Deep Learning Algorithm Research and Performance Optimization of Financial Treasury Big Data Monitoring Platform

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***Abstract*—With the rapid development of information technology and the advent of the digital age, the management of fiscal treasury is facing unprecedented challenges and opportunities. In order to improve the efficiency and effectiveness of deep learning algorithms in the financial and treasury big data monitoring platform, this paper further studies the performance optimization methods of the model. This paper deeply studies deep learning algorithm research and performance optimization of financial Treasury big data monitoring platforms. This paper reviews the basic concepts, methods, and applications of deep learning and their application in the financial database big data monitoring platform. In the financial Treasury big data monitoring platform, deep learning algorithms are widely used in image recognition, natural language processing, recommendation systems and other fields. This article first conducts in-depth theoretical research on deep learning algorithms, including various neural network structures (such as convolutional neural network CNN, recurrent neural network RNN, etc.), optimization algorithms (such as gradient descent method and its variants), regularization techniques, etc. In addition, we also studied the practical applications of deep learning in fields such as image processing, natural language processing, and recommendation systems. In order to verify the effectiveness of deep learning algorithms in the financial and treasury big data monitoring platform, we designed corresponding experiments. These experiments include using deep learning algorithms for image recognition of financial documents, natural language processing, and building recommendation systems. We collected real fiscal treasury data as the experimental dataset and preprocessed and annotated the data.**

***Keywords*—Deep learning; financial database big data monitoring; algorithm research; performance optimization**

I. Introduction

The financial treasury's big data monitoring platform is an important tool for the government to supervise financial funds effectively. It is significant for ensuring financial funds' safety and rational use [1]. The role of deep learning algorithms in the financial Treasury big data monitoring platform: Deep learning algorithms can extract valuable information from a large amount of data to provide more accurate data support for financial decision-making. Improve the performance of the financial Treasury big data monitoring platform. Studying deep learning algorithms and performance optimization methods improves the performance of the financial Treasury big data monitoring platform and provides more accurate data support for financial decision-making [2]. Protecting the privacy of financial big data: In the financial Treasury big data monitoring platform, it is crucial to protect the privacy of financial big data [3]. Ensure the security and privacy of big data in financial institutions by researching privacy protection methods. Research on deep learning algorithms: Research on deep learning algorithms applicable to financial Treasury big data monitoring platforms, such as convolutional neural networks and recurrent neural networks [4].

Performance optimization methods: Research methods to improve the performance of financial Treasury big data monitoring platforms, such as model compression, model acceleration, etc. [5]. Methods to protect the privacy of financial big data in the financial Treasury big data monitoring platform, such as differential privacy, homomorphic encryption, etc. [6]. This paper introduces the background and importance of the Financial Treasury big data monitoring platform and the role of deep learning algorithms in the Treasury big data monitoring platform [7]. Review the application of deep learning algorithms, performance optimization, and privacy protection methods in the financial database big data monitoring platform. The deep learning algorithm applicable to the big data monitoring platform of financial Treasury is introduced in detail. Performance optimization method: The method to improve the performance of the financial Treasury big data monitoring platform is introduced in detail [8]. Privacy protection method: The method of protecting the privacy of big data in the financial treasury big data monitoring platform is introduced in detail. Experiment and evaluation: The effectiveness of the proposed deep learning algorithm, performance optimization, and privacy protection methods is verified through experiments [9]. The main achievements and limitations, as well as the future research direction, are presented. A new deep learning algorithm is proposed, which is suitable for the financial Treasury big data monitoring platform and improves the performance of the platform [10]. A new performance optimization method is proposed to improve the performance of the financial Treasury big data monitoring platform while ensuring the privacy of financial big data [11]. A new privacy protection method is proposed to protect the privacy of financial big data in the financial Treasury big data monitoring platform while ensuring the performance of the platform [12].

II. Literature Review

In recent years, deep learning algorithms have been applied more and more widely in the financial Treasury big data monitoring platform, becoming an effective means to solve complex problems [13]. This paper summarizes the research and application of deep learning algorithms in the financial Treasury big data monitoring platform, focusing on the basic concepts, methods and applications of deep learning and its application in the financial Treasury big data monitoring platform [14]. Deep learning is a branch of machine learning that simulates the working mechanism of the human brain by building deep neural networks that automatically learn features from data to deal with complex problems. Deep learning mainly includes convolutional neural networks (CNN), recurrent neural networks (RNN), long and short-term memory networks (LSTM), generative adversarial networks (GAN), etc. In the financial Treasury big data monitoring platform, deep learning algorithms are mainly applied to image recognition, natural language processing, recommendation systems and other aspects [15]. In the context of globalization, supply chains have become increasingly complex, involving numerous participants and massive transaction data [16]. This complexity not only brings business opportunities to enterprises, but also risks, especially the risk of financial fraud. Traditional financial fraud detection methods often struggle to cope with such large-scale and high-frequency transaction data [17]. Therefore, developing a financial fraud detection method based on distributed big data mining is particularly important. Distributed big data mining technology is a technology that can process and analyze massive amounts of data. It distributes data across multiple computing nodes and achieves rapid analysis and mining of data through parallel computing and collaborative processing. This technology can not only handle large-scale data, but also cope with the rapid growth and changes of data, providing strong technical support for financial fraud detection [18]. Image recognition technology can help identify image information such as bills and bills and improve data processing efficiency. Natural language processing technology can process much text data, such as news, reports, etc., for public opinion analysis and risk warning. Based on their behavioral data, the recommendation system can recommend relevant services or products to users. The performance optimization problem of a deep learning algorithm in financial Treasury big data monitoring platform. Although deep learning algorithms have wide applications in the financial database big data monitoring platform, some performance optimization problems remain, such as model compression, parameter optimization, calculation acceleration, etc. Model compression technology can improve the inference speed of the model by simplifying the model structure and reducing model complexity. Parameter optimization technology can improve the model's generalization ability by adjusting the parameters. Computing acceleration technology can improve models' training and reasoning speed using hardware acceleration devices such as GPU and TPU.

In summary, deep learning models typically have high complexity and require a large amount of computing resources for training and inference. However, in the financial and treasury big data monitoring platform, computing resources are often limited. To solve this problem, we can use model compression technology to reduce the consumption of computing resources by reducing the number of model parameters and reducing model complexity. In addition, utilizing hardware acceleration devices such as GPUs and TPUs can significantly improve the training and inference speed of the model. The financial and treasury big data monitoring platform needs to process and analyze data in real-time to address potential risks and fraudulent behavior. However, the training of deep learning models usually takes a long time, and the accuracy of the model directly affects the performance of the monitoring platform. To solve this problem, we can adopt incremental learning and online learning techniques to enable the model to continuously update and optimize itself while processing new data. In addition, we can also use transfer learning and ensemble learning methods to combine the prediction results of multiple models to improve accuracy.

III. Deep Learning Algorithms for Big Data Monitoring Platforms

A. Basic Principles of Deep Learning Algorithms

The convolutional neural network then classifies and outputs the feature representations formed after multiple convolutions and pooling through the fully connected network. Convolutional neural networks can extract and learn data features automatically and efficiently. Based on the structural characteristics of the convolutional layer and pooling layer, convolutional neural networks have gained rapid development and many applications in computer vision fields, such as image recognition and object detection. Autoencoder is an unsupervised deep learning algorithm that can learn the potential feature representation of data and then realize the functions of data dimensionality reduction, noise reduction, and new data generation. An automatic encoder usually includes an encoder and decoder, two components; the encoder can encode the data into the encoding space and compress it into a low-dimensional space representation, and the role of the decoder is to decode the compressed representation back to the original data space. At the same time, the autoencoder trains the model by minimizing the error between the encoder's input and the output reconstructed by the decoder. Then, it learns the underlying characteristic representation of the data. The autoencoder is flexible, efficient, and widely used in data compression and noise reduction. The basic reinforcement learning framework mainly comprises agents, environments, states, actions and rewards, as shown in Fig. 1. The agent is the learner in reinforcement learning. As the core of reinforcement learning, it learns strategies by interacting with the environment. In contrast, other things interacting with the agent are called environmental states and are used to describe the current information about the environment. The reinforcement learning process is embodied in that the agent chooses actions to perform according to the current state of the environment and affects the environment. Then, the environment will give feedback and reward signals to the agent's actions, and the new state agent will continuously improve its action strategy according to the feedback of the environment and perform subsequent actions according to the strategy. The agents continue to conduct trial-and-error learning and strategy improvement in this interaction process to maximize the final cumulative income.

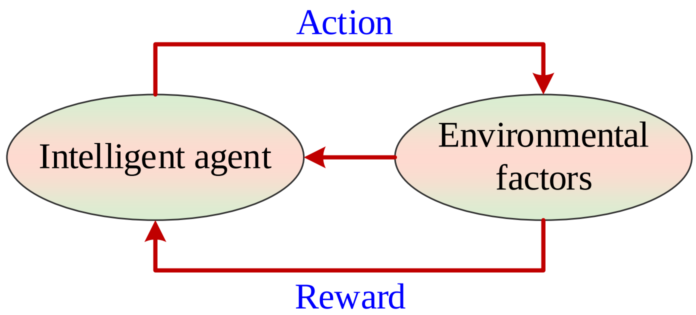

Fig. 1. Reinforcement learning basic frame.

Deep reinforcement learning is still a reinforcement learning method, and its essence and basic framework are the same as reinforcement learning. It uses reinforcement learning ideas to define problems and optimize strategies, while deep learning is used to solve value or strategy functions and optimize objective functions through backpropagation algorithms. The research in this paper mainly uses an algorithm based on a value function, which approximates the value function through the neural network. The agent and environment interaction data is used to train the neural network. DQN and DDQN, two deep reinforcement learning algorithms used in this paper, are mainly introduced.

DQN algorithm (Deep O-network) First proposed by Google's DeepMind team in 2013 and further modified and improved in 2015, the DQN algorithm is the first deep reinforcement learning algorithm, which was originally used to play video games. For DQN, people do not need to provide the game rules to the agent, but only the game screen as the input of the DQN algorithm; the agent can automatically conduct trial and error learning and show that it can reach or even exceed the level of human games. Due to the different nature of deep learning and reinforcement learning, there are too many differences in their training data and learning process, and there have been many problems with how to integrate the two. The emergence of the DQN algorithm solves these problems through experience playback and other technologies, and deep reinforcement learning technology has opened a new chapter. Deep learning is a supervised machine learning method. To train and update the weight parameters in the Q network, a loss function must be defined to determine the network's optimization goal. Meanwhile, this loss function also represents the objective function of reinforcement learning. DQN's update rule based on the Q-learning algorithm defines the loss function as shown in Formula 1:

$$L(\theta) = \left[\left(R + \gamma \max_{a'} Q\,(s', a'; \theta)\right)^2\right] \qquad (1)$$

Among them, R Represents the reward received by the agent, γ Represents the discount rate, a constant between 0 and 1, which controls how much attention is paid to future value, S' and a' Indicates the status and the next action. The loss function of DQN is expressed as the mean square error of the target Q value and the predicted Q value, where the target Q value is shown in Formula 2.

$$Target Q = R + \gamma \max_{a'} Q(s', a'; \theta) \qquad (2)$$

The weight parameters of the Q network in DQN are not updated and trained by the gradient descent algorithm to minimize the loss function so that the deep neural network approximates the value function, and the target Q value is constantly approximated based on the current predicted Q value. However, there are also great differences in training data between deep learning and reinforcement learning, affecting the performance of deep reinforcement learning algorithms. The training data of deep learning is usually independent and distributed. There is no obvious correlation or temporal relationship between the data. In contrast, the training data of reinforcement learning is obtained by the interaction between the agent and the environment. Each state and action will affect the next state and action, and the training data is usually strongly correlated and non-static. If the neural network is used directly for training, the loss value may fluctuate continuously, the model may become unstable, and it may be challenging to converge. To solve this problem, DQN adopts the experiential playback mechanism to train the model. It counts the number of experience samples each time an agent interacts with the environment $(s,\ a, R, s')$ It stores the number of experience samples each time the agent interacts with the environment in a buffer called playback cache experience pool. During training, the agent randomly draws a small batch of experience sample data from the experience pool to update the parameters of the neural network. The empirical playback mechanism uses random sampling to remove the correlation and timing relationship between the training data. At the same time, under this mechanism, every sample may be used and reused, which can smooth the change of the data distribution, help smooth the gradient, and make the model easier to converge.

Further improvements were made to DQN to solve the above problems. This version of DQN uses a separate Q network called the target network to calculate the target Q value, thus decoupling the calculation of the target Q value from the predicted Q value. The weight parameters of the target network are updated in a delayed way. It freezes into the old predictive network weight parameter θ'; and only after a certain number of predicted network updates θ'; be updated to θ; at this time, the loss function of DQN is updated, as shown in Formula 3.

$$L(\theta) = E\left[\left(R + \gamma \max_{a'} Q(s', a; \theta^{-}) - Q(s', a'; \theta)\right)^2\right] \qquad (3)$$

After the update, DQN includes two Q networks, prediction networks $Q(s, a; \theta)$ used to evaluate the value of the current state action and target network $Q(s, a; \theta)$ is used to calculate the target Q value. Since the weight parameters of the target network are updated and delayed, the target Q value will remain unchanged for a period, which can provide a stable training target for the prediction network. The dual network structure effectively reduces the possibility of model oscillation and divergence and improves the stability of the DQN algorithm. In the further decoupling of DQN, action selection and evaluation are also carried out by using two different Q networks, and the improved DQN algorithm of 2015 has two Q networks itself, so the prediction network can undertake the task of action selection, while the target network is still used to estimate the target Q value. So that the selection and evaluation of the action are realized, and the target Q value is updated as shown in Formula 4.

$$T\,arg\,e\,tQ = R + \theta Q(s', argmax\, Q\,(s', a; \theta); \theta^{-}) \qquad (4)$$

Among them, θ corresponding to the weight parameters of the prediction network, θ^{-} weight parameter of the target network. At this point, predict the network according to the next state s' select the next action a' , and target the network to estimate the action value function $Q(s', a')$. Two different Q networks are used to select and evaluate the actions, so the algorithm is called Double DeepQ-Network, which reduces the overestimation problem and makes the DQN algorithm obtain better stability and performance.

The ratio of correctly classified samples to the total number of samples is shown in Formula 5.

$$Accuracy = \frac{TP + TN}{TP + FN + FP + TN} \qquad (5)$$

The proportion of results predicted to be positive turned out to be positive, as shown in Formula 6.

$$Pr\,e\,cision = \frac{TP}{TP + FP} \qquad (6)$$

The proportion of positive samples correctly judged to be positive, as shown in Formula 7.

$$Re\,c\,all = \frac{TP}{TP + FN} \qquad (7)$$

F1 scores take precision and recall into account, and for highly imbalanced datasets, F1 scores are available via , It is often considered a better indicator of evaluation, as shown in Formula 8

$$F1 = 2 \times \frac{Pr\,e\,cision \times Re\,c\,all}{Pr\,e\,cision + Re\,c\,all} \qquad (8)$$

This paper mainly introduces some key technologies and the theoretical basis involved in this study. First, the commonly used anomaly detection algorithms are introduced into two categories: traditional machine learning algorithms and deep learning algorithms. Then, reinforcement learning is outlined, and the algorithms DQN and DDQN used in this study are introduced. Finally, the data set and evaluation index used in the experiment are explained.

B. *Application of Deep Learning Algorithm in Financial Treasury Big Data Monitoring*

With the advent of the era of big data, deep learning algorithms are being applied more and more widely in the big data monitoring of the financial treasury. This paper will elaborate on applying deep learning algorithms to the big data monitoring of the financial treasury. The deep learning algorithm is a machine learning algorithm based on a deep neural network, which mimics the working principle of the human brain and maps input data to high-level feature space through a multi-layer nonlinear transformation to achieve efficient representation and prediction of data. Deep learning algorithms have achieved remarkable success in image recognition, natural language processing, recommendation systems and other fields. The big data monitoring platform for financial funds is used to monitor the revenue and expenditure of financial funds and changes in financial funds. The platform provides data support for government decision-making by collecting, analyzing and forecasting financial data in real-time. The application of deep learning algorithms in the financial Treasury big data monitoring platform mainly includes the following aspects:

Image recognition: Deep learning algorithms can be used to identify key information in images such as financial bills and contracts, such as amount, date, payee, etc., thereby improving the efficiency and accuracy of data entry. Natural language processing: Deep learning algorithms can analyze key information in financial reports, such as revenues, expenditures, budgets, etc., to provide data support for government decisions. Recommendation system: Deep learning algorithms can recommend finance-related policies, regulations, research reports, etc., to provide a reference for government decision-making. Although the deep learning algorithm has a wide application prospect in the financial database big data monitoring platform, it still has some problems, such as high computational complexity and long training time. Therefore, it is necessary to optimize the performance of the deep learning algorithm to improve its application effect in the financial Treasury big data monitoring platform. The performance optimization methods include model compression, parameter optimization, calculation acceleration, etc. The number of parameters of deep learning models can be reduced through model compression technology, thus reducing the models' computational complexity and storage space. Deep learning networks Q are typically over-parameterized, the parameters are highly overlapping, and the contribution of parameters to performance varies greatly from part to part. As the name implies, network pruning is the pruning away some unnecessary parameters in the model. Prioritize training a large, accurate network. Evaluate the "importance" of each neuron for each parameter in the network parameter. By what method is the "importance" of the parameter neuron measured? The most intuitive idea is that the importance of a parameter can be represented by its absolute value, and the parameter with a larger absolute value has a greater impact on the overall network and is more important. The importance of a neuron can be characterized by recording the number of times it outputs zero for multiple inputs, and often, the output is zero, indicating that it is not too important. Remove unimportant parameter neurons. When pruning a network, the network's performance usually decreases after some neurons are removed. At this time, the pruned network is fine-tuned to increase its accuracy. More details can be observed in Fig. 2.

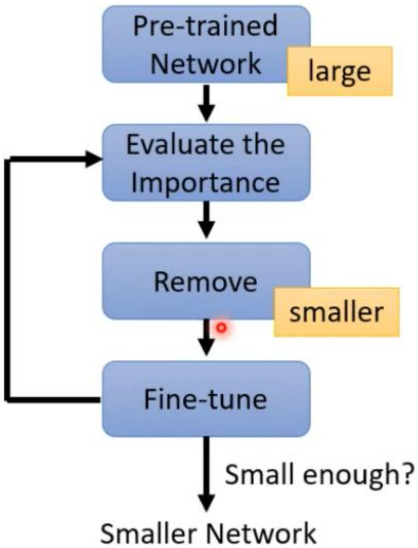

Fig. 2. Removing parameters/removing neurons.

The process of removing parameters is shown in Fig. 3 below. The result will be irregular, bringing two problems: first, it is difficult to implement; think of deep learning frameworks like Torch. The framework will give a standard layer when defining the network layer by directly specifying the number of neurons. Specifying that certain parameters of certain neurons are absent is considered more troublesome. The second could be more conducive to GPU acceleration. Modern neural networks mostly use parallel acceleration through the GPU, whether full connection or convolution. Matrix multiplication is employed as its underlying implementation. Additionally, removing non-existent parameters becomes troublesome for GPU acceleration; a feasible and direct approach does not remove parameters, but the parameter weight is reset to 0. This avoids the two problems mentioned above and has the same effect as removing the specified parameters. If it were considered, model pruning would be seen to be happening right now. Without removing the parameters, no decrease in the parameters of the network in the big land and the computationally big land would occur; it does not make sense. So, in practice, it's usually done by removing neurons.

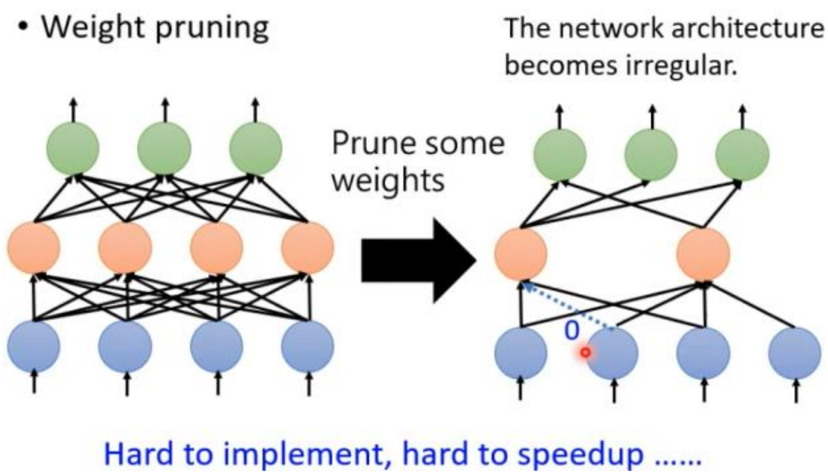

Fig. 3. Removing parameters.

Parameter optimization: By adjusting the parameters of a deep learning model, the model's prediction accuracy and generalization ability can be improved. Computational acceleration: By using hardware accelerators such as GPUs and Opus, the speed of training and prediction of deep learning models can be greatly improved.

Fourth, the performance optimization of the financial Treasury big data monitoring platform. The so-called inflow of local financial Treasury funds mainly includes the daily financial revenue of the financial department at the same level, the dispatch funds and bond loan funds allocated to the financial department at the same level by the financial department at the higher level, and the fund portion of the financial revenue of the financial department at the lower level. The so-called outflow of local financial Treasury funds includes the daily financial expenditures of the financial departments at the same level, the funds allocated to the financial departments at the higher level from the financial revenues of the financial departments at the same level as expenditure, the dispatch funds and bond transfer funds allocated by the financial departments at the lower levels as well as external temporary payments, etc. The balance of local Treasury funds is the balance of funds after the revenue and expenditure of local Treasury funds are offset, which mainly includes the balance carry-over funds of the financial departments and units at the same level, the current funds between the financial departments at the same level and the upper and lower financial departments, the balance of temporary, temporary payments of the financial departments at the same level, and the budget stabilization fund and working capital. From the perspective of the nature of financial accounts, the inflow, outflow, and balance composition of financial accounts are detailed in Table I.

As can be seen from the concept and composition of financial funds in Table I, local financial funds are not only a centralized reflection of financial operation and management level but also the material basis for local governments to perform the functions of stable growth, promoting reform, adjusting structure, benefiting people's livelihood and preventing risks. Excessive scale of fiscal funds will reduce the investment income and leverage effect of fiscal funds, and too small scale of fiscal funds will hinder the government's performance of functions and breed risks of fiscal funds, so it is necessary to control the scale of local fiscal funds within a reasonable range through fiscal funds management. More explanations are tabulated in Table II.

TABLE I. SUMMARY OF REVENUE, EXPENDITURE, AND BALANCE OF FINANCIAL FUNDS

Revenue from the fiscal treasury	Financial expenditure	Balance of fiscal funds
Include tax revenue, nontax revenue, and local government general bond revenue in budget management; Land included in government fund management.	General public budget expenditures, government fund expenditures, social security fund budget expenditures, state-owned capital operation budget expenditures, etc.	General public budget surplus, government fund budget surplus, state-owned capital operation budget surplus, budget stability adjustment fund, budget turnover fund, and other accounts receivable and payable balances.

TABLE II. LIST OF THE ORGANIZATION, FUNCTIONS AND POWERS OF THE NATIONAL TREASURY

Organizational structure	Basic duty	Main permissions
(1) Establish a national treasury at the central level, a national treasury branch at the provincial, autonomous region, and municipality directly under the central government, a central branch at the provincial level, and a branch at the county level and equivalent cities and districts. (2) The directors of the national treasury at all levels are concurrently held by the governors of the people's banks at that level. In contrast, the deputy directors of the national treasury at all levels are concurrently held by the deputy governors in charge of the national treasury. (3) The work of the national treasury business shall be under vertical leadership, and each province, autonomous region, and municipality directly under the central government's branch treasury and its affiliated branch treasury shall be both a branch of the central treasury and a local treasury. (4) Each level of national treasury shall establish specialized working institutions to handle national treasury business	(1) Handle national budget revenue collection, allocation, and retention. (2) To handle the allocation of national budget expenditures, (3) to report the implementation of budget revenue and expenditure to the higher-level treasury and the same-level financial organs, (4) to assist the financial and tax authorities in urging enterprises and other units with economic income to pay their payable amounts to the state timely. Those who repeatedly fail to pay should be assisted in deducting and storing them according to tax law. (5) Organize, manage, inspect and guide the work of the lower-level treasury. (6) Handle other tasks related to the national treasury assigned by the state.	(1) Supervise and inspect whether all the funds collected by the collection offices and revenue agencies have been paid into the national treasury by regulations, and promptly investigate and handle any illegal nonpayment. (2) The national treasury has the right to refuse to execute any unauthorized changes in the scope of revenue division, the proportion of revenue sharing and retention between different levels of finance, and arbitrary adjustments to the balance of deposits between treasury accounts. (3) For those who do not meet the requirements of national regulations for returning funds, the national treasury has the right to refuse to handle (4) supervision of the opening of financial deposits and the disbursement of financial funds. (5) Any unit or individual that forces the national treasury to handle matters that violate national regulations,

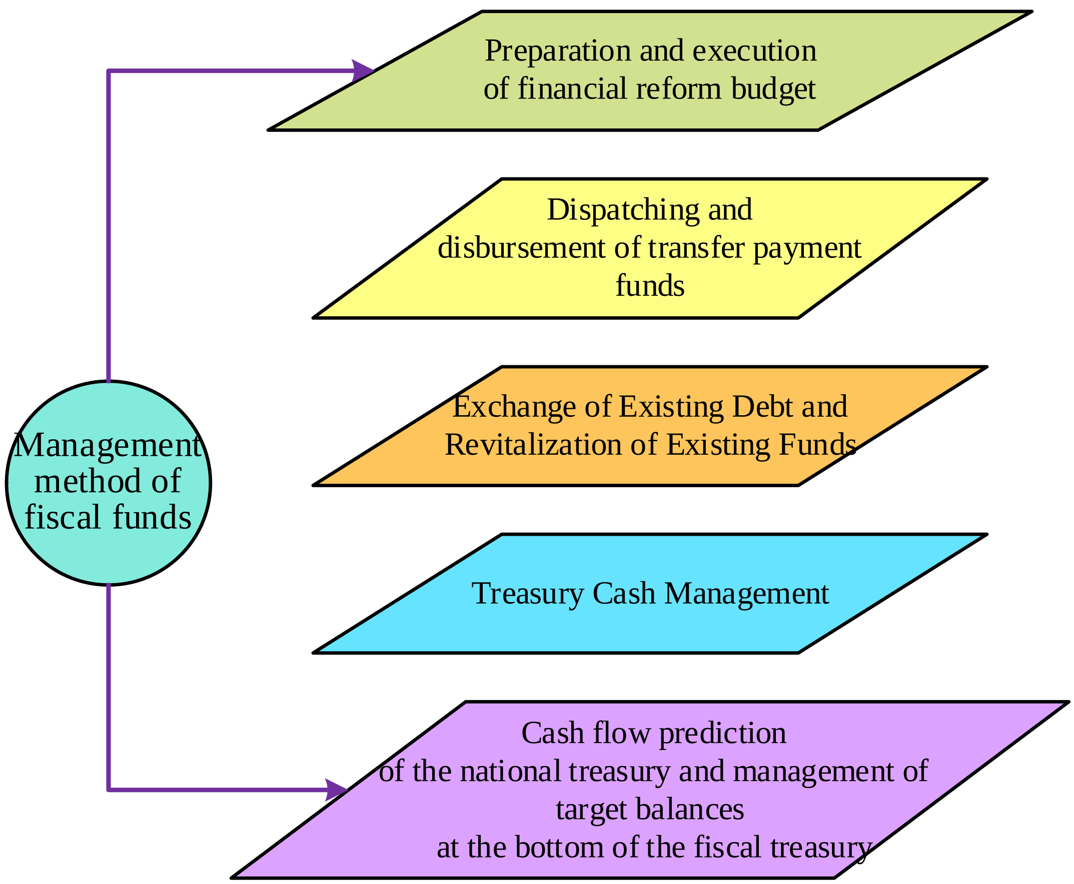

Fig. 4. The way treasury funds are managed.

From the perspective of management methods, as shown in Fig. 4, financial departments at all levels manage financial funds through such tools as the preparation and implementation of financial budgets, the dispatch and allocation of transfer payment funds, the replacement of outstanding debts and the activation of outstanding funds, Treasury cash management, Treasury cash flow forecast and target balance management of Treasury bottom.

The management of Treasury funds means that the central and local financial departments control the scale of local Treasury funds within a reasonable range through the scientific preparation of fiscal budgets and effective implementation of fiscal budgets, reasonable arrangements for the dispatch and allocation of transfer payment funds, effective replacement of outstanding debts, active activation of outstanding funds, and standardized measures to promote Treasury cash management. Based on the core concept of financial treasury management, this paper uses public finance, public choice, and monetary value theories to study local treasury management's problems and optimization paths.

IV. Experiment and Case Analysis

It is clear that the platform construction is mainly carried out around the "six comprehensive" goals: first, the overall overall construction pattern, relying on the integrated budget management system, making full use of big data thinking and advanced technology, and establishing a comprehensive and overall financial information pattern; The second is the comprehensive coverage of data exchange, the construction and improvement of financial unified data service platform, data exchange to achieve "up to down, horizontal to the edge"; Third, comprehensively improve the level of data, build an advanced financial big data platform, and comprehensively improve the level of data utilization; The fourth is a comprehensive and effective supervision means, the time spans several years to form a historical comparison, the space covers all financial and budget units, the level covers the province, states, cities and counties, and the accounts cover all financial funds of the four budgets; Fifth, comprehensive and flexible function expansion, according to the needs of business management reform, timely expansion of new functional modules, extend the scope of supervision; The sixth is a full-service data ecology, providing convenient and comprehensive financial data analysis services for all levels and improving the data service ecology. Around the above goals, the monitoring and analysis platform is built according to the idea of "one center, two platforms, three levels of coverage, and four types of applications." "One center," that is the establishment of a provincial financial data center. Establish a standardized data storage structure and data collection standards, and integrate internal and external financial data at all levels in the province into a unified data center. The "two platforms" are to create a unified data center and build a monitoring and analysis platform for financial fund operation. Centralized management of financial data analysis requirements at all levels, establishment of multidimensional data analysis models, development and expansion of general functions. Based on the unified data center, a monitoring and analysis platform bearing various financial big data analysis applications is built. "Three-level coverage," that is, the financial data covers all the financial funds of provinces, cities and counties, and the scope of use covers the three-level financial users of provinces, cities and counties. "Four types of applications," focusing on the four directions of real-time monitoring, decision support, monitoring and early warning, report management, in-depth mining of data value, and building financial big data applications for multi-scenario and multi-users. More details are depicted in Fig. 5.

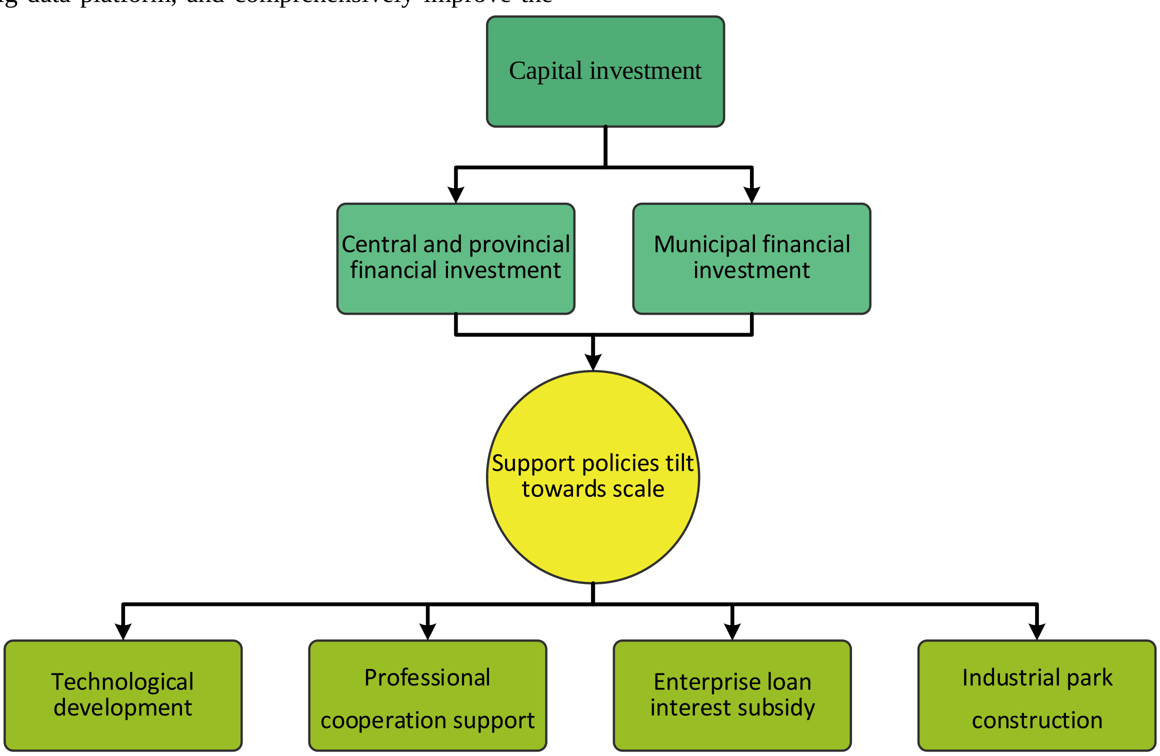

Fig. 5. Three-level financial diagram.

The national Treasury centralized electronic payment management and the integration of budget management have successfully established an information connection mechanism between financial departments, budget units, the People's Bank, agent banks and other departments, and solved the bottleneck problems restricting the use of big data such as the formation of "information islands" due to their governance, resulting in the loss of business data and the difficulty of cleaning garbage data. The fragmented "information islands" are integrated into a unified whole by constructing the standardization system so that the business, capital, and information flow can operate simultaneously. The standard and collection of financial and treasury data information can be unified and summarized, forming a natural "budget execution data center" covering the whole province, overall utilization and unified access, and providing reliable data support for applying big financial data. On this basis, it explores the information sharing of multiple departments such as finance, taxation and statistics, as well as cross-departmental data fusion, establishes unified standards and norms, and initially builds a data resource center oriented to analysis topics. By integrating internal financial data such as budget preparation, budget implementation, monthly reports of fiscal revenue and expenditure, and general final accounts, as well as external data such as inventory daily of the People's Bank of China, financial special accounts of commercial banks, social insurance premium transfer of tax departments, and statistical yearbook of the Bureau of Statistics, the data model and special database are established. At the same time, data governance standards should be established, data governance rules should be formulated, all kinds of data extracted and imported should be integrated and counted, a data asset catalog should be formed, and data quality management should be strengthened. The mentioned explanations are visualized in Fig. 6.

Adhere to the goal orientation and effect orientation from the perspective of improving the financial Treasury management and informatization level, sorting out the current business needs and priorities, designing and developing functional application systems in a targeted way, and building a financial big data monitoring and analysis application platform. Through technical means such as data analysis, data mining, data model and visual presentation, the results of financial informatization construction and the data resources accumulated by the financial Treasury for many years are displayed more conveniently, more effectively and intuitively. Up to now, the real-time monitoring application of the monitoring and analysis platform has been built into nine display screens, such as fiscal revenue, fiscal expenditure, fund flow, transfer payment, and dynamic monitoring of budget implementation, to achieve real-time online monitoring and analysis of various financial business activities. A decision analysis application has been built, including financial overview, financial revenue, financial expenditure, financial resources, subsidies and upper solution, Treasury Management and six other major themes of 38 functional modules in the form of graphics tables, using multidimensional analysis methods, from the time, space, object attributes and other dimensions, a comprehensive reflection of the financial and economic operation of local areas. The monitoring and early warning application has completed the construction of functional modules such as indicator allocation, implementation, and direct funds. The allocation and use of each financial fund can be grasped in real time through preset monitoring rules. This allows for the whole-life cycle tracking, monitoring, and risk early warning of common cause rights, special transfer payment indicators, and direct funds of various localities on a project-specific basis. Report management applications have collected and imported data such as ten-month financial reports, general financial accounts, and other budget execution reports at all province levels in recent years, which can automatically generate budget execution analysis reports and realize report query and analysis functions. More information are tabulated in Table III.

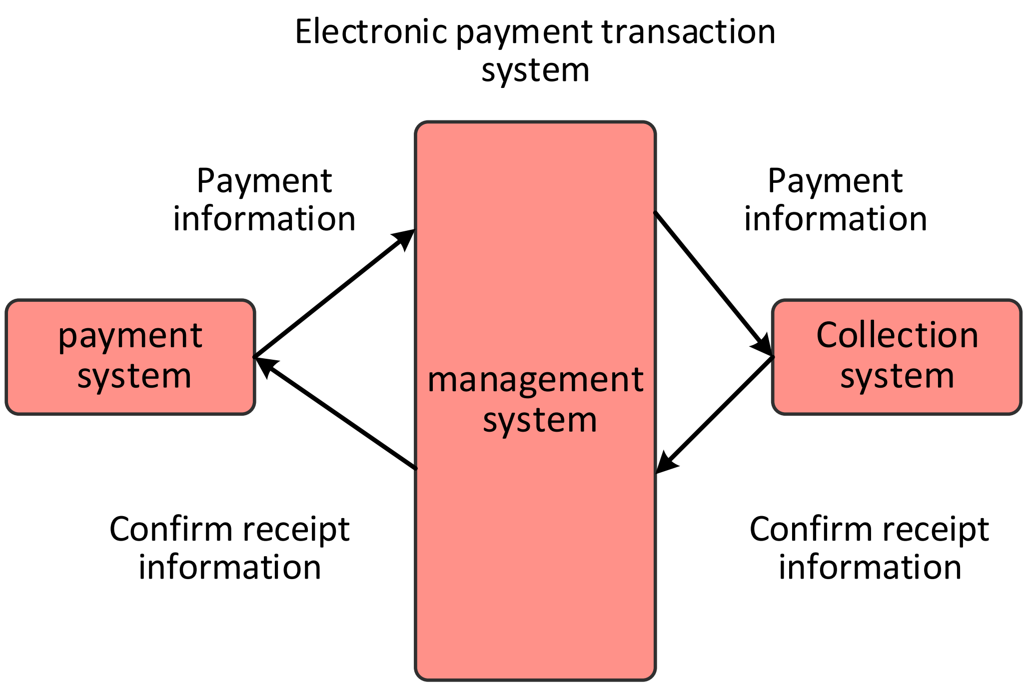

Fig. 6. Electronic management of centralized treasury payments.

TABLE III. ACHIEVEMENTS OF FINANCIAL INFORMATIZATION CONSTRUCTION AND FINANCIAL TREASURY DATA RESOURCES

9	Industrial transformation	The proportion of added value of core industries in the digital economy to GDP (%)	7.8	10	Anticipation
10		The proportion of enterprises that fully digitize key business processes is (%)	48.3	60	Anticipation
11		Cloud coverage rate of industrial equipment in enterprises (%)	13.1	30	Anticipation
12		Online retail sales (trillion yuan)	11.76	17	Anticipation
13		Information consumption scale (trillion yuan)	5.8	7.5	Anticipation
14	Government services	Online processing rate of provincial-level administrative licensing matters (%)	80	90	Anticipation
15		Real-name user scale of online government services (in billions)	4	8	Anticipation
16		Electronic social security card application rate (%)	25	67	Anticipation
17		Electronic litigation proportion (%)	18	30	Anticipation

Based on the three-level data interconnection of the integrated construction of budget management, the platform gathers and collects the expenditure data of the states (cities) and counties (cities and districts) in the budget execution system. According to the management needs, based on fully considering the business needs of various places, the platform framework system is built as a whole, the functional modules are designed and developed scientifically and reasonably, and the data of various business systems are expanded and integrated. Through personnel management and authority setting, financial users at the provincial, municipal and county levels can log in to the monitoring and analysis platform through the "Yunnan Financial Management Information System" portal interface and conveniently and quickly query their respective data analysis data, which greatly improves the application level of information technology in various regions, and effectively avoids repeated construction and resource waste. Under the unified framework system, the platform has better scalability compatibility. According to the needs of management work, new functional modules can be added at any time, and various existing monitoring and analysis systems can be integrated to form a unified system and a unified platform, which is easy to manage and improve efficiency. By the principle of "building while using, gradually improving," some functional modules developed have been opened to the relevant fund departments in the Office and local financial departments. At the same time, for the problems found by users in the process of use, timely collection and feedback to the software developer, and constantly modify and improve the system.

The comprehensive analysis and utilization of data based on the platform has expanded the coverage of financial supervision and effectively built the province's electronic financial supervision framework. The use of platform information means that it has realized the dynamic supervision of financial funds of financial departments and budget units at all levels and has integrated supervision into the whole financial management process. Through the monitoring and analysis platform, the discipline inspection and supervision department can monitor the whole process of special financial funds, discover illegal operations on time, and determine the focus of supervision and inspection. The discipline inspection and supervision team of the Provincial Department of Finance takes platform construction as a typical practice of innovating financial supervision methods by using modern information technology. The construction of the monitoring and analysis platform clarifies the main data sources, clarifies the data acquisition aperture of analysis, opens up the collection channels of other parts of business data, preliminarily completes the accumulation of financial data, and further sorts out various financial management needs. The relevant standards and norms have been improved, laying the foundation for comprehensively promoting the application of financial big data in the province in the next step.

In the context of globalization, supply chains have become increasingly complex, involving numerous participants and massive transaction data. This complexity not only brings business opportunities to enterprises, but also risks, especially the risk of financial fraud. Traditional financial fraud detection methods often struggle to cope with such large-scale and high-frequency transaction data. Therefore, developing a financial fraud detection method based on distributed big data mining is particularly important. Distributed big data mining technology is a technology that can process and analyze massive amounts of data. It distributes data across multiple computing nodes and achieves rapid analysis and mining of data through parallel computing and collaborative processing. This technology can not only handle large-scale data, but also cope with the rapid growth and changes of data, providing strong technical support for financial fraud detection.

V. CONCLUSION

The deep learning algorithm research and performance optimization of the big data monitoring platform of the financial Treasury are deeply studied. First, it reviews the basic concepts, methods, and applications of deep learning and their application in the financial database big data monitoring platform. To discuss the research progress of deep learning algorithms in the big data monitoring platform of financial Treasury, including image recognition, natural language processing, recommendation system, etc. Then, the performance optimization of deep learning algorithms in the financial database big data monitoring platform is analyzed, including model compression, parameter optimization, calculation acceleration, etc. This paper summarizes the research status and future development direction of deep learning algorithms in financial database big data monitoring platforms. The following conclusions are drawn through in-depth research: Deep learning algorithms have broad application prospects in the financial Treasury big data monitoring platform, which can improve monitoring accuracy and efficiency and reduce labor costs. However, deep learning algorithms have challenges in the financial Treasury big data monitoring platform, such as high model complexity and large computing resource requirements.

Therefore, further study of the performance optimization problem of deep learning algorithms to improve their application in the financial Treasury big data monitoring platform is necessary. Applying deep learning algorithms in the financial Treasury big data monitoring platform will be more extensive and in-depth. With the continuous progress of technology, it is expected that deep learning algorithms will play a greater role in the financial Treasury big data monitoring platform and provide more accurate, efficient and intelligent solutions for financial Treasury monitoring.

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Competing of Interests

The authors declare no competing of interests.

Authorship Contribution Statement

Ding Ding: Writing-Original draft preparation, Conceptualization, Supervision, Project administration.

Yanbing Wang: Methodology, Software, Validation.

Data Availability

On Request.

Declarations

Not applicable.

References

[1] A. Mohammed and R. Kora, "A comprehensive review on ensemble deep learning: Opportunities and challenges," Journal of King Saud University-Computer and Information Sciences, vol. 35, no. 2, pp. 757–774, 2023.

[2] R. A. de Oliveira and M. H. J. Bollen, "Deep learning for power quality," Electric Power Systems Research, vol. 214, p. 108887, 2023.

[3] K. Sharifani and M. Amini, "Machine learning and deep learning: A review of methods and applications," World Information Technology and Engineering Journal, vol. 10, no. 07, pp. 3897–3904, 2023.

[4] V. Narayan, P. K. Mall, A. Alkhayyat, K. Abhishek, S. Kumar, and P. Pandey, "Enhance-Net: An Approach to Boost the Performance of Deep Learning Model Based on Real-Time Medical Images," J Sens, vol. 2023, 2023.

[5] G. Novakovsky, N. Dexter, M. W. Libbrecht, W. W. Wasserman, and S. Mostafavi, "Obtaining genetics insights from deep learning via explainable artificial intelligence," Nat Rev Genet, vol. 24, no. 2, pp. 125–137, 2023.

[6] H. Xiang, Q. Zou, M. A. Nawaz, X. Huang, F. Zhang, and H. Yu, "Deep learning for image inpainting: A survey," Pattern Recognit, vol. 134, p. 109046, 2023.

[7] C. Li, X. Li, M. Chen, and X. Sun, "Deep learning and image recognition," in 2023 IEEE 6th International Conference on Electronic Information and Communication Technology (ICEICT), IEEE, 2023, pp. 557–562.

[8] C. Isert, K. Atz, and G. Schneider, "Structure-based drug design with geometric deep learning," Curr Opin Struct Biol, vol. 79, p. 102548, 2023.

[9] A. Ahmad, D. Saraswat, and A. El Gamal, "A survey on using deep learning techniques for plant disease diagnosis and recommendations for development of appropriate tools," Smart Agricultural Technology, vol. 3, p. 100083, 2023.

[10] V. Narayan, S. Awasthi, N. Fatima, M. Faiz, and S. Srivastava, "Deep learning approaches for human gait recognition: A review," in 2023 International Conference on Artificial Intelligence and Smart Communication (AISC), IEEE, 2023, pp. 763–768.

[11] J. C. Laguna de Paz, "Some implications of the new global digital economy for financial regulation and supervision," Journal of banking regulation, vol. 24, no. 2, pp. 146–155, 2023.

[12] E. D. Zamani, C. Smyth, S. Gupta, and D. Dennehy, "Artificial intelligence and big data analytics for supply chain resilience: a systematic literature review," Ann Oper Res, vol. 327, no. 2, pp. 605–632, 2023.

[13] Y. H. Wu, L. Bai, and X. Chen, "How does the development of fintech affect financial efficiency? Evidence from China," Economic research-Ekonomska istraživanja, vol. 36, no. 2, 2023.

[14] Y. Sun, S. Liu, and S. Chen, "Fund style drift and stock price crash risk–analysis of the mediating effect based on corporate financial risk," China Finance Review International, vol. 13, no. 2, pp. 183–206, 2023.

[15] D. K. Nguyen, G. Sermpinis, and C. Stasinakis, "Big data, artificial intelligence and machine learning: A transformative symbiosis in favour of financial technology," European Financial Management, vol. 29, no. 2, pp. 517–548, 2023.

[16] P. Polak, C. Nelischer, H. Guo, and D. C. Robertson, "'Intelligent' finance and treasury management: what we can expect," AI Soc, vol. 35, no. 3, pp. 715–726, 2020.

[17] H. Zhou et al., "A distributed approach of big data mining for financial fraud detection in a supply chain," Comput Mater Continua, vol. 64, no. 2, pp. 1091–1105, 2020.

[18] I. Lee and Y. J. Shin, "Machine learning for enterprises: Applications, algorithm selection, and challenges," Bus Horiz, vol. 63, no. 2, pp. 157–170, 2020.