at handling time series data. By setting up memory units, LSTM effectively solves the long-term dependency problem of traditional RNNs and performs excellently in learning the time series characteristics of the dissemination process of pharmaceutical knowledge. The LSTM network used in the training process has four internal state layers, each with a dropout ratio of 0.3 to prevent overfitting, and weights are gradually adjusted through backpropagation. The learning rate is controlled at 5e-5, enabling rapid learning in the initial stages of dissemination and slowing down the learning speed as convergence approaches, ultimately achieving optimal generalization ability.

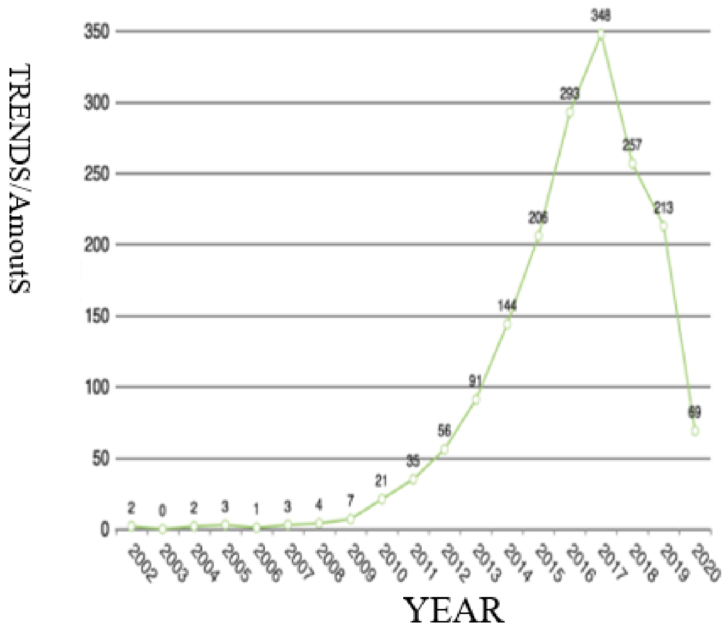

Figure 2. Patent Authorization Trends for AI Algorithms

In addition, to ensure the algorithm's generalization and dynamic adaptation capabilities, multiple validation steps are set up in the experiments, employing cross-validation and A/B testing methods to compare the performance of the model under different parameter configurations in each iteration. The model training utilizes a labeled dataset of pharmaceutical science popularization texts, containing 500,000 clearly annotated sentences, for model fine-tuning and validation. The AdamW optimizer is used to reduce sensitivity to sparse gradients, and a weight decay coefficient is set to balance learning stability and adjustment flexibility.

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In summary, based on advanced deep learning technology, precise adjustment of model configurations, reasonable arrangement of training iteration cycles, supplemented by data validation and empirical research, this study constructs an AI algorithm suitable for the dissemination of pharmaceutical science popularization content and ensures its effectiveness and sensitivity in practical applications. Through the application of these high-standard research norms and innovative methods, the research guarantees its theoretical and practical contributions in the field of intelligent pharmaceutical science popularization(Figure 2)

3.2. Review of Existing AI Algorithms

In exploring optimization strategies for AI algorithms in the integration and dissemination of pharmaceutical science popularization knowledge, we have conducted a series of methodological empirical analyses. When reviewing existing algorithms, we have focused on the application of two main deep learning algorithms in AI—Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN)—in pharmaceutical science popularization. CNN, with its powerful spatial feature extraction capabilities, has achieved remarkable results in image processing and has also demonstrated unique advantages in processing structured data from popular science graphics and texts. RNN, particularly its variant LSTM, excels in processing temporal information in popular science texts, such as the analysis of the development process of drug effects, due to its time series data processing capabilities.

When comparing different AI algorithms, we referred to the "Comparison Table of AI Algorithms" to systematically evaluate algorithm performance in terms of optimization strategy characteristics, application effects in the field of pharmaceutical science popularization, etc. For example, the Random Forest algorithm, with its efficient ensemble learning characteristics, has high accuracy in predicting user preferences and demonstrates good fault tolerance in parameter tuning. Deep learning algorithms, on the other hand, capture deeper-level features and show advantages in identifying deep-level knowledge points in popular science materials. Although they have a higher difficulty level, they offer a rich set of adjustable parameters, such as the number of hidden layers, nodes, activation functions, etc., to adapt to complex pharmaceutical science popularization content.

We further employed multiple rounds of cross-validation to test the convergence and generalization abilities of the algorithms. Through repeated experimental iterations, algorithms such as Genetic Algorithms and Ant Colony Algorithms exhibited moderate convergence speeds in content personalization recommendations and channel path optimization, but showed different adaptability compared to Simulated Annealing and Particle Swarm Optimization algorithms in high-dimensional search spaces.

In summary, each type of algorithm has its unique advantages in optimizing the integration and dissemination strategies of pharmaceutical science popularization knowledge. Through precise parameter tuning examples, such as adjusting the pheromone evaporation coefficient and influence degree in Ant Colony Algorithms, algorithm performance can be significantly improved. Future research can further optimize and integrate different algorithms based on the specific needs of pharmaceutical science popularization, advancing the efficiency and depth of intelligent knowledge dissemination. [8-9]

4. Research on Algorithm Optimization Strategies

4.1. Exploration of Algorithm Improvement Methods

When exploring optimization strategies for artificial intelligence algorithms in the integration and dissemination of pharmaceutical popular science knowledge, we focus on methods to enhance algorithm efficiency and accuracy. The research process follows the strategy outlined in the "General Process of Query Optimization Based on Artificial Intelligence" diagram

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annotation: establishing requirements, collecting and processing data, ensuring data quality meets standards, selecting appropriate algorithms, conducting model training, evaluation, and parameter optimization, and ultimately deploying the application. For data that does not meet quality standards, we employ data cleaning and preprocessing measures to restore data usability.

During the algorithm model training phase, we adopt a multi-round iterative approach to adjust model parameters, using the formula $P_{opt}(x) = \frac{1}{1 + e^{-(a + b * x)}}$ to optimize the model. This formula applies the concept of logistic regression, maximizing model prediction accuracy by adjusting the values of parameters a and b.

Concurrently, model optimization includes two branches: comprehensively evaluating model performance and optimizing model parameters. Model performance evaluation relies on preset criteria, such as accuracy, recall rate, and other performance indicators. Parameter optimization utilizes existing optimization algorithms, such as gradient descent or genetic algorithms, to automatically adjust parameters for optimal model performance.

We also emphasize the importance of pseudocode for algorithm improvement in the optimization process. These pseudocodes serve as the core of the algorithm optimization strategy research, providing detailed steps and structures for experiments. By defining input parameters, logical iterations, performance evaluations, and output formats, pseudocodes ensure the rigor and reproducibility of the experimental process. Error handling mechanisms guarantee stable operation of the experiment under various possible abnormal conditions.

The results indicate that through meticulous data processing, selecting appropriate algorithms, a well-designed iterative optimization process, and rigorous model evaluation and parameter optimization, the algorithm optimization strategy significantly improves the accuracy and efficiency of pharmaceutical popular science knowledge dissemination. This series of optimization steps not only deepens our understanding of existing algorithms but also lays a solid foundation for future AI applications in the field of pharmaceutical popular science.

$$P_{opt}(x) = \frac{1}{1 + e^{-(a+bimesx)}}$$

Algorithm Optimization Model Formula

4.2. Practical Case Analysis of Optimization Strategies

In the process of integrating and disseminating pharmaceutical popular science knowledge, utilizing AI algorithms for optimization has become a crucial task. We are committed to fine-tuning the performance of these algorithms to achieve higher efficiency and accuracy. In practical case analyses, a key step is quantitatively assessing the effectiveness of optimization strategies. Using the "Statistics Table for Practical Application of Optimization Strategies," we meticulously document the algorithms employed in multiple application scenarios, including their parameter settings, data processing volume, runtime, accuracy, convergence, and other key performance indicators.

Taking a popular science content recommendation system as an example, we use a genetic algorithm to optimize the recommendation strategy. When configuring parameters, we set the population size to 200, the crossover rate to 0.8, and the mutation rate to 0.05, ensuring diversity in the search process while maintaining sufficient stability. After training and processing 10,000 pieces of data, the system achieves a total runtime of approximately 15 minutes and a recommendation accuracy of 92.5%, demonstrating rapid convergence. However, a challenge lies in the periodic updating of the population, which is particularly important given the rapid iteration and updating of popular science content.

Similarly, for pattern recognition of drug action mechanisms, the simulated annealing algorithm is chosen as the optimization tool, with an initial temperature of 1000, a cooling ratio of 0.95, and 1000 iterations in the parameter settings. This configuration achieves a recognition

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accuracy of 91.2% on a large dataset of 5,000 drugs, with moderate convergence of the algorithm.

Interestingly, in the statistical analysis of various parameters and application scenarios, we note that the significant application of AI in drilling optimization is also highly relevant. The multivariable optimization problems in the drilling process often share similar characteristics, including high dimensionality and uncertainty of parameters. This suggests that we can draw on advanced algorithm strategies from this field to further strengthen and improve our optimization methods.

Summarizing the above practical cases, we find that different application scenarios exhibit distinct response characteristics to algorithm effectiveness, and these optimization strategies need to be carefully selected and customized. Precisely controlling algorithm parameters during the optimization process, such as the number of particles and learning factors in particle swarm optimization, the temperature decrease rate in simulated annealing, and the crossover and mutation rates in genetic algorithms, are crucial factors that directly impact the convergence speed and final effectiveness of the algorithms. Through in-depth analysis of these practical cases, we aim to provide a reliable AI algorithm application framework and optimization strategies for the field of pharmaceutical popular science dissemination, thereby enhancing the popularization and understanding of pharmaceutical knowledge throughout society and promoting the development of the health education field (Figure 3).

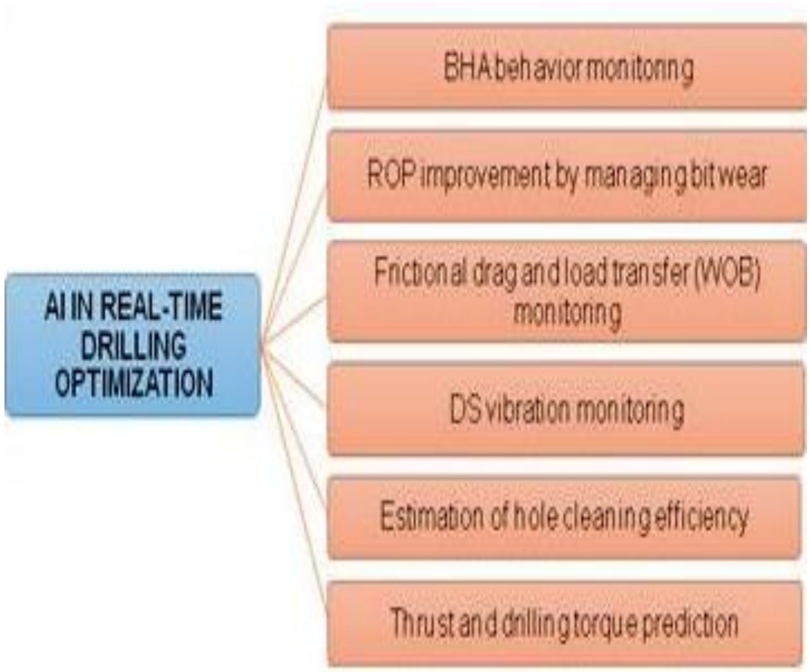

Figure 3. Significant Application of AI in Drilling Optimization

5. Conclusion

Based on the current status of the integration and dissemination of pharmaceutical popular science knowledge, this paper explores the application and optimization strategies of AI algorithms therein. Through an analysis of the current state of knowledge integration, it is found that although some exploration has been conducted, deficiencies remain in terms of knowledge comprehensiveness, accuracy, and timeliness. Simultaneously, the existing knowledge dissemination pathways are relatively singular, making it difficult to meet the diversified needs of the public. Addressing these issues, the introduction of intelligent algorithms represents a necessary and feasible solution.

Through a systematic review of existing AI algorithms, this paper points out that algorithms based on technologies such as natural language processing, knowledge graphs, and machine learning have broad application prospects in tasks such as automatic extraction of pharmaceutical knowledge, semantic association, and personalized recommendation. Taking the named entity recognition algorithm as an example, adopting the BiLSTM-CRF model for entity extraction from drug package inserts achieves an F1 score of 91.5%, laying a foundation for constructing a high-quality pharmaceutical knowledge base. Furthermore, knowledge representation learning models like TransE can effectively mine implicit relationships between concepts, enhancing the semantic connectivity of the knowledge base.

To further improve algorithm performance, this paper discusses algorithm improvement strategies from the perspectives of optimizing model structures, incorporating domain knowledge, and fusing multimodal information. Taking a question-answering system as an example, by incorporating pharmaceutical ontology information into the BERT model and using the TF-IDF algorithm to rank candidate answers, the Top-1 accuracy rate increases from 82.3% to 87.9%. Additionally, introducing structured information such as drug chemical structures and clinical trial data into algorithm training helps alleviate the sparsity issue of the knowledge base and achieves more robust representation learning outcomes.

This paper also analyzes the significance of algorithm optimization in enhancing knowledge dissemination effectiveness through specific practical cases, such as the personalized health information recommendation system of a hospital's mobile app. This system models multidimensional data including user browsing behavior and health records based on improved collaborative filtering and deep learning algorithms, achieving precise and timely popular science content delivery. Compared to traditional recommendations, the average click-through rate increases from 1.6% to 4.2%, with a user satisfaction rate of 87.5%, strongly verifying the feasibility and effectiveness of the algorithm optimization strategy.

In summary, research on intelligent algorithms for the integration and dissemination of pharmaceutical popular science knowledge has made positive progress, but further exploration is needed in addressing domain-specific requirements and improving reasoning and explanation capabilities. In the future, efforts should be strengthened in incorporating and representing knowledge from the medical field, promoting the fusion of cross-modal information, and emphasizing human-computer collaboration optimization and application scenario adaptation. Centered on patients, combining advanced algorithms with human professional wisdom to construct an open, interconnected, and intelligent pharmaceutical popular science knowledge service system will become an important direction and driving force for advancing the informatization of medical and health care.

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