Integration of Genetic Algorithm and Neural Network for Financial Early Warning System: An Example of Taiwanese Banking Industry

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Abstract

Genetic algorithm and neural network (GNN) are integrated to build a financial early warning system. An example of Taiwanese banking industry is discussed to test the hit ratio of each system. The performance is compared with other four early warning systems, namely, case-based reasoning, backpropagation neural network, logistic regression analysis, and quadratic discriminant analysis. The result indicates that the GNN proposed in this research is a little superior to the other two soft computing early warning systems. And the GNN outperforms the statistical early warning systems at least 13%.

Keywords: Genetic algorithm, Neural network, Financial early warning system.

1. Background

Information technology facilitates economic activities. Among these activities, banking plays a principal role. The success or failure of a bank is definitely related to the local economic development, even to the international economics. Consequently, to build an early warning system is able to diagnose the financial operation conditions for banking.

Early research of financial early warning systems applied statistical methods such as Cheng [4], Martin [11], Lane et al. [9], Sinkey [13], and Taffler [14]. In recent years, the statistical methods are replaced with soft computing techniques. Various soft computing techniques especially neural networks and genetic algorithms are considered such as Barniv et al. [1], Bell [2], Boritz and Kennedy [3], Colin [5], Etheridge and Sriram [6], Kingdom and Feldman [8], Lee et al. [10], and Odom and Sharda [12]. All the research showed satisfactory results. Therefore an integration of genetic algorithm and neural network is proposed to build a financial early warning system for banking industry in Taiwan.

2. Integration of Genetic Algorithm and Neural Network

To integrate genetic algorithm and neural network, a genetic neural network (GNN) is proposed to build a financial early warning system. The GNN consists of three stages. The structure of GNN is depicted in

Figure 1.

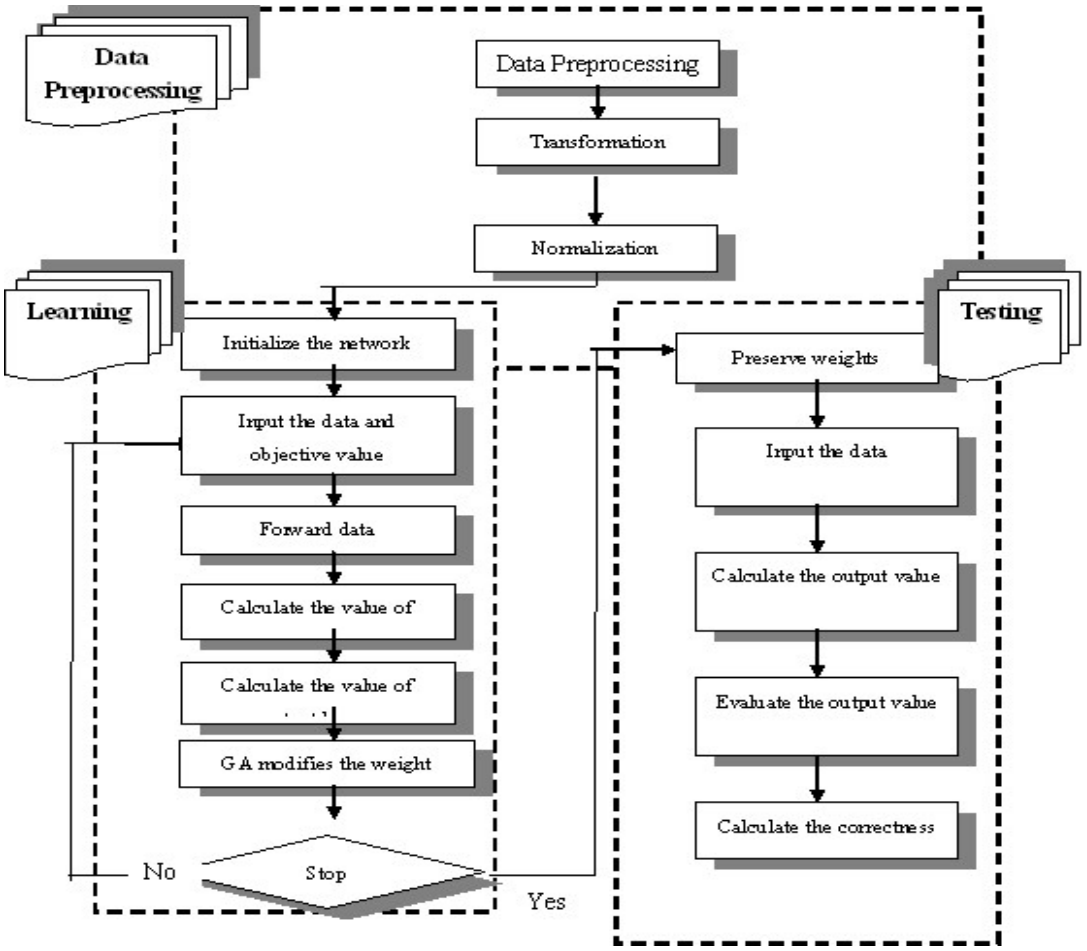

Figure 1. Structure of GNN

Stage 1 deals with data preprocessing including data transformation, variable selection, and data normalization. The processed data then are fed into Stage 2 to implement network learning. In the learning process, a genetic algorithm is embedded to adjust the weights of the neural network. The genetic algorithm applied real number encoding, selection by roulette wheel method, crossover by two-point method, and mutation by single-point method. The rates for crossover and mutation are shown in Table 1.

Table 1. Crossover and mutation rates of the genetic algorithm

Operator	Rate
Crossover	0.8
Mutation	0.3

The fitness function of genetic algorithm equals 1-MAPE, where MAPE denotes mean absolute percent error of neural network. The settings of parameters of neural network are reported in Table 2. Stage 3 tests the network, outputs the forecasts and computes hit ratio. Hit ratio denotes the ration of GNN that makes correct decisions.

Table 2. Parameter of the neural network

Parameter	Rate
Hidden layers	1
Hidden neurons	2
Transfer function	Sigmoid
Learning Rule	Delta
Learning rate	0.4
Momentum	0.5
Iteration	100000

3. Case study

3.1 Case statement

The banking industry in Taiwan has a unique characteristic from others all over the world. The banking industry is protected by government to prevent from severe financial crisis. Government takeover the problem bank in case of any out-of-control situation appears. There is no bankruptcy in Taiwan. Therefore, simply the performance of each bank is discussed in this paper.

Data of 49 banks are collected from 1998 to 2002. The data include 28 input variables and 1 output variable. The input variables denote the financial ratios of the banks while the only output indicates a decision which a bank is judged to be good or bad.

3.2 Early warning systems

Hsieh and Chang [7] applied case-based reasoning (CBR) to construct a financial early warning system. The result was compared with three other early warning systems based on backpropagation neural network (BPN), logistic regression analysis (LR), and quadratic discriminant analysis (QDA) respectively. The comparison reported that case-based reasoning approach was with a superior performance. The result of Hsieh and Chang [7] is applied and compared with GNN proposed in this research.

3.2.1 Comparative study

Data collected from 1998 to 2001 are used train the network and data of 2002 are used to test the network. Hit ratio is applied to be the criterion in judging which system is the best.

The result reported in Table 3 indicates that the GNN proposed in this research is a little superior to the other soft computing early warning systems. Also, GNN outperforms the statistical early warning systems at least 13%. The performance of soft computing techniques is around 10% leading the statistical methods.

Table 3. Hit ratios of early warning systems

Systems	Hit Ratio
GNN	85.71%
CBR	84.62%
BPN	80.39%
LR	72.45%
QDA	65.20%

4. Conclusions and future works

GNN integrates genetic algorithm and neural network is proposed to build a financial early warning system for Taiwanese banking industry. Data collected from 1998 to 2002 are used to be a case study. GNN is compared with other four systems based on CBR, BPN, LR, and QDA

respectively. The result has shown that GNN leads in all the comparisons. However, the gaps of GNN between the other two soft computing based early warning systems are not significant. That means GNN is potential and has room to be further developed to have better performance.

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