Application research of machine learning method based on DBN and RL in financial data analysis

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Abstract. With the continuous development of various emerging information technologies such as big data, cloud computing, artificial intelligence and machine learning, many traditional enterprises are actively cross-integrating with it, especially financial enterprises. For example, the background of big data is used to help transform financial accounting into management accounting [1]; The application of Python in financial data mining and analysis [2]. In addition, machine learning technology also has a deeper application in the field of financial data analysis, and many experts and scholars have also studied the importance of machine learning technology in financial data analysis. For example, Cheng Ping, Yu Chang, Wang Jianjun et al. have elaborated on the intelligent early warning of enterprise internal audit based on deep self-coding network in the GhatGDP era [3] and so on. These research results highly confirm the promoting role of machine learning methods in the field of financial data analysis, and further stimulate people's enthusiasm to use machine learning methods to improve financial data analysis. In this paper, by studying the application of machine learning methods based on DBN and RL in financial data, the advantages of deep belief neural network and reinforcement learning are combined to provide a more efficient method for enterprise financial data analysis..

Keywords: financial enterprises, machine learning methods, Financial data analysis.

1. Existing background technology

1.1. Overview of financial statements

The data of financial statements can truly reflect the current operation of an enterprise, and provide data reference for credit, investment, audit and other businesses. Compared with other information in the market, the data presented in financial statements are generally mainly quantitative indicators, which are significantly different from market analysis, industry evaluation and policy analysis in form, which is more reasonable and accurate, and can truly reflect the actual situation of an enterprise. At the same time, because the enterprises have the same accounting basis, the financial data of different enterprises in the same industry can be compared horizontally, which is conducive to the objective assessment of the current market environment and industry status of the enterprises.

1.2. Traditional neural network

A traditional neural network (also known as a feedforward neural network) is a Multi-Layer Perceptron (MLP) -based model consisting of an input layer, several hidden layers, and an output layer. It can be used for tasks such as classification, regression, and performs well in some applications, such as image recognition, speech recognition, etc.

2. Overview of key technologies

2.1. DBN Overview

A DBN is a deep learning model that consists of a stacked structure of multiple constrained Boltzmann sets. DBN can learn the feature representation of data through unsupervised pre-training and supervised fine-tuning, and has strong expression and learning ability. The training process of DBN is mainly divided into the following two main stages:

a) Pre-training: In the pre-training phase, each RBM is trained independently, where the hidden layer output of one RBM serves as the input to the next RBM, thereby building the DBN layer by layer. During the training of each RBM, parameter updates are performed by either a contrast divergence algorithm or a continuous contrast divergence algorithm.

b) Fine-tuning: After pre-training is complete, the entire DBN can be fine-tuned using supervised methods such as backpropagation algorithms to further optimize model performance.

In financial data analysis, DBN can be applied in a number of ways:

a) Financial risk assessment: DBN can assess and classify risks by learning the characteristic representation of financial data. For example, DBN can be used to predict stock price fluctuations, assess credit risk, etc.

b) Trading strategy optimization: DBN can analyze market data, company financial data, etc., to help optimize trading strategies. By learning the characteristic representation of the data, DBN can discover potential patterns and trends, thereby providing more accurate trading recommendations.

c) Financial market prediction: DBN can make financial market prediction by learning the characteristic representation of historical financial data. For example, DBN can be used to predict stock prices, currency exchange rates, etc.

2.2. RL Overview

RL is a machine learning method designed to learn optimal policies through interaction with the environment. In RL, the agent picks up reward signals by observing the state of the environment and taking action, and then adjusts its strategy based on these reward signals for a larger total reward. The core idea of RL is based on trial-and-error learning, where the agent gradually optimizes the strategy by constantly trying different actions and observing the results. A key concept of RL is the Markov decision process, which describes the interaction process between the agent and the environment and defines elements such as states, actions, rewards, and transition probabilities. In financial data analysis, RL can be applied in the following ways:

a) Portfolio management: RL can help optimize portfolio allocation and adjust strategies. By interacting with the market environment, the agent can learn the optimal portfolio weights to maximize expected returns or reduce risks.

b) Trade execution strategies: RL can be used to optimize trade execution strategies, including order cutting, trade cost estimation, and trading strategy selection. The agent can learn the optimal trading strategy to minimize trading costs and market shocks.

c) Dynamic risk management: RL can be used to dynamically adjust risk management strategies. By interacting with the market environment, the agent can adaptively adjust the risk management strategy based on current market conditions and risk appetite to maximize portfolio value protection.

d) Stock trading strategies: RL can be applied to the development of stock trading strategies, such as the decision on the timing of buying and selling stocks. By interacting with historical market data, the agent can learn the optimal trading strategy to achieve long-term stable returns.

3. Shortcomings of traditional financial analysis

3.1. Excel Analysis

In the traditional financial analysis, Excel is an indispensable tool, it is a powerful data statistics and analysis of office software, providing a wealth of functions, plug-in tools and VBA programming language, but massive data and more intelligent analysis needs to use VBA programming tools, but the difficulty of VBA professional programming makes everyone discouraged. Secondly, Excel will be stuck when faced with millions of data, which affects the efficiency of analysis [4].

3.2. Traditional neural network

There are still some limitations in the application of traditional neural networks for financial data analysis: traditional neural networks generally have a single hidden layer, at most two hidden layers, because once there are too many neurons and too many hidden layers, the number of parameters of the model will increase rapidly, and the model training time will be very long; The traditional neural network, with the increase of the number of layers, it is generally difficult to find the optimal solution by using random gradient descent, and it is easy to fall into the local optimal solution. In the process of back propagation, gradient dispersion or gradient saturation is also easy to occur, which leads to unsatisfactory model results. With the increase of the number of layers of the neural network, the model parameters of the deep neural network are many, which requires a large number of label data during training, because it is difficult to find the optimal solution when the training data is small, which means that the deep neural network does not have the ability to solve the problem of small samples.

3.3. Other Problems

In addition to the above problems, the existing enterprise financial terminal system can only analyze and organize the enterprise financial information, but does not have the ability to simulate the information, which will make the financial management of the enterprise need to be artificially corrected, thus reducing the security of the enterprise financial information, and reduce the efficiency of financial analysis and the intelligence of the financial terminal.

4. DBN-RL method

4.1. Model framework of DBN-RL method

The DBN-RL method proposed in this paper consists of an input layer to input the information at all times, and then the financial data processor will analyze and produce a result report and make a prediction. If the prediction does not meet the expectation, the financial data processor will provide a corresponding correction plan, and then conduct a simulation again. At this time, the operation of the system is not finished, and if the result still fails to meet the expectation, Then the above process will be repeated. The model training method of financial data analysis based on DBN and RL trains the sample financial data layer by layer to give the initial weight to the whole network, so that the network can reach the optimal solution after fine tuning; By training the weights among neurons, the whole neural network can generate the training data according to the maximum probability; The neural network structure includes a visible layer and a hidden layer. In each layer, the hidden layer is inferred through the data vector, and then the hidden layer is regarded as the data vector of the next layer. In the training process, the current layer can be trained only after the fusion neural network of the previous layer is fully trained, until the last layer.
The whole framework is shown in the following figure:

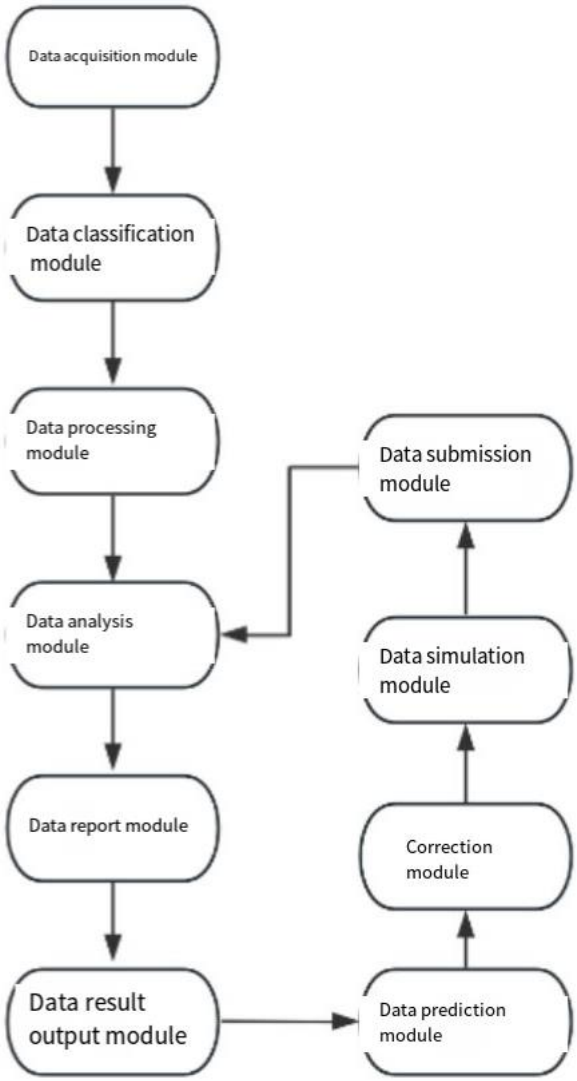

Figure 1. General flowchart of the DBN-RL method

4.2. DBN-RL Operation Flow

a) Firstly, collect and classify the financial data of the enterprise and enter it into the enterprise financial database, process and analyze the financial data through the financial data processor, and form financial statements and store them in the enterprise financial database;

b) the financial data processor will analyze the data and produce a result report, and the financial data processor will predict the future financial data information of the enterprise by referring to the data result report;

c) When the financial forecast result of the enterprise is a loss result, the financial data processor can design a revised plan for the enterprise according to the predicted result of the financial data information of the enterprise, and simulate the financial operation of the enterprise based on the revised plan, and then submit the simulated data to the financial data processor, and analyze the simulated data of the enterprise again through the financial data processor;

d) the financial data processor carries out a secondary analysis of the simulated financial data, and obtains the financial profit and loss results of the enterprise.

4.3. DBN-RL component introduction

a) The financial analysis system is connected with a neural network module and an algorithm learning module. The neural network module is a deep belief neural network, and the algorithm learning module is reinforcement learning.

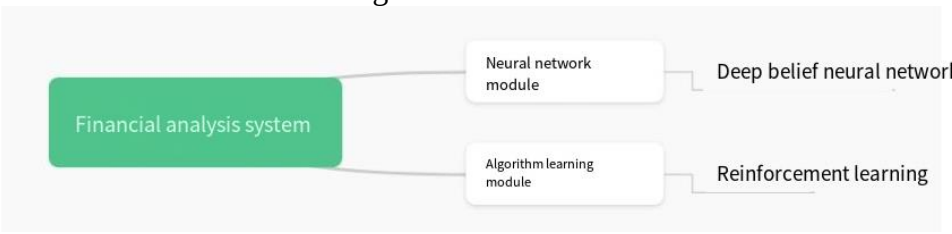

Figure 2. Display of the financial analysis system

b) The financial analysis system comprises a data acquisition module, the data acquisition module is connected with a data classification module, the data classification module is connected with a data entry module, the data entry module is connected with a data processing module, the data processing module is connected with a data analysis module, the data analysis module is connected with a data report module, The data report module is connected with the data result output module, the data result output module is connected with the data prediction module.

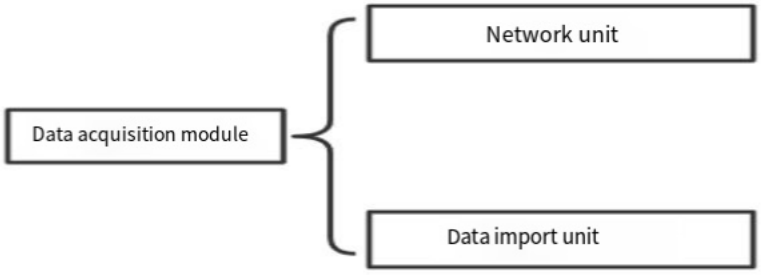

Figure 3. shows the data acquisition module

c) The data analysis module includes assets and liabilities analysis unit, cash income and expenditure analysis unit, cost and profit analysis unit, budget analysis unit and project analysis unit. The financial data processor generates multiple result reports after analyzing the data, making the data analysis results more intuitive.

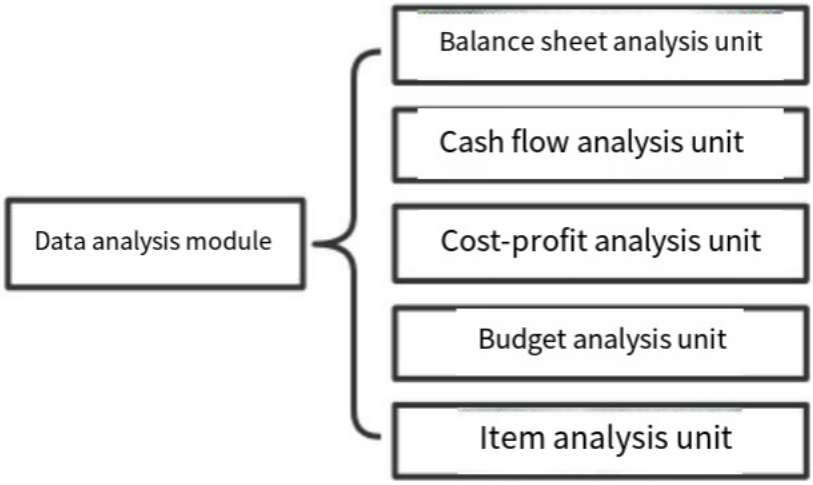

Figure 4. Data analysis module display diagram

d) The data report module includes an income report unit, a form unit and a profit report unit. Personnel entering the database can see the profit and loss status of the enterprise intuitively by viewing the contents of the report after finishing.

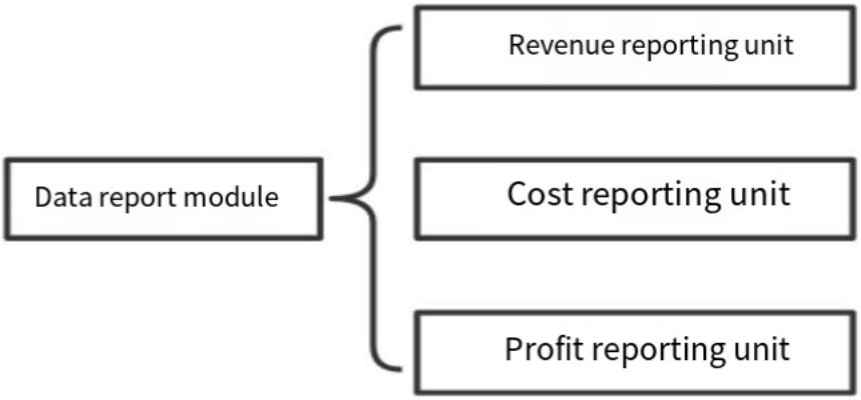

Figure 5. Data report module

5. Advantages of DBN-RL method are summarized

The DBN-RL method proposed in this paper can combine the advantages of deep belief neural network and reinforcement learning to provide a more efficient method for enterprise financial data analysis, make enterprise financial analysis more accurate, indirectly improve enterprise income, and improve the efficiency and quality of collection, classification, processing and analysis of financial data. At the same time, a data correction module and a data simulation module are set in the financial analysis system. Through the data prediction module, the analysis results of the financial data of the enterprise are predicted, and the correction plan is proposed, and the financial operation of the enterprise is simulated until the final output result is positive or in line with the financial plan of the enterprise, which is then used as the guidance of the financial plan of the enterprise. Improve the profitability of enterprises and the efficiency of enterprise financial analysis, and provide a new idea for the intelligent integrated development of enterprise financial management field.

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