International Journal of Signal Processing, Image Processing and Pattern Recognition
Vol.7, No.5 (2014), pp.375-388
http://dx.doi.org/10.14257/ijsip.2014.7.5.32

Measuring Goodwill Value with Wavelet Neural Network: A Case Study on Heilongjiang Animation Enterprises

Han Dong Ping[1] and Bao Di[2]

[1]*School of management, Harbin Institute of Technology, Weihai, Heilongjiang, China*
[2]*School of management, Harbin Institute of Technology, Harbin, Shandong, China*
handongping@hit.edu.cn, baodi0824@163.com

Abstract

As one part of cultural enterprises, recently years have witnessed the development of Animation Enterprises. Even though the development of Animation Enterprises has become mature nowadays, there is still lack of quantitative understanding of Animation Enterprises. As one of the most valuable assets, goodwill quantifies the value of the survival and development of Animation Enterprises. An established method is to use Wavelet Neural Network (WNN) model for learning the predicted value of goodwill given a set of indicators. However, there are some issues of the basic WNN model. For example, the randomly determination of the initial state of the neural network leads to the possibility of converging to a local optimal point. Besides, the Animation enterprises cost of basic WNN is typically big and its convergence speed is relatively slow. To solve above challenge, we propose to improve WNN using Particle Swarm Optimization (PSO) algorithm. At the end, we conduct a case study on Heilongjiang Animation Enterprises to evaluate the performance of our proposed algorithm for goodwill measurement.

Keywords: *Animation Enterprises, Goodwill, Wavelet Neural Network (WNN), Particle Swarm Optimization (PSO)*

1. Introduction

Cultural enterprises are one of the significant components of the national economy. Recently years have witnessed the development of cultural enterprises in Heilongjiang. Statistics show that the increment of the whole national cultural industries in China was 1,347.9 billion in 2011, accounting for 2.85% of the national GDP. Among that, the increment of Heilongjiang cultural enterprises was 28.5 billion, 2.27% of the GDP in Heilongjiang in 2011. By the end of 2011, the number of cultural enterprises in Heilongjiang has grown to 65,900, with 360,000 employees. The residential expenditure on services, culture, Animation enterprises facilities was 483 averages in cities, approximately 9.37% of total per capita living consumption expenditure, and 569 average in countries, 12.77% of total per capita living consumption expenditure. From above data, we can observe that culture consumption in Heilongjiang has been in great demand. Therefore, the work in this paper is based on the background of Heilongjiang cultural enterprises.

Animation enterprises [1] is one part of cultural enterprises, referring to the creative ideas represented by animation and comic, including the developing, producing, publishing, broadcasting and selling of animation books, newspapers, movies, audio and video products and theater plays, as well as the production and operation of other derivative products such as costumes, toys and video games related to animation. Animation enterprises is one the most

ISSN: 2005-4254 IJSIP

promising sunrise industries in 21th century. In 2008, the direct output of global animation reached $400 billion, and that of derivative products was more than $4,000 billion.

Recently, Animation enterprises have been attached importance in China. In 2006, the General Office of the State Council issued the “Notice on several opinions to promote the development of China's Animation enterprises” [2], which pointed out that policy support should be strengthened and the industrial structure need to be adjusted to help facilitate the development of Animation enterprises. Moreover, the Heilongjiang government introduced a series of policies to encourage and support the development of Animation enterprises.

The survival and development of enterprises is grounded on credit. As one of the most valuable intangible assets of companies, goodwill is defined as “the excess of the cost of the acquired company over the sum of the amounts assigned to identifiable assets acquired less liabilities assumed” [3]. Goodwill is not about a single factor but the whole enterprise, and is significant for the development of the enterprise. Therefore, understanding and valuating goodwill is necessary.

In this paper, we propose a model to measure the goodwill of Animation enterprises through qualitative and quantitative analysis, and provide a case study of Animation enterprises in Heilongjiang province. Specifically, by comprehensive analysis on the factors related to goodwill, we design a multi-layered indicator system. Then, we propose to employ Wavelet Neural Network (WNN) [4] based model to learn the value of goodwill by integrating the above indicators. WNN is an established model for evaluation and prediction problems given a set of indicators [5-8]. However, the traditional gradient descent method for learning the parameters of WNN has some limitations. For example, it is easy for the network to fall into the local minimum, and therefore affect the Animation enterprises. Also, typically gradient descent requires long iterations. To solve these issues, we propose to use Particle Swarm Optimization (PSO) algorithm [9] to learn the parameters.

The Animation enterprises of this paper are organized as follows. Section 2 provides some related work. In Section 3, we first analysis the indicators of Animation enterprises goodwill value, and then present our modified WNN model. Empirical experiments of Heilongjiang Animation enterprises are conducted in Section 4. Finally, the paper is concluded in Section 5.

2. Related Work

The research on ANIMATION ENTERPRISES began at 1970s, including the factors of Animation enterprises development, the status and market analysis of Animation enterprises. Kahin, *et al.*, [10] investigated the factors of Animation enterprises for Asia and the Pacific areas, especially Japanese and Korean animation industry. They found the significant reasons are government support and funding, and talent cultivation of animation. Whitaker, *et al.*, [11] analyzed the status and issues of the development of Animation enterprises in US, and studied on the operation and market mechanisms by regression and statistical analysis. Case study on Disney was conducted [12] for understanding the history, background and status of Disney animation development. The authors believed that the major reasons for the popularity of Disney lie in the originality, audience positioning as well as the promotion strategies.

In China, many efforts are also made on the studies on Animation enterprises. For example, Gao, *et al.*, [13] pointed out some relevant factors that affect the development of Chinese Animation enterprises, and indicated that the originality is somehow overlooked by many Animation enterprises in China. Besides, the poor research and develop capability, unsound market legal system, and the short of talents, *etc.*, restrict the development of Animation enterprises. Zhou, *et al.*, [14] provided a case study on Hangzhou Animation enterprises to study on the industry integration problem. Zhou, *et al.,* [15] investigated the success of Zhejiang Animation enterprises, and believed that the key is to combine the modern and traditional culture together. Zhang, *et al.,* [16] pointed out the existing issues during the development of Animation enterprises of China, and the coping strategies are to foster the complete Animation enterprises and develop the animation industry professionals.

Many researchers have done efforts on understanding and measuring goodwill. Bourne defined goodwill as "being the money value over and above the value of the actual assets of a concern (such as book debts, stock-in-trade, machinery, *etc.,*) which can be realized in cases of death, dissolution, retirement, or liquidation" [17]. More, *et al.,* [18] tried to valuating goodwill using annuity method, and Paton also believed that goodwill is the present value of excess profits [19]. Nelson, *et al.,* [20] proposed momentum theory to quantify purchased goodwill.

Besides, there are also many works on WNN and its application. The characteristics of WNN such as locality and self-learning, WNN has been applied in many areas such as function approximation, data compression and Animation enterprises detection [21-23]. Some researchers also try to improve WNN with PSO. For example, Xiong, *et al.,* [24] optimized BP neural network with modified PSO to detect the Animation enterprises of transformers with high accuracy. Yin, *et al.,* [25] used WNN and PSO to optimize the space propulsion systems. More prediction applications have employed BP neural network with PSO, such as power load [26], environmental evaluation [27] and economic prediction [28].

In this paper, with the background of Animation enterprises in Heilongjiang province, we propose to study on the evaluation of enterprise goodwill. Specifically, we employ a WNN based method improved by PSO algorithm.

3. Goodwill Modeling for Animation Enterprises

3.1. Designing Indicators of ANIMATION ENTERPRISES

The development of Animation enterprises is related to various factors. With the Animation enterprises knowledge of Animation enterprises, we consider five aspects of factors as follows.

Internal factors of enterprises, such as a variety of talented staff, technical equipments, management level, cultural environment and communication and coordination between departments, would affect the production of excellent animation works.

Marketing and promotion factors. No matter how novelty the design of the animation works is or how much upfront investment has been made, if the animation products cannot be sold successfully, all Animation enterprises would be in Animation enterprises. Therefore, the success of marketing and promotion is the key factor of the development of Animation enterprises. Market influence. The development of Animation enterprises is greatly influenced by the market, and therefore knowing better of the market demand actively guides the development of Animation enterprises. Take cartoons for example, in America they are good for the whole nation, Japanese ones are det Animation enterprises classified for the tastes of different groups of people, and Korean cartoons attract audiences of various ages through the developed Internet.

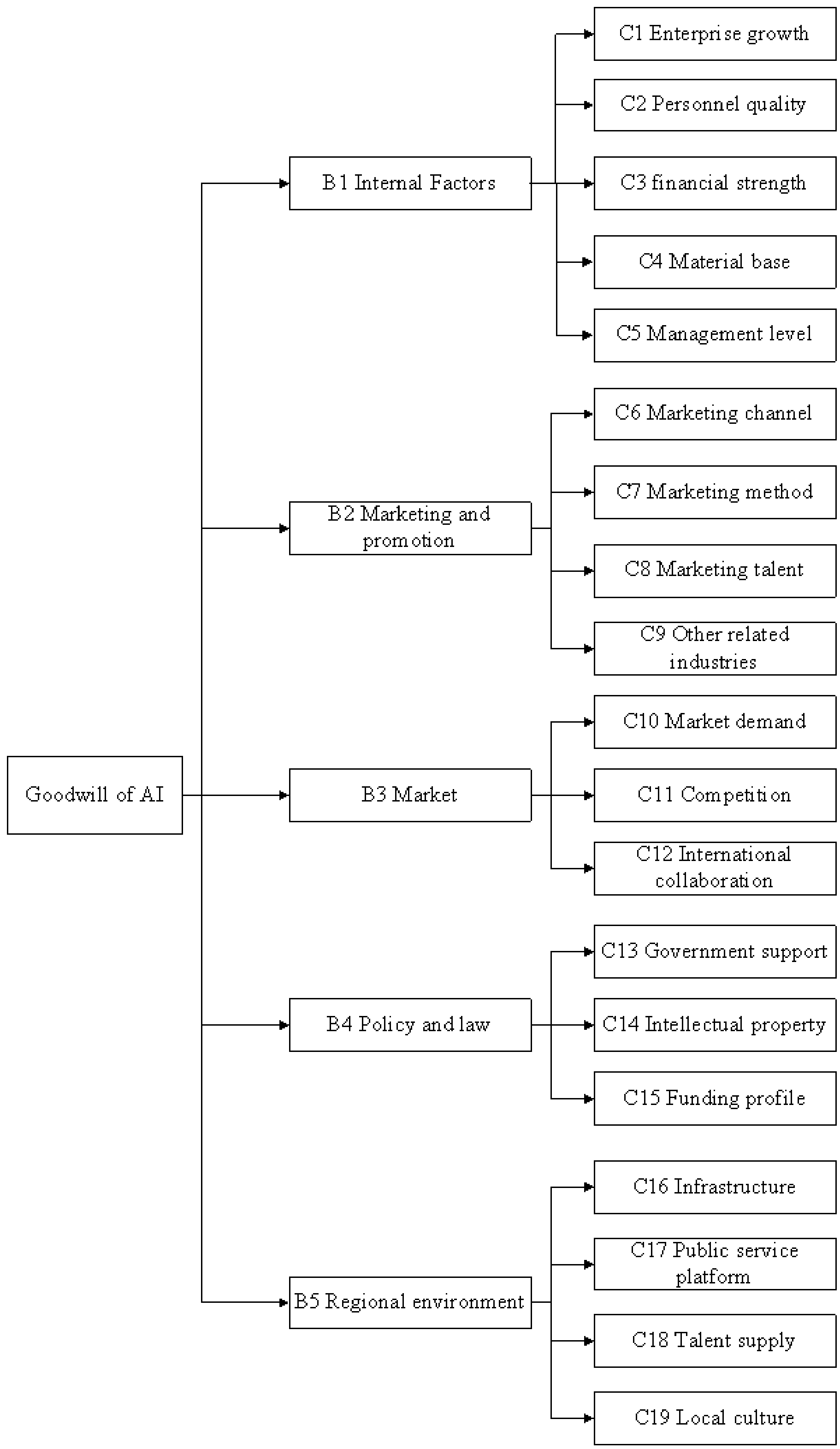

Figure 1. The Indicator System of Goodwill of ANIMATION ENTERPRISES

(1) Policy and law factors, such as the support policies form the government, and the intellectual property protection. From the situation in Japanese and Korean ANIMATION ENTERPRISES, the government support and financial grant played an important role in the development of Animation enterprises.

(2) Regional environment factors. Each region has its own resource advantages and development characteristics. Cultivating Animation enterprises should take the characteristics of regions into consideration by, for example, fully understanding local culture, economic and politics.

In order to quantize above aspects to measure the goodwill of Animation enterprises, we design a multi-layered indicator system, as illustrated in Figure 1.

3.2. Measuring Goodwill of ANIMATION ENTERPRISES using Modified WNN

Given the indicator system we built before, in this section, we introduce a model to measure the value of goodwill based on WNN.

As illustrated in Figure 2, which is a 3-layer Back Propagation (BP) neural network with Morlet wavelet basis function:

$$\varphi(t) = \cos(1.75t)\exp(-\frac{t^2}{2})\,. \quad (1)$$

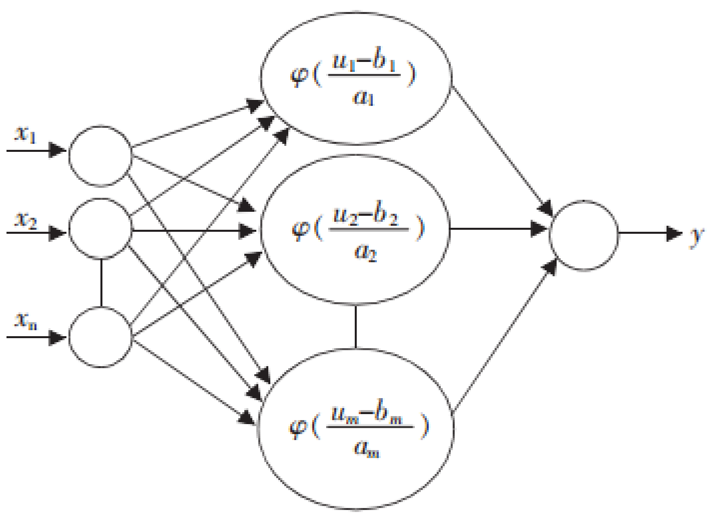

Figure 2. Morlet WNN Model

And the output can be calculated as:

$$y_l = \sum_{j=1}^{n} w_j \varphi\left(\frac{\sum_{i=0}^{m} w_{ij} x_l(i) - b_j}{a_j}\right), \quad (2)$$

where $x_l(i)$ is the normalized value of indicator i for instance l, w_{ij} is the weight from input layer to hidden layer, w_j is the weight from hidden layer to output layer, and a_j, b_j are scaling and translation coefficients respectively.

Typically, the Animation enterprises process of WNN employs a gradient descent method to adjust parameters, such as w_{ij}, a_j, b_j. However, it might cause local minimum and concussion. In order to optimize the network parameters, reduce the Animation enterprises time and improve the performance, we propose to introduce PSO algorithm for parameters optimization. The general idea is to adjust PSO for optimizing parameters of WNN at first, and then employ gradient descent method.

The process of PSO can be described as follows. Suppose there are n particles in a D -dimensional space. The position vector of the i -th particle is represented as $X_i = (x_{i1}, x_{i2}, ..., x_{id}, ..., x_{iD})$, the speed is $V_i = (v_{i1}, v_{i2}, ..., v_{id}, ..., v_{iD})$, and the best position is $P_i = (p_{i1}, p_{i2}, ..., p_{id}, ..., p_{iD})$. Suppose the best position of all particles is the position of g, notated as P_g. The speed of particle i at next iteration is calculated as:

$$v_{id}(t+1) = W \times v_{id}(t) + c_1 \times rand() \times (p_{id}(t) - x_{id}(t)) + c_2 \times rand() \times (p_{gd}(t) - x_{id}(t)), \quad (3)$$

$$x_{id}(t+1) = x_{id}(t) + v_{id}(t+1), \quad (4)$$

where c_1, c_2 are acceleration coefficients, $rand()$ generates a random number within [0,1], and W is the inertia weight factor. Larger W is more suitable for large scale exploration in solution space, and smaller W is good for small area exploitation. There are three components in Equation (3): the product of the last speed and inertia weight factor, the difference of the particle's own behavior, and the difference between the particle and the swarm. Maurice Clerc has analyzed the parameters and convergence of PSO [29].

Now we use PSO algorithm to Animation enterprises the network parameters of WNN. As mentioned earlier, suppose w_{ij} is the weight from input layer to hidden layer, w_j is the weight from hidden layer to output layer, and a_j, b_j are scaling and translation coefficients respectively. Let the position vector of particle i as:

$$present(i) = [w_1, w_2, ..., w_k, a_1, a_2, ..., a_k, b_1, b_2, ..., b_k], i = 1,2,...,n, \quad (5)$$

where k is the number of neurons in the hidden layer.

The input Animation enterprises sample is $x_l(i)$, the expected output is y_l, and $l = 1,2,..., L$, where L is the number of input samples. We use Morlet wavelet as mother wavelet function (or basic wavelet function) as shown in Equation (1).

At iteration d, update the position and speed of particles using Equations (3) and (4), and record the best position of each particle p_i^d, as well as the global best position of all particles p_g^d. Define the fitness as the Minimum Mean Square Error (MMSE) between the real output of the network $\hat{y}$ and the expected output y:

$$MMSE = \frac{1}{2}\sum_{i=1}^{L}(y_l - \hat{y}_l)^2, \quad (6)$$

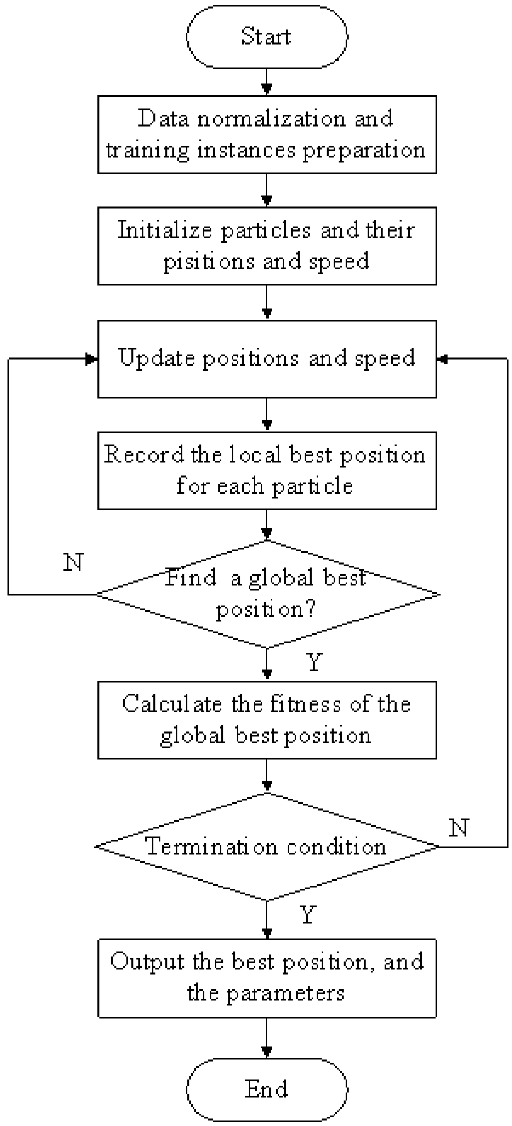

Figure 3. Process Flow of Modified WNN with PSO

Calculate the fitness value for p_i^d and p_g^d, notated as $MMSE_i^d$ and $MMSE_g^d$ respectively. If $MMSE_g^d$ is smaller than a predefined threshold, the algorithm stops, otherwise, return to the WNN Animation enterprises process. Finally, the algorithm outputs the global best position p_g. The whole process of modified WNN with PSO is illustrated in Figure 3, and the Animation enterprises are described in Algorithm 1.

Algorithm 1 WNN-PSO algorithm

repeat
  input training instances and expected outputs
  initialize particles and their positions, speed
  for each particle i **do**
    for each dimension d **do**
      $v_{id}(t+1) = W \times v_{id}(t) + c_1 \times rand() \times (p_i d(t) - x_{id}(t)) + c_2 \times rand() \times (p_g d(t) - x_{id}(t))$
      $x_{id}(t+1) = x_{id}(t) + v_{id}(t+1)$
    end for
    $p_i = x_i$
    calculate $\hat{y}$ based on Equation (2)
    calculate $MMSE$ based on Equation (6)
    if $MMSE_i < MMSE_g$ **then**
      $p_g = p_i$
    end if
  end for
  $t = t + 1$
until $t > MAX\_INTERATIONS$

Figure 4. Algorithm Description of Modified WNN with PSO

4. Experiment

In this section, we provide a case study on measuring the goodwill of Animation enterprises in Heilongjiang province. Specifically, we conduct a survey on the Animation enterprises in Heilongjiang by random sampling. The question Animation enterprises is issued by either on-site form filling or Animation enterprises. Our question Animation enterprises is designed based on the indicators proposed in Section 3.1, where each question describes one single indicator with a ten-point system. The data is normalized into the range from 0 to 1 as indicators for further analysis. Besides, we invite five authoritative experts to manually evaluate the goodwill of enterprises by Animation enterprises knowledge. The expected goodwill values are determined by the average of authoritative experts. We compare our modified WNN using PSO (notated as WNN-PSO) with the original WNN (notated as WNN).

Table 1 gives the results of estimation $\hat{Y}_l$ of WNN-PSO and WNN. We run the algorithms for 10 times for Animation enterprises, and perform prediction on the 11th and 12th time. We can observe that our WNN-PSO model outperforms WNN. The average prediction error is 0.34% compared to 1.315% for the original WNN. Moreover, Figure 5 shows the MMSE curve for two algorithms. We can see that at the initial stage of WNN-PSO model, the fitness is unstable. The possible explanation might be the randomness nature of PSO algorithm. However, the algorithm converges fast after approximately 200 iterations. The above results show that our proposed WNN-PSO algorithm is more suitable for goodwill evaluation in both accuracy and convergence speed.

Besides, the weights for our indicator systems learned by WNN-PSO model are shown in Table 2.

Table 1. Comparison of Prediction Errors

Algorithm	11th estimation	12th estimation	Average	Number of iterations till convergence
WNN-PSO	0.36%	0.32%	0.34%	216
WNN	1.35%	1.28%	1.315%	525

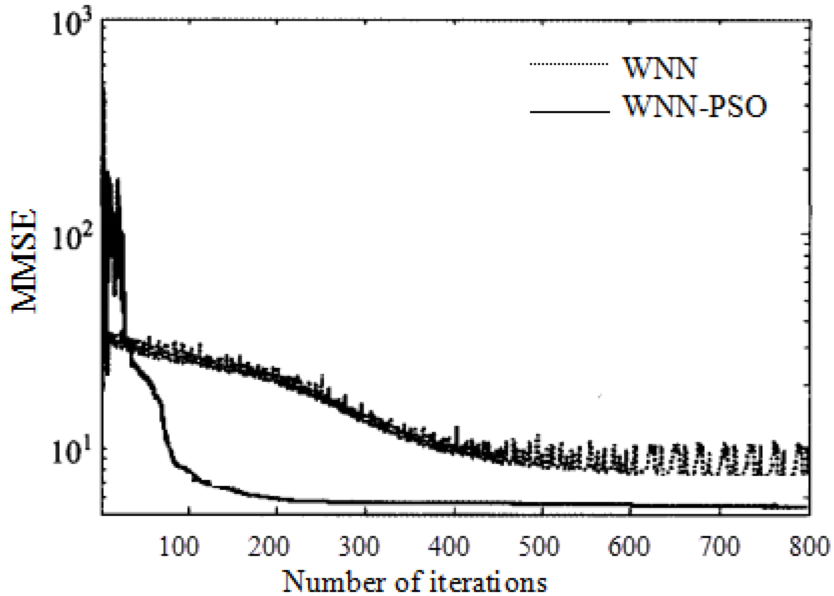

Figure 5. MMSE Curve of WNN-PSO and WNN

Table 2. Comparison of Prediction Errors

Level 1	Weight	Level 2	Weight
B1	0.24	C1	0.23
		C2	0.18
		C3	0.22
		C4	0.17
		C5	0.20
B2	0.17	C6	0.26
		C7	0.24
		C8	0.23
		C9	0.22
B3	0.16	C10	0.38
		C11	0.32
		C12	0.30

B4	0.20	C13	0.37
		C14	0.28
		C15	0.35
B5	0.23	C16	0.28
		C17	0.26
		C18	0.20
		C19	0.26

5. Conclusion

Based on the background of Animation enterprises in Heilongjiang, in this paper, we study on the problem of measuring the goodwill for quantitatively understanding the value of Animation enterprises. Our modified WNN model with PSO algorithm exhibits better performance than the original WNN. In future, we would like to extend the model to more applications.

Acknowledgements

Thank all our reviewers and family.

References

[1] J. A. Lent, "The animation industry and its offshore factories." Global Productions: Labor in the Making of the' Information Society, **(1998),** pp. 239-254.
[2] "Notice on several opinions to promote the development of China's animation industry", The central People's Government of the People's Republic of China, http://www.gov.cn/gongbao/content/2006/content_310646.htm.
[3] "Accounting Principles Board", Business Combinations, New York: Animation Enterprises CPA, no. 16, **(1970)**.
[4] Q. Zhang and A. Benveniste, "Wavelet networks", Neural Networks, IEEE Transactions on 3.6, **(1992),** pp. 889-898.
[5] Y. Chen, B. Yang and J. Dong, "Time-series prediction using a local linear wavelet neural network", Neuro computing, vol. 69.4, **(2006)**, pp. 449-465.
[6] X. Zhang, *et al.*, "Prediction of programmed-temperature retention values of naphthas by wavelet neural networks", Computers & chemistry, vol. 25.2, **(2001),** pp. 125-133.
[7] N. M. Pindoriya and S. K. Singh, "An adaptive wavelet neural network-based energy price forecasting in electricity markets", Power Systems, IEEE Transactions on, vol. 23.3, **(2008)**, pp. 1423-1432.
[8] V. K. Kumar, *et al.*, "Software development cost estimation using wavelet neural networks", Journal of Systems and Software, vol. 81.11, **(2008)**, pp. 1853-1867.
[9] R. C. Eberhart and Y. Shi, "Particle swarm optimization: developments, applications and resources," Evolutionary Computation, 2001. Proceedings of the 2001 Congress on IEEE, vol. 1, **(2001)**.
[10] B. Kahin and H. R. Varian, "eds. Internet publishing and beyond: The economics of digital information and intellectual property", MIT Press, **(2000)**.
[11] H. Whitaker and J. Halas, "Timing for animation", Taylor & Francis, **(2009)**.
[12] P. Wells, "Understanding animation", Rout ledge, **(2013)**.
[13] G. Ying-ying, "Itch start of China's animation industry", Reporters' Notes, **(2004)**. (in Chinese)
[14] Z. Xu-xia. "Base and Power of Industry Amalgamation-Evidence from Cosplay Industry of Hangzhou", East China Economic Management, vol. 20, no. 1, **(2006)**. (in Chinese)
[15] Z.Shi-feng, X. Meng, G. Li, Y. Ying, Z. Xiao-Junm and G. Peng-cheng, "Causes and Implications of the Japanese animation industry", Zhejiang Today, no. 10, **(2005)**. (in Chinese)
[16] Z. He, "Several problems exist in our country and the animation industry solutions", Journal of Liaoning Teachers College (Social Sciences Edition), no. 3, **(2007)**. (in Chinese)
[17] J. H. Bourne, "Goodwill", The Accountant, vol. 9, **(1888),** pp. 604-606.

[18] B. V. Carsberg, "The contribution of PD Leake to the theory of Goodwill valuation", Journal of Accounting Research, **(1966),** pp. 1-15.
[19] E. S. Hendriksen and M. F. Van Breda, “Accounting theory”, RD Irwin, **(1982)**.
[20] R. H. Nelson, "The momentum theory of goodwill", Accounting Review, **(1953),** pp. 491-499.
[21] X. Lei, Z. Fengming, Z. Shu and S. Yunyun, “Application of Particle Swarm Optimization Based Wavelet Network in Flight Data Compression”, Electronics Optics & Control, vol. 17, no. 3, **(2010)**. (in Chinese)
[22] H. Zhenya, L. Wenhua and W. Chengjian, “An Adaptive Time Delay Wavelet Neural Network for Signal Approximation”, vol. 20, no. 5,**(1998)**, pp. 604-610. (in Chinese)
[23] Z. Lei, H. Li-gang, G. Da-ming, P. Xiao-hong and W. Wu-chen, “Fault Diagnosis of Analog Circuit Based on PSO-WNN”, Journal of Beijing University of Technology, vol. 36, no. 3, **(2010).** (in Chinese)
[24] X. Zhongyang, Y. Qingbo and Z. Yufang, “Improved PSO-BP neural network for power transformer fault diagnosis”, Computer Application, vol. 30, no. 3, **(2010).** (in Chinese)
[25] Y. Yi-yun and H. Guo, “Animation enterprises-ding, Optimization of turbine disk based on particle swarm optimization and neural network”, Journal of Aerospace Power, vol. 22, no. 9, **(2007).** (in Chinese)
[26] S. Biao, L. Yu-Xia, Y. Xin-Hua and Y. Wang, “Short-term load forecasting based on modified particle swarm optimizer and fuzzy neural network model”, Systems Engineering-Theory & Practice, vol. 30, no. 1, **(2010)**. (in Chinese)
[27] S. Wei and Z. Ying, “Application of Particle Swarm Optimization based BP neural networks to atmosphere environment assessment of thermal power plants”, East China Electric Power, vol. 36, no. 2, **(2008)**. (in Chinese)
[28] “Animation enterprises Yongguan, The modeling and application in stockk market forecast based on neural network with particle swarm optimization”, Thesis of Hefei University of Technology, **(2009)**. (in Chinese)
[29] M. Clerc and J. Kennedy, "The particle swarm-explosion, stability, and convergence in a multidimensional complex space", Evolutionary Computation, IEEE Transactions on, vol. 6.1, **(2002),** pp. 58-73.

Authors

Han Dong Ping, learned a Bachelor of Accounting Degree (1990) in Dongbei College of Finance & Economics, then a Master's degree in Thermal engineering in Harbin Institute of Technology (1994), and a Doctoral of Accounting Degree (2002) in Harbin Institute of Technology. I studied first at Hong Kong University of Science &Technology in1997, and then enrolled at Finland Lappeenranta Industrial Technology University in 1998. I was a teacher in College of Management, a gradute and doctoral tutor in Harbin Institue of Technology between 1987 and 2005. In 2005, i worked as a Deputy Division Chief in finance department and the dean of School of Economic and Management in Weihai at the Harbin Institute of Technology in 2012.

Bao Di, received my Master of Management in Public Administration (2010) from Yanshan University. Now i am majoring in Phd of Management in management Department from Harbin Institute of Technology University. My current research interests include different aspects of Valuating Goodwill of Cultural enterprises Using Wavelet Neural Network

