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Financial crisis monitoring and prevention of listed companies based on the internet of things and deep learning

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Abstract: This study develops a financial crisis prediction and monitoring system for listed companies based on IoT and deep learning (DL) to make up for the lack of real-time financial risk management. Based on a multi-layer IoT framework (perception layer, network layer, and application layer) for data collection, a hybrid deep learning model integrating convolutional neural network (CNN) and autoencoder is designed. The model processes 20 financial indicators covering the dimensions of solvency, profitability, operational efficiency, and crisis level. Validated on the K company dataset, the architecture reduces the features from 20 to 5 through a hierarchical structure, and the prediction accuracy reaches 90% (2022), 94% (2023), and 96% (2024), respectively. The results show that the accuracy rate remains above 90% within three years, confirming that the IoT-DL fusion can effectively extract potential risk patterns and achieve early crisis detection. The system can provide proactive financial protection, prompting enterprises to adopt real-time monitoring, diversified financing, and optimize cash flow. Its practical significance lies in the ability to build a scalable risk warning framework for data-driven decision-making in turbulent markets.
Keywords: *DL, Listed companies, Financial crises, Internet of things, Monitoring and prevention.*

1. Introduction

In recent years, the continuous development of China' s economy has brought new opportunities and challenges to listed companies in terms of management and operation and also endowed listed companies with new connotations of financial management, gradually changing their initial business decisions and strategic transformation. Since the establishment and continuous improvement of China's socialist market economy after the reform and opening up, listed companies must face increasingly complex challenges and crises if they still hope to have their own foundation in the fierce market competition and hope to exist and develop for a long time. In the production and operation process of the whole enterprise, the most important thing is the monitoring and management of financial crises. Financial management extends to all business scopes of the company, and financial crises have become the main crises faced by the company, among which the main crises are production, investment, internal management, and technology. In the modern market economy environment, monitoring and preventing financial crises has become an important task for enterprises, and the consequences of financial crises directly threaten the survival and further development of enterprises, which should be assessed by every employee of the business. Listed companies strengthen their understanding and control of economic crises to promote the healthy and stable development of their businesses.

In today' s diversified economic development, how to control financial crises in the company' s project decision-making has far-reaching significance for the development and expansion of the company' s operation. Nowdays, DL has been a hot topic in the computer field. With the gradual improvement of computer hardware equipment and computing power, DL technology has also made great progress. Mature DL models and applications have emerged in the fields of language processing

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and target detection. Simultaneously, since the idea of the Internet of Things was first mentioned in 1999, its application scenarios have become more and more common in real life. It is of great significance for the strategic arrangement of the Internet of Things system and the guidance of real life. Based on the Internet of Things and DL methods, there are few restrictions on the problem to be solved, so it has a wide range of applications in the financial crisis monitoring and prevention of listed companies. In recent years, scholars have used DL to solve corporate financial problems, but there are relatively few applications and researches on the Internet of Things in this area. Therefore, this paper applies the improved Internet of Things to the research of monitoring and preventing corporate financial crises, which has both theoretical and practical significance.

With the advancement of society, more and more people have studied the Internet of Things. Among them, Dohler, et al. [1] studied the application of IoT technology in the construction industry and business model construction in the 5G network environment Dohler, et al. [1] and proposed the flexible application of IoT. While Rathore, et al. [2] believed that IoT technology provided a way to integrate and share common communication media, he proposed an IoT-based combined system for smart city development and urban planning using big data analysis. Additionally, he proposed a complete system consisting of various types of sensor deployments, including smart home sensors, in-vehicle networks, weather and water sensors, smart parking sensors, and monitored objects Rathore, et al. [2]. Singh, et al. [3] proposed that to accomplish the open vision of everywhere computing supported by the "The Internet of Things" (IoT), it is necessary to decomposite the silos based on applications and technologies to support extensive connectivity and data sharing. The current state of cloud-enabled IoT is analyzed to identify security efforts that need further improvement Singh, et al. [3]. Mozaffari, et al. [4] studied the efficacious improvement and fluidity of diverse unmanned antenna vehicles (UAVs) used as antenna base stations to gather data from terrestrial Internet of Things (IoT) equipments. Especially to enable the fair-weather uplink communication for IoT equipments with minimal total transmit power, a new frame was supposed to be the jointly majorizating 3D layout and fluidity of drones, equipment-drone associations, and uplink power control. First, he determined the location and association of the best drone given the location of active IoT equipments at each moment. Next, to moving serve IoT equipments in a time-varying network, he analyzed the best movement patterns of drones. Based on the activation process of the IoT device, he also deduced the instance of time at which the drone must update its position. Furthermore, the best 3D trajectory of every drone was gained by minimizing the total energy used for drone movement while serving IoT equipments. Emulation results showed that the total transmit power of IoT equipmentsis declined 35% by using the proposed method compared to the case where fixed air base stations were deployed. Compared to the stationary case, the method he proposed in his experiments could produce up to 28% increase in system reliability. His findings also revealed an inherent trade-off between update times, drone mobility, and IoT device transmit power. Essentially, multiple updates reduce the transmission power of IoT-related equipments, but at the same time increase the maneuverability of the drone [4]. From the Internet of Things, Verdouw, et al. [5] conducted research and analysis on virtual food supply, and conducted remote real-time monitoring, management, planning, and optimization of virtual performance. At the same time, they also provided an infrastructure aimed at realizing a bio-enabled information system through the FIsPAce platform, and this framework was also applied to the case research and development of the fish supply chain Verdouw, et al. [5]. Laplante and Laplante [6] believed that new applications of the Internet of Things (IoT) technology are emerging, especially in healthcare, with leverage that can significantly improve patient well-being while alleviating the problem of scarce resources. However, the hype surrounding these apps far exceeded the reality, and utilizing these technologies could separate caregivers from patients, potentially putting patients at real crisis of losing care. In Laplante P A' s research, they reviewed some of the most promising applications of IoT in healthcare and proposed major challenges for IoT technology applications in healthcare in the future [6]. However, the shortcomings of these studies are that the research and experiments are relatively complicated, which require a lot of time, energy, and material support and are not practical.

The innovation of this paper is that: this paper finds out the key for Chinese listed companies to deal with economic crisis and crises by analyzing the financial crisis performance and financial crisis causes of Chinese listed companies. By comparing their financial status with the average of the same industry, the development status of the same industry is obtained. Then, combined with the analysis of internal and external environment, a comprehensive investment warning for K Company is obtained, and DL technology is introduced to analyze the investment development status of K Company. Corresponding financial crisis prevention strategies are proposed based on the final conclusion.

2. IoT and DL

2.1. Connotation of The Internet of Things

In August 2009, China put forward the strategic concept of " perceiving China". Since then, the Internet of Things has set off layers of waves around the world, and has been continuously pushed to new heights by human beings. The Internet of Things refers to a kind of information sensing equipmentsusing radio frequency identification technology (RFID), infrared sensors, GPS, laser scanners, etc., and a network for smart distinguish, positioning, overseeing and control of objects. The ultimate aim to be realized by the Internet of Things is to realize the acquisition of any object at any place and at any time by providing various objects, including living and inanimate, with a body as small as an ant and a spacecraft, and installing smart chips and other sensing equipmentsto form a ubiquitous information-aware global network [7]. The basic formula of IoT is: (NSID-IOT)+(NB-IOT)+(OID-IOT)=IOE/IOE*N=IOT [8].

2.2. Key Technologies of the Internet of Things

At present, according to the function, the technical structure of the Internet of Things including three levels: one is the perception layer for information collection, which is located at the bottom. The second is a network layer that can realize multi-line transmission and exchange of information, and it is in the middle layer. The last is located at the topmost layer [9] which implements diversified applications based on the underlying data and implements management functions for the middle layer and the bottom layer. In the structure of the Internet of Things, the role of each layer and the relationship between the three layers can be understood in an anthropomorphic way. If the Internet of Things is compared to a person, the perception layer at the bottom can be regarded as the skin of " The Internet of Things" and facial features. The network layer in the middle layer is regarded as the nerve center of "The Internet of Things" , and the application layer at the top is regarded as the brain of " The Internet of Things ". The structure diagram of the Internet of Things is shown in Figure 1:

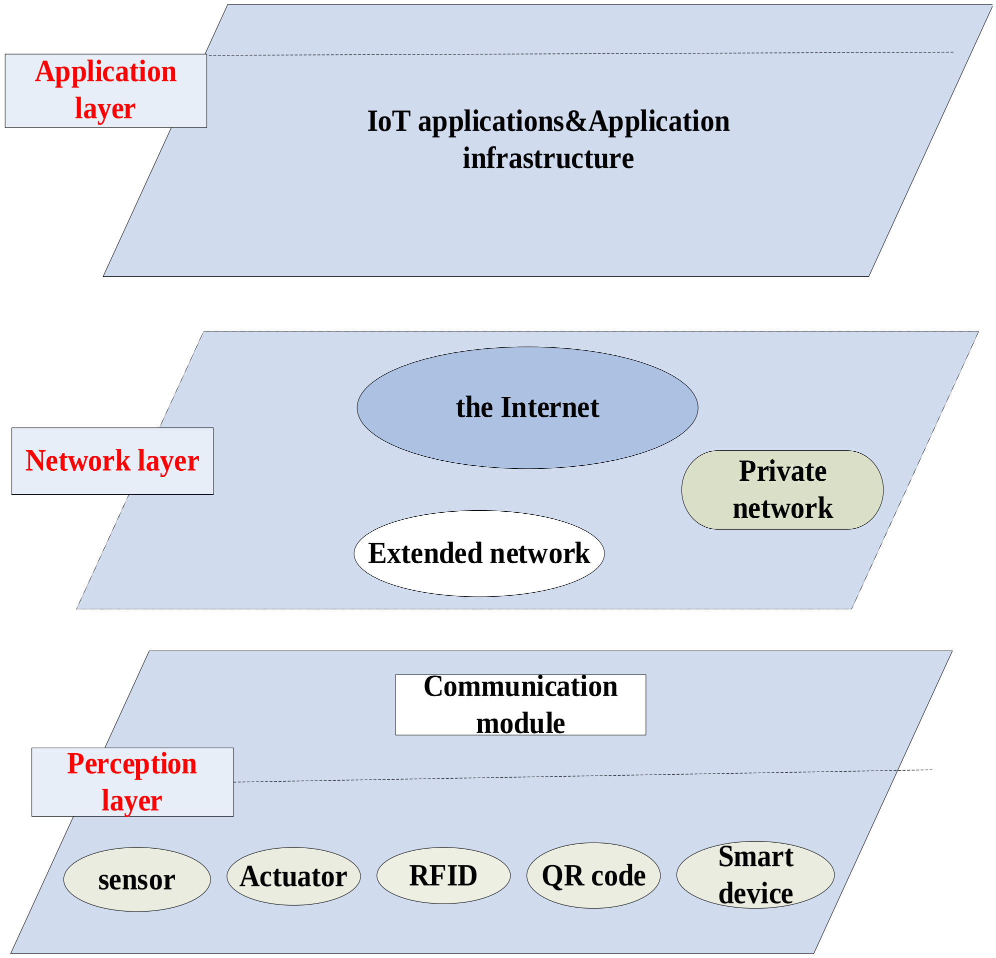

Figure 1.
IoT architecture diagram.

2.2.1. Perception Layer

The perception layer is the basis for the development and application of the Internet of Things. It is divided into two situations: one is the direct perception method, and the other is the multi-hop method of the ad hoc network, most of which are the former. Through two-dimensional code tag identifiers, RFID tag readers, image detection equipment, GPS positioning equipments, temperature detectors and liquid sensing detectors, and other independent sensing equipmentsas the skin and facial features of " The Internet of Things " to collect information from the outside world.

2.2.2. Network Layer

The network layer in the middle layer is a bridge connecting the perception layer and the application layer, including the bearer network and intelligent computing technology. The bearer network is a variety of wired and wireless networks used for data communication or sharing. Wired networks include telephones, dedicated lines, private, and local networks. Wireless networks include mobile communications, wireless local area networks, wireless metropolitan area networks, and wireless wide area networks. Intelligent computing technology is a technology for storing, analyzing, managing, and processing sensory data. It is an important part of the network layer and the support base for specific applications at the application layer.

2.2.3. Application Layer

The top-level application layer is the layer that displays business to users: one is business middleware, and the other is specific application. The former refers to a more general service model, which is the basis of specific applications, such as user management, billing management, etc. The latter mainly refers to the use of data obtained through the network layer and the assistance of middleware to achieve specific applications in specific fields, such as environmental monitoring, traffic intelligence, expressway non-stop toll collection system, etc. [10].

2.3. Basic Idea of DL

DL is originated from the study of artificial neural networks. A DL neural network consists of a neural network with an input layer, three hidden layers, and an output layer. The basic idea of DL can be expressed as follows: supposing there is a system L, it has n layers (L1, ..., Ln); the input is A; the output is B, which can be visually expressed as: A=>L1=>L2=>… =>Ln=>B. By properly adjusting the parameters in the system, the output B can be as close to the input A as possible, and the multi-level features L1, L2, ..., Ln of the input A can also be obtained. By properly adjusting the parameters in the system, the output B can be as close to the input A as possible, and the multi-level features L1, L2, and Ln of the input A can also be obtained. However, for different levels of data stacking, the results of the before layer is usually made to be the input of the next layer to achieve different levels of representation of input information and output data [11]. The DL neural network diagram is shown in Figure 2:

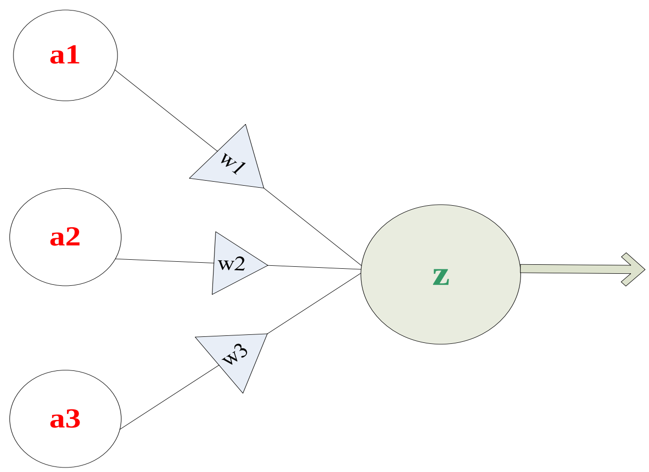

Figure 2.
DL neural network diagram.

2.4. Training Process of DL

During the training process, all deep network layers cannot be trained at the same time, otherwise the results are too complicated. It is not feasible to train only one layer at a time, because this causes the deviation to increase layer by layer. The deep network structure has many neurons and parameters, which can easily cause the problem of data inconsistency. On the basis of unsupervised data, a multi-layer neural network can be effectively established. The process is divided into two steps: one is to train only one layer at a time, and the other is to optimize the high-level expression b generated from the original input a and the high-level expression output a' generated by b downwards is as consistent as possible [12].

However, difficulties are also encountered in the training process, that is, the training speed is too slow, and the generation speed is slow. In general, DL is a process of repeatedly tuning model parameters to generate results, and by improving GPU and other hardware performance to achieve complex DL training. If the training time is too long, on the one hand, it reduces the number of

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iterations in the same total training time, affecting the accuracy, and on the other hand, reduces the number of training, thus reducing the chance of testing other parameters [13].
The training flow chart of DL is shown in Figure 3:

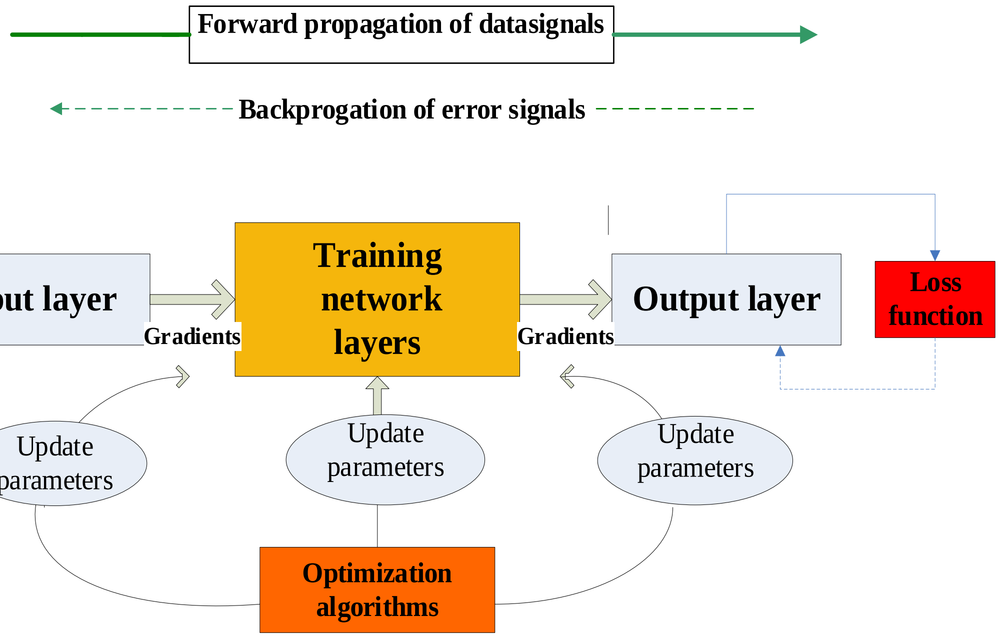

Figure 3.
The training flow chart of DL

2.5. Common Models of DL
2.5.1. Autoencoder Automatic Encoder
An autoencoder is a neural network that with a back dissemination algorithm to make the output results be the same as the input information. It concentrates the input information into potential features firstly and then uses these features to reconstruct the output value [14]. This process is inseparable from the two important components of the autoencoder: the encoder and the decoder. The encoder concentrates the input into a uncanny space characterization, and it can be depicted by the encoding function g=f(x). To achieve reproduction, an autoencoder must acquire the most critical factors capable of reproducing the input data and find initial information that can represent the key elements of the data [15].

2.5.2. Sparse Coding Sparse Coding
Sparse coding is a type of unsupervised learning algorithm used to find a set of perfect basis vectors to represent example data more efficiently. Using the concept of basis in line generation, that is, O= $a_1 * b_1 + \ldots\ldots a_n * b_n$, b_i is the basis; o_i is the coefficient; the following optimization problem is obtained: Min|I–O|, where I represents the input, and O represents the output. Solving this majorization formula to get the modulus o_i and the basis b_i, which are another similar expression of the input [16]. They can be used to represent the input I, which is automatically encoded. The formula can be shown as follows:

$$x = \sum_{i=1}^{a} bi\Phi_i \tag{1}$$

This method is called sparse coding, which represents a signal as a set of linearly combined basis, and only needs a few basis to fully represent the signal [17]. The coefficient b_i is required to be as far greater than zero as possible, and the rest are all zero.

The sparse coding training process is divided into two parts:

(1) Training stage: giving a series of samples [x1, x2, …], learning to obtain a set of bases [Φ1, Φ2, …], which is essentially a process of repeated iterations, the formula is as follows:

$$\min \sum_{i=1}^{m} \prod x_i - \sum_{j=1}^{k} a_i, \theta + \gamma \sum_{i=1}^{m} \sum_{j=1}^{k} a_i, j \quad (2)$$

Each iteration has two steps:

(1) Fixing Φ[k] in formula (2) and then adjusting a[k] so that the formula' s objective function is the smallest.

(2) Fixing a[k] in formula (2) and adjusting Φ[k] to make the formula's objective function minimum.

The iteration is repeated until convergence, and a set of bases that can well represent the series of input samples are obtained.

(2) Coding stage: giving a new input x, Φ[k] is obtained by formula (2), obtaining the sparse vector a by solving formula (3). This sparse vector is a sparse representation of the input vector x. The formula is as follows:

$$\min \sum_{i=1}^{m} x_i - \sum_{j=1}^{k} a_i \theta + \Upsilon \sum_{i=1}^{m} \sum_{i=1}^{k} a_i j \quad (3)$$

2.6. Convolutional Neural Networks

Convolutional Neural Network (CNN) is a representative algorithm of DL, generally at least one layer will use convolution operation. The convolution operation is a special linear operation that can replace matrix multiplication in general neural networks. Convolutional neural network mainly improves the expression of traditional neural network through three ideas of sparse interaction, parameter sharing, and equivariant representation, and can classify input information invariably according to hierarchical structure, so it is also called "translation invariant artificial neural network". [18]. In general, the most common convolutional neural network consists of an input layer, a convolutional layer, an activation layer, a pooling layer, a fully connected layer, and a final output layer. From input to output, different neural nodes are used to establish the computational relationship between the convolutional computational neural network layer and the bottom layer, and the input information is transmitted layer by layer. The continuous convolution operation-group pooling architecture can encode, deduce, organize, and map the feature information of the initial data into the closet layer feature space, and then, the fully connected layer can classify and transmit the newly acquired feature information.

2.6.1. Convolution

The convolution method is a calculation method just like addition and subtraction. Since the convolutional neural network has good processing ability for two-dimensional images, this paper briefly introduces the application of convolution method in two-dimensional image processing. In the two-dimensional image processing, the convolution operation is mainly used for template calculation (multiplying the pixel value of the template covering the image position corresponding to the standard template value and adding it), and then adding the template from left to right in the image, from top to bottom sliding down to run the template calculation, the convolution effect of the two-dimensional image can be calculated [13]. If the size of the template is m*n, the convolution operation table of the template on the image can be expressed as:

$$T(x*y)*M(u,v)=\sum_{i=-a}^{a}\sum_{j=-b}^{b}m(i,j)t(x+i,y+j) \quad (4)$$

Among them, the symbol T(x*y)*M(u,v) represents the convolution operation between the image M(x,y) and the template m(u,v); m(i,j)t(x+i , y+j) delegates the weight of the template (i, j) position represented by m(i, j); the pixel of the image pixel coordinate (x+i, y+j) position t (x+i, y+j) values is multiplied accordingly.

2.6.2. Activation Function

Activation functions run on ANN neurons and are responsible for mapping the neuron' s inputs to outputs. Activation functions are very helpful for artificial neural networks to learn and understand very complex and nonlinear functions, and are indispensable for convolutional neural networks. There are three typical activation functions, namely: Sigmoid activation function, Tanh activation function, and Relu activation function [19].
The function curve is shown in Figure 4:

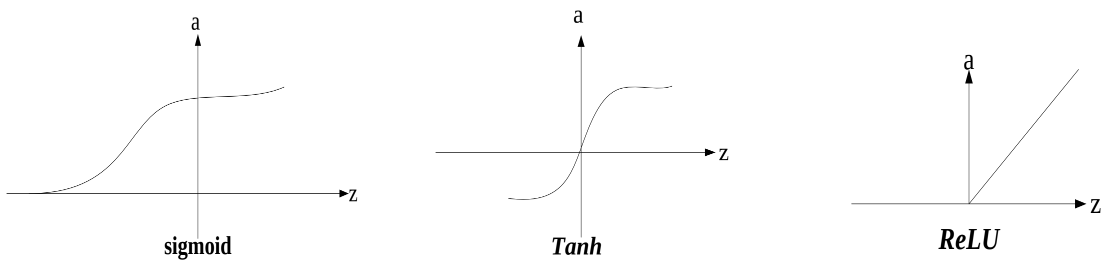

Figure 4.
Function graphs.

Its relative activation function formula is as follows:

$$\text{Sigmoid:}\,\sigma(z)=\frac{1}{1+e^{-z}} \quad (5)$$

$$\text{Tanh:}\,\sigma(z)=\frac{1-e^{-2z}}{1+e^{-2z}} \quad (6)$$

$$\text{ReLU:}=\sigma(z)=\langle 0, z\le 0, z, z>o\rangle \quad (7)$$

The sigmoid function is an activation function that is earlier used in neural networks. The value range of the function is (0,1) interval, and the function characteristic is: when the input value is 0, the function value is 0.5. When the input value approaches positive infinity, the function value approaches 1. When the input value approaches negative infinity, the function value approaches 0. The sigmoid function is formulated as:

$$f(x)=\frac{1}{1+e}x \quad (8)$$

The Tanh function is also known as the hyperbolic tangent function. The Tanh function can be obtained by translating and scaling the Sigmoid function downward. Its function range is (−1,1) and passes through the coordinate origin. The function is formulated as:

$$f(x)=\frac{e^{x}-e^{-x}}{e^{x}+e^{-x}} \tag{9}$$

The Relu function can also be called a modified linear unit function. Its characteristics are: when the input value is positive, the function value is always 1. When the input value is negative, the function value is always 0. The Relu activation function can be expressed as:

$$\mathbf{F(x)}=Max(0,x) \tag{10}$$

The Sigmoid activation function and the Tanh activation function have the same feature, that is: when the independent variable is infinite or infinitely small, the gradient of the function becomes infinitely small, which reduces the solution speed of the gradient descent algorithm. In practical applications, neural networks using Relu activation function generally learn faster than using Sigmoid activation function or Tanh activation function.

2.6.3. Batch Normalization

Batch Normalization (BN) makes the input data more stable by normalizing the data. During the CNN training process, the change of the parameters of the previous level affects the change of the next level, and if the number of network levels is too large, this change gradually increases. Most of the current CNN optimization methods are optimized by stochastic gradient descent (SGD). However, if there are too many network levels, the parameters of each network level are continuously optimized, and each network level is continuously optimized during the optimization process. This situation may lead to the failure of the final optimization of the entire network.
The BN method is normalized to each input and expressed as follows:

$$x^{(i)}=\frac{x^{i}}{\sqrt{Var[x^{-i}]}}-E[x^{i}] \tag{11}$$

Among them, x^{i} is the i-th dimension of the data; $E[x^{i}]$ is the average of the i-th dimension data; $\sqrt{Var[x^{-i}]}$ is the standard deviation of the i-th dimension data.

Although the above method fixes the data distribution of each layer, this normalization method changes the original features, so the BN method restores the data distribution that should be learned next, and the formula is expressed as follows:

$$y^{(i)}=r^{i}x^{i}+\beta^{i} \tag{12}$$

In the way, BN transforms the original input data into the desired data distribution.

2.6.4. Cost Function of Logistic Regression

Giving a sample set $m\{(x^{1},y^{1}).....(x^{m},y^{m})\}$ needs to be obtained through the loss function, the loss function (L, y) is a function used to measure the operation of the algorithm, so in predicting the y value, the error should be as small as possible, that is, the loss function should be as small as possible, which is usually expressed by the following formula in logistic regression:

$$L(y^{i},y)=-y\log(y^{i})-(1-y)\log(1-y^{i}) \tag{13}$$

When y=1, the largest possible value is required to minimize the loss function, because the value range of the sigmoid function is between (0, 1), so y^ must be infinitely close to 1. Similarly, when y=0, y^ also approaches 0 infinitely.

The loss function is to evaluate a single sample, so on all samples, it is necessary to define a cost function J(w, b), to calculate the loss function for all samples, and then average and minimize them to optimize w and b value:

$$j(W,b)=\frac{\sum i=1L(y^{i})}{m}=\frac{\sum i=1(-y^{i})\log y^{i}-(1-y^{i})}{m} \quad (14)$$

3. Financial Crisis Monitoring Experiment and Analysis of Listed Companies

3.1. Test Subject

This paper selects K listed company as the experimental object. The reason for the selection is that the company has been listed for a long time; the company has a solid operating foundation, and its financial status has always been stable with occasional fluctuations. The experimental data obtained by choosing this company as the experimental object is more informative.

3.2. Experimental Method

Model analysis: the main work of the experiment under the guidance of this method includes: model design, index selection, data processing, and model training and testing.

Figure 5 shows the model construction idea of using the DL of the Internet of Things to carry out the K-listed company' s financial crisis early warning experiment:

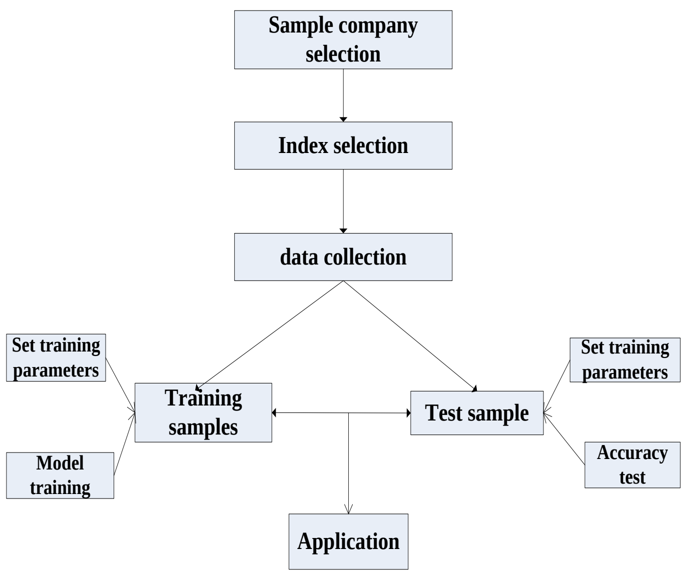

Figure 5.
The idea of constructing the experimental model.

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3.3. Experimental Data
3.3.1. Selection of Experimental Indicators (Table 1):

Table 1.
Selection of experimental indicators.

First level indicator **Secondary indicators**	**First level indicator** **Secondary indicators**
Flow rate	Flow rate
Solvency index	Solvency index
Quick rate	Quick rate
Cash rate	Cash rate
Assets and liabilities	Assets and liabilities
Interest coverage ratio	Interest coverage ratio
Profitability indicator	Profitability indicator
Total rate of return	Total rate of return
Net yield	Net yield
Total net profit	Total net profit
Operating profit margin	Operating profit margin
Earnings per share	Earnings per share
Total turnover rate	Total turnover rate
Operational capability index	Operational capability index
Turnover rate	Turnover rate
Fixed turnover rate	Fixed turnover rate
Crisis level indicator	Crisis level indicator
Financial leverage	Financial leverage
Operating leverage	Operating leverage

3.3.2. Data Processing
In this paper, the identified financial indicators are made to be the input value of the DL model algorithm. DL has the characteristics of self-learning, and it can perform unsupervised learning in a huge database. However, if the financial data is insufficient, DL cannot give full play to its own advantages. To avoid errors caused by insufficient financial indicators, it is necessary to perform DL training on as much data as possible. This paper uses the selected financial indicators to make predictions, which can reduce the error to a certain extent.

3.3.3. Model Training and Testing
Although an accuracy rate can be obtained through the training data of the DL model, the accuracy of this data is less reliable. At this point, it is necessary to test the test data again to obtain a final and reliable accuracy rate.
The following is the DL network structure design:

3.3.3.1. Input Layer
The initial link of the DL model is the input layer, and the input layer is the selected indicator data.

3.3.3.2. Hidden Layer
Determining the number of hidden layers requires a specific analysisin view of the actual circumstances. Since this paper selects 20 financial indicators of the listed company, the initial value of the number of hidden layers is 20 nodes. Since it is difficult to judge whether K company has financial crises based on a single financial indicator data, it requires DL to integrate and analyze 20 financial indicators, that is, to reduce the 20-dimensional hidden layer to 2 layers [20]. After many training and debugging, the most suitable number of hidden layers is selected, that is, the number of hidden layers is 15, 10, and 5, respectively, which means that the financial indicators of real estate enterprises are reduced from 20 dimensions to 5 dimensions [21].

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3.3.3.3. Output Layer

According to the selection of the hidden layer dimension, a five-layer training model can be obtained, namely 21, 15, 10, 5, and 2. Since the dimension of the final output layer is 2, two states of the company can be obtained, namely the financial crisis state and the financial normal state, where the crisis state is represented by (0,1) and the normal state by (1,0).

3.3.3.4. Parameter Training

There are a total of 220 training samples in this paper. After many debuggings, the training times and training batches to obtain the best results are determined, that is, the training times are 1000, and the training batches are 171.

Train:

MATLAB 2014a software is used to continuously adjust the training parameters, and different training results are obtained through parameter transformation and repeated until the most satisfactory results are obtained. The algorithm code is:

fprintf (1, 'Displaying.in figure 1: Top row-real data, Bottom.rom-reconstructions) output = [output data (ii, 1:end)' dataout (ii:)]

Figure 6 shows the training effect graph of the output as original data and normalized data. According to the setting of training parameters, the final accuracy rate reaches 91.7%, and the training accuracy rate reflects the accuracy of network prediction. It can be seen that after many training and debugging, the prediction error rate of K company' s financial crisis is significantly reduced. The training effect diagram is shown in Figure 6:

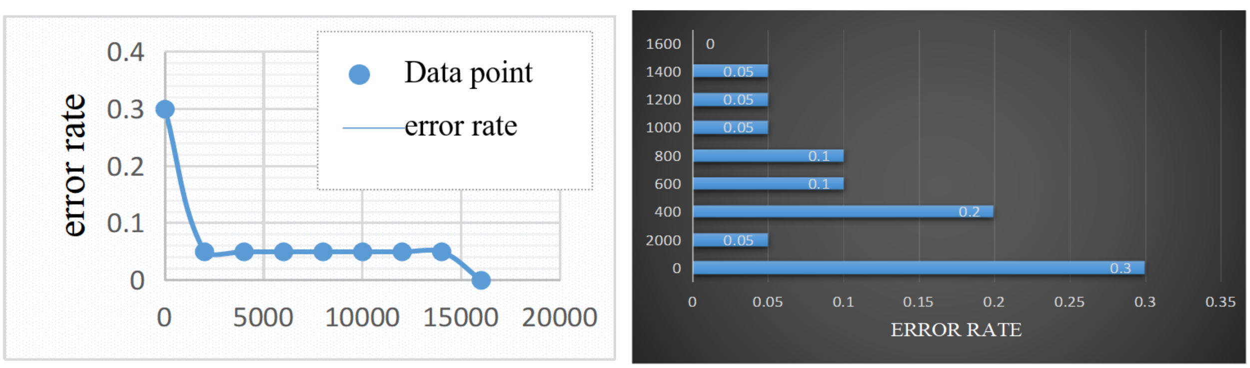

Figure 6.
Training effect diagram.

To test the accuracy of DL for financial crisis warning of listed companies, it is necessary to predict the samples that have not participated in the training, that is, the test samples. The specific algorithm code is:

[textnujmcases.textnumidims.textnumbatches]=size(textbatchdata)

where: N=textnumcases epoch=err/textnumbatches

The test results are analyzed and data processed. Table 2 and Figure 7 are available:

Table 2.
Crisis Analysis Values.

Year	Normal company	Judging the right company	Accuracy rate
2022	76	67	90.00%
2023	75	7	94.00%
2024	79	0	96.00%

Figure 7.
Accuracy of financial crisis early warning of listed companies.

As can be seen from Figure 7, in 2024, the prediction accuracy of DL for financial crisis beforehand notification of listed companies is the highest in the three years from 2022 to 2024, reaching 96%.

3.4. Experimental Analysis

According to the experimental results and the contents of Table 2, it can be concluded that after relevant training and debugging, the precise portion of DL for financial crisis beforehand notification of listed companies is corresponding high, and although the prediction accuracy rate fluctuates slightly, the general trend is correct. The accuracy rate of the company' s crisis judgment has gradually improved, and the accuracy rate of the prediction for the past three years has reached more than 90%. It is undeniable that the financial crisis early warning method of listed companies based on DL is more effective. If this method is applied to the financial crisis beforehand notification of listed companies, it can effectively predict crises and avoid financial losses.

4. Discussion

The rise and fall of listed companies is directly related to the development of the national economy. Its financial status is closely related to changes in national policies and economic environment. Changes in national policies and economic conditions also affect various financial elements of listed companies, which easily lead to fluctuations in the financial status of the company, and even lead to financial crises for the company. The Internet of Things and DL have a more significant effect on the operation of complex functions, but so far there is no example of using them in the financial crisis warning of listed companies. Therefore, this paper applies the two to the financial crisis early warning of listed companies and takes K company as an example to make a specific analysis. The empirical results show that the DL of the Internet of Things has obvious effects on the early warning of financial crises of listed companies. Combined with the DL related technologies and experimental results of the Internet of Things, this paper gives the following suggestions on how to better carry out financial crisis early warning and prevention for K company: stabilizing the market, preventing price crises, maintaining a reasonable cash flow organizational structure, and developing more diversified financing methods, scientific financial decision-making, etc.

5. Conclusions

Aiming at how to carry out financial crisis monitoring and early warning of Chinese listed companies, this paper selects K company as the experimental object and mainly does the following work:

first, the research background, significance, and research status are clarified. Secondly, the concepts and related theories and technologies of the Internet of Things and DL are introduced. Then, based on the Internet of Things and DL, the financial crisis early warning analysis of listed companies is carried out. The model design ideas are determined, and samples of companies and financial indicators are selected. The data processing is divided into two parts: training and testing, which are used to create a DL model for the financial crisis of the sample companies and test the model's accuracy. The accuracy of DL is used to predict the financial crisis of the listed company. The experiment concludes that the DL of the Internet of Things has a significant effect on the financial crisis early warning of listed companies. Finally, according to the experimental results and related technologies, this paper gives some suggestions on how to better carry out financial crisis early warning and prevention for K company, including: stabilizing the market, preventing price crises, maintaining a reasonable cash flow organizational structure; more diversified financing methods are developed, and scientific financial decisions are made.

Transparency:

The author confirms that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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