Simulation Driven Intelligent Business Data Analysis and Decision-Making

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Abstract. This paper builds a neural network decision model based on back propagation neural network and deep Q-learning algorithm, studies intelligent business data analysis and decision-making driven by simulation technology, conducts decision model training by collecting actual business data and simulating business data, improves the accuracy and efficiency of decision output, completes real-time business data update decision-making, and provides decision-making basis for business operation.

Keywords. Neural network, deep Q-learning, intelligent business decision.

1. Introduction

The rapid development of the Internet, artificial intelligence, Metaverse and other technologies has provided strong support for the widespread use of mobile intelligent terminals and various APPs. The multi-dimensional information of consumers' service expectations, product needs, social professions, financial capabilities and other dimensions has become the necessary analysis data for the development of business data platforms and enterprises, bringing new development directions for the development and decision-making of business data platforms [1].

In recent years, research on improving decision-making effectiveness through artificial intelligence technology has emerged one after another, mainly divided into the following categories: ① For classic problems in business data decision-making, artificial intelligence methods are used for decision making, normalizing and dimensionality reducing business data; ② Improve intelligent decision-making methods for business data, improve the operational efficiency and reliability of results. Overall, artificial intelligence technology has a wide range of practical applications, including autonomous driving, energy distribution, gaming, and commercial development [2]. At the same time, AI technology will also have some application defects, such as the inherent exploration and utilization of contradictions and dimensional disasters in reinforcement learning, the reliability allocation problem of agent decision-making, the problem of non-stationary decision-making environment, the problem of optimal equilibrium solution, etc. Therefore, how to solve the problem of business decision-making and the shortage of minimum intelligent decision-making methods is the key to intelligent business data analysis and decision-making at present [3].

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In this paper, artificial intelligence method modeling design and decision model framework analysis are carried out for intelligent business data analysis and decision problems [4]. Simulation driven method is used to solve the design, input and output, algorithm application and other problems of intelligent business decision network, and decision model is optimized and improved. The results are compared to prove the intelligent decision effect of the network.

2. Market Analysis

The "New Generation Artificial Intelligence Development Plan" issued by the State Council emphasizes the important role of artificial intelligence technology in government decision-making and services [5]. Similarly, artificial intelligence technology also plays an important auxiliary role in the decision-making and development process of enterprises [6]. The study and assessment of complex business environments, development strategy evaluation, enterprise risk warning, and emergency response are key directions for enterprise decision-making research, and also the main problems to be solved in intelligent decision-making research. Think tanks are usually non-profit research and consulting institutions that focus on development strategies and public policies. At the same time, think tank problems with high uncertainty and early prediction can be solved using data-driven artificial intelligence technology [7].

According to market research reports, the size of China's business data intelligence market in 2021 was approximately 118.2 billion yuan, a year-on-year increase of 28.4%. By 2025, the market size will increase to 346 billion yuan, with a compound growth rate of about 30% between 2020 and 2025, showing a high-speed growth state. The market share of vertical applications in the industry is the heaviest and will continue to increase, accounting for about two-thirds of the entire business data intelligence market by 2025. Among them, finance, retail e-commerce, the share of vertical applications in the manufacturing industry are high, and the development prospects of business data intelligence applications in the manufacturing industry are promising [8].

For example, most shopping websites achieve precise push of goods and services based on user browsing history and purchase order data, in order to better meet user needs. Therefore, in the era of big data, while the business competition environment and the iteration of technology update promote enterprises to carry out the vertical dimension competition of quality, it is also necessary to increase the technical investment in the collection, storage, mining, processing and analysis of data such as user potential demand information, shopping demand information, and commodity feedback information. Improve the efficiency of enterprise intelligent business decision-making based on consumer data, and better match consumers' preferences for horizontal dimensions such as product brand, corporate culture, and product characteristics [9].

3. BP neural network and DQN algorithm

Intelligent business data analysis and decision-making are a series of digital tools, services, and solutions based on data science that serve enterprise decision-making. Among them, "enterprise decision-making" is a broad concept that covers the business decisions of grassroots employees, management decisions of middle-level managers, and strategic decisions of enterprise executives. Digital methods such as artificial intelligence,

neural networks, and machine learning belong to the overall digital tools, which act on local digitization, global visualization, and intelligent application of analysis [10].

The uncertainty and variability of the current market environment are increasing day by day, and relying solely on traditional experience for decision-making analysis is no longer sufficient to support high-frequency and large-scale business data processing. Intelligent decision-making technologies that introduce artificial intelligence, machine learning, and other methods have emerged. How to assist enterprises in responding to development changes, improving operational levels and benefits, and promoting high-quality business development and growth, becoming a key topic of general concern for enterprises and society at present [11].

At present, the level of intelligent data decision analysis of enterprises in China is not high. Most manufacturing enterprises are in the process informatization stage, and most small and micro enterprises are in the primary stage of production management relying on human experience. In the context of economic globalization and increasingly fierce competition, most enterprises in China are facing more complex decision-making problems, generally lacking the ability to make intelligent decisions. It is urgent to complete the transition from process informatization and mechanical informatization to intelligent decision-making.
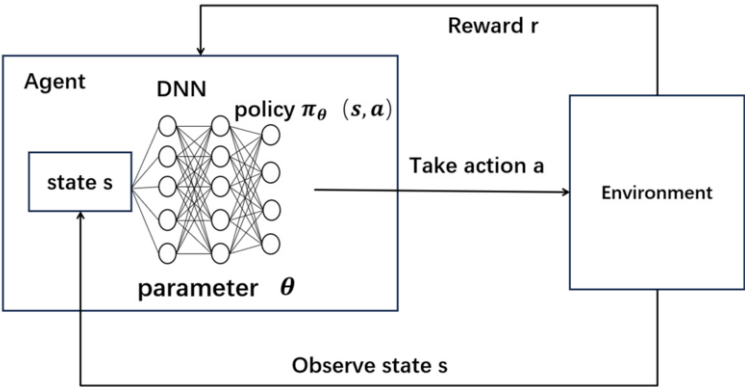

Figure 1. Schematic diagram of reinforcement learning training process.

As Figure 1 shows, the development paradigm of data-driven and artificial intelligence technology has introduced profound changes to social and economic life. As data technology is based on BI technology and then processed using Flume, Hadoop, cloud computing technology, etc., the processing process must have continuous strengthening of data resources to ensure data continuity and processing speed. The processing and application of data is a continuously changing and long-lasting process. Only by accumulating a certain amount of data resources can the "quality" of business data decision-making be promoted.

4. Intelligent business decision-making based on data

Simulation-driven intelligent business data-based decision-making is based on data science and serves a series of digital tools, services and solutions for enterprise decision-making.
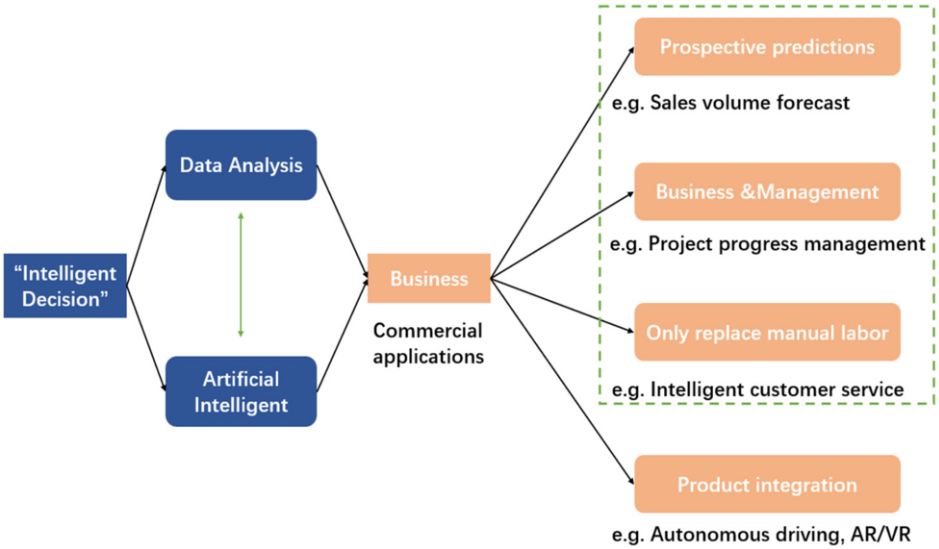
Figure 2. Schematic diagram of intelligent business decision-making categories.

As shown in Figure 2, with the continuous expansion of the scale and quantity of enterprises, the volume of business data is increasing exponentially. How to analyze and obtain effective information from a large amount of business data, form correct cognition, and make decisions quickly has become an important challenge for enterprise managers at present.

Traditional business decision-making methods that rely solely on expert experience cannot effectively address the challenges posed by complex and rapidly changing situational information. There is an urgent need to introduce new technologies to assist people in making decisions and improve the efficiency and accuracy of business decision-making. In addition, the big data processing platform represented by Spark can realize parallel processing of massive situation data by combining it with the deep learning framework, greatly improving the data processing speed and business decision-making efficiency, as shown in Figure 3:
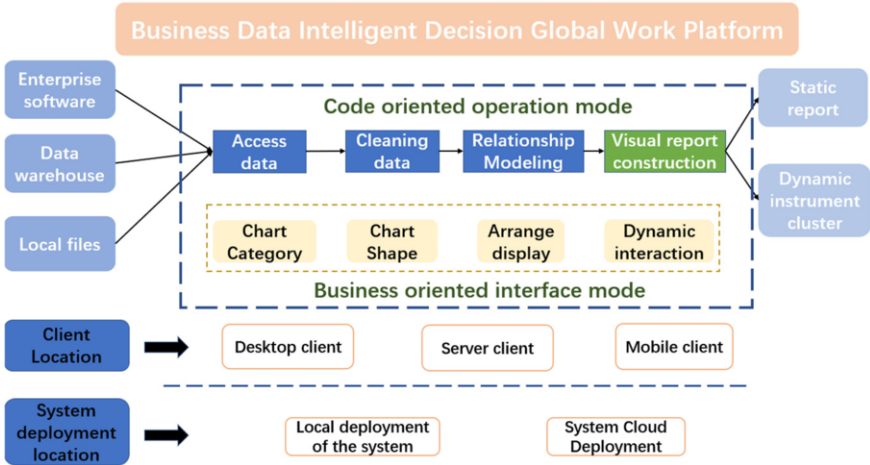

Figure 3. Schematic diagram of business data intelligent decision-making platform.

In the final stage of business decision-making, it is necessary to increase and strengthen human participation. Since the advent of deep learning and reinforcement learning, it has played a great role in application, but the interpretability of the method has not been clearly solved, and the principle of extracting features or making decisions needs to be further studied. Therefore, for business intelligence decision-making, decision commands are crucial for the operation and development of enterprises, and the decision-making power of enterprise development cannot be completely delegated to machines. Machines can only serve as auxiliary decision-making tools. The same is true for the business intelligence decision model. The final decision of the business decision needs to be discussed and issued by the management and experts.

5. Experimental Process

For the original multi-dimensional situation data in the form of image, audio, video, text and other forms in some business environments, data pre-processing, data cleaning, data coding and normalization and other methods are used to process the original data, and the input vectors that can be recognized by BP neural network are obtained. Then, the network is used to conduct deep learning on the spatial and temporal features of business environment situation data.

After deep network learning, the features are merged after being output by the maximum pooling layer and output gate, that is, the spatial and temporal features of the business environment situation are concatenated. Finally, the merged spatiotemporal features of the business situation are input into the fully connected layer of the decision network for further feature fusion and extraction, and ultimately output the spatiotemporal features of the business environment situation. At the same time, in the deep learning network and spatiotemporal feature extraction process, to effectively improve the speed of situation data processing, a data processing platform is introduced to parallelize the data.

Therefore, this paper proposes an intelligent decision model for business data, which is driven by multi-dimensional business situation data and driven by the neural network processing platform. On the basis of deep perception of business data using deep learning network and neural network processing platform, the extracted spatiotemporal characteristics of business data situation are used as a comprehensive environment to train the reinforcement learning algorithm. Through the dynamic interaction between agent (business decision center) and the comprehensive environment, the agent decision rewards and action strategies are updated iteratively, and the intelligent decision-making ability of the model is constantly strengthened, the final output of decision recommendations under the given business decision situation conditions assists managers in making business operation decisions, thereby maximizing the effectiveness of business decision-making.

Compared with the reinforcement learning algorithm that only relies on the business operation environment, taking the spatiotemporal characteristics of the business environment situation as the comprehensive environment, we can consider the business environment factors and the development characteristics and resources of our business model and those of others, so as to further improve the accuracy of agent decision-making.

During the experiment, taking 80% of all data sets as the training set, and the remaining 20% as the verification set, using the Sigmoid Activation function and MSE

Loss function, a neural network with four hidden layers (8/16/8/1 for each layer of neurons) is defined.

In order to better demonstrate the impact of each training on classification performance, the classification accuracy of each iteration is recorded in Table 1:

Table 1. Intelligent decision classification training iterative data record table.

Epochs	Train loss	Accuracy
50	0.1343	51.75%
1020	0.0147	93.75%
1950	0.0097	95.75%

The train loss value is a relatively direct indicator to evaluate the degree of fitting of the model on the training set, which is to evaluate the degree of fitting on the training set. In fact, the model performance usually refers to the generalization ability of the model, that is, the test set or verification set can also perform well. The smaller the loss, the more fitting with the training data, which indicates that the generalization ability of the model is often not ideal, so the smaller the loss function is, the better. But reaching a certain range can prove the training and generalization ability of the model. Therefore, controlling the number of training iterations to 2000 can achieve good results.

After training 2000 epochs with a learning rate of 0.005 (the number of data points selected for each training), the classification accuracy of the network has stabilized to more than 95%. As shown in Figure 4, it indicates that the network has already achieved good classification performance at this time:
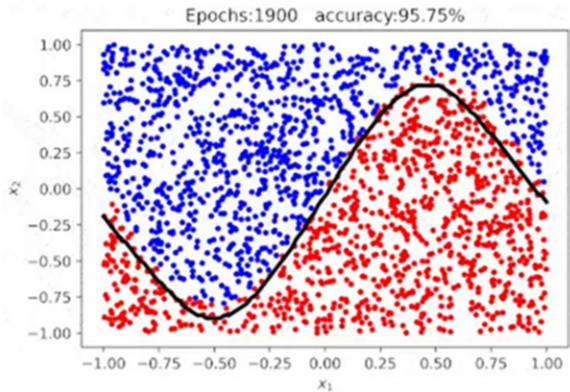
Figure 4. Schematic diagram of training classification with multiple iterations.

Under the guidance of consumer brand preference psychology, compared to when enterprises adopt empirical decision-making, if enterprises adopt intelligent business decision-making, the optimal sales decision-making level of the enterprise remains unchanged, and the optimal price and equilibrium benefits will decrease, both of which are negatively correlated with the efficiency of intelligent decision-making. With the continuous improvement of decision-making technology and efficiency, in the case where most enterprises adopt intelligent decision-making, through consumer demand and market filtering, the product services provided by enterprises to consumers will continue to trend towards the ideal level of consumers, and the differences in brand dimensions of products will continue to decrease. In order to compete for consumers, enterprises will engage in fierce quality competition and price competition.

6. Conclusion

The business data analysis decision model is driven by the business environment situation data, supported by neural network and reinforcement learning algorithm as the core technology, and combined with the characteristics of deep learning and reinforcement learning, it applies the business operation intelligence decision model to make decisions.

Acknowledgement

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