Artificial-Neural-Network-Based Consumer Behavior Prediction: A Survey

Chun-Cheng Peng, Yuan-Zhi Wang*, Chun-Wel Huang

[1]Department of Information and Communication Engineering, Chaoyang University of Technology
168, Jifeng E. Rd., Wufeng District, Taichung, 413310 Taiwan, R.O.C.
*+8869-030-076617, s10830619@gm.cyut.edu.tw

Abstract

With the rapid development of the Internet, consumers can understand the differences between products and advertising effects. In recent years, artificial intelligence (AI) is currently a hot topic in various fields, so many papers use artificial neural networks (ANN) in consumer behavior prediction (CBP). This paper will compare the differences between AI and statistical systems. It's believe that in the near future, this survey will be useful for systems using AI for CBP.

Keywords: Artificial Neural Networks, Consumer Behavior Prediction, Marketing, Credit Card Spending

Introduction

In the past, when the Internet was still underdeveloped, consumers usually had to go to large shopping malls to buy almost everything they needed. Maybe they still had to shop around before deciding what to buy. But now, consumer behavior (CB) has changed a lot. With the rapid development of the Internet, consumers can distinguish the difference between real products and advertising effects. If the marketing philosophy remains the same, even with the blessing of advertising, there will be no good sales results.

In recent years, artificial intelligence (AI) has become a hot topic in various fields, and people are increasingly interested in artificial neural networks (ANN), especially in recognition, prediction, and big data analysis. Intelligent systems have been widely used in computer science and many other applications and have a relatively competitive advantage compared to traditional statistical models. The four main theories of artificial intelligence are artificial neural networks, fuzzy inference systems, expert systems and evolutionary computing. Among them, artificial neural networks can learn human behavior through training, and CBP mainly analyzes consumers' purchasing behavior and through consumer behavior changes such as purchasing habits, consumption propensity, consumption preferences, etc., to study what products and quantity consumers buy , Where to buy, when to buy, etc., will make consumers have the idea of buying, so the industry can buy more of these products, not only can increase monthly sales, but also can reduce consumer purchases Impossible commodities to reduce the cost of loss.

Based on the literature analysis of 1,675 related papers, it is found that more and more AI applications are used to predict consumer behavior, such as shopping browsing data, credit card consumption and corresponding subsequent data analysis. Therefore, this article aims to propose an overall survey of CB prediction in ANN.

It's believe that in the near future, this investigation will be beneficial to the realization of a new intelligent CB prediction system with higher accuracy and stronger learning ability.

Artificial Intelligence

AI [16] is a field of computer science dedicated to solving common cognitive problems related to human intelligence, such as learning, problem solving, pattern recognition, and decision making.

In recent years, due to the improvement of statistical operation efficiency, AI has moved forward in many fields. AI refers to the wisdom displayed by human-made machines. Wisdom is the ability of humans to understand and learn things, but also the ability to think and understand problems rather than instinctive or automatic processing of problems. Hence, for thinking, one old but great question is, whether it is human or other things must have a brain, so that one who can have the ability to learn and understand things, to solve problems and make judgments.

In short, AI is a system or machine that can imitate human intelligence to perform tasks. It can also continuously learn and adjust itself through the collected data. Compared with other specific format or function machines, AI is more focused on the super .The process and ability of thinking and data analysis, AI appears not to replace humans, but to help and extend our ability.

Artificial Neural Networks

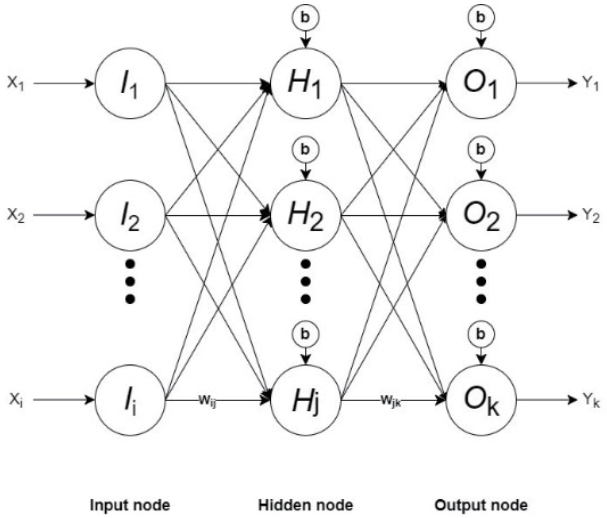

Fig. 1 ANN network architecture

A. Neural Network

There are three types of processing units in the network: input units, output units, and hidden units. As shown in Fig. 1, the input unit accepts the signals and data of the external world; the hidden unit refers to the hidden layer that implies her expected output value, and the neuron type of which cannot be

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analyzed through the input and output behavior of the network. the formula of ANNs is as follows.

$$O(\mathrm{a}) = step\left[\sum_{i=1}^{j} I_i(a)W_i(a) - \theta\right], \quad (1)$$

where j is the number of input node nodes, step is the excitation function, a is the number of epoch, and O(a) is the result of this network.

There is no obvious way to understand the expected output value of the hidden layer, but by continuously increasing the number of training neurons, he can collect more data to make the expected output value better. Generally, commercial ANN will have three to four layers, where each layer contains neurons ranging from 10 to 1000, which is more complicated in the experiment. The hidden layer may be five to six layers, and the number of neurons in each layer is more. One million, the requirements for computing resources are relatively more important, otherwise it will consume a lot of time in order to run a more complete simulation. The output layer refers to the output unit to achieve the output of the system processing results. The connection weight between neurons reflects the connection strength between units, and the representation and processing of information is reflected in the connection relationship of network processing units. Neural-like network is a kind of non-programmed, adaptable, brain-style information processing. Its essence is to obtain a parallel and decentralized information processing function through the cunning and dynamic behavior of the network, and to imitate people at different levels and levels Information processing function of the brain nervous system. It is an interdisciplinary field in design neuroscience, thinking science, artificial intelligence, computer science and other fields. ANN is a parallel decentralized system. It uses a completely different mechanism from traditional artificial intelligence and information processing technology. It overcomes the defects of traditional artificial intelligence based on logical symbols in processing intuitive and unstructured information. And the characteristics of instant learning.

B. ANN

ANN is a network similar to neurons in the human brain.

There are five major elements of ANN: algorithm, learning category, network architecture, training mode and optimization.

(1) Algorithm refers to the completion of specific things within a limited time, the main categories are LM (Levenberg-Marquardt), SCG (Scaled Conjugate Gradient), CGB, GDX, etc.

(2) Learning categories are divided into supervised learning and unsupervised learning. Supervised learning is a learning method in which a computer analyzes patterns from labeled information and makes predictions. The data of the training samples is added to the network input, and the corresponding expected output and network output are also provided. Compared,The marked data is like a standard answer. The computer learns through comparison errors while correcting to achieve more accurate predictions. This method gives supervised learning the advantage of high accuracy. Unsupervised learning is to directly give the network to the environment without giving standard samples in advance, and the learning phase and the working phase become one.

(3) The network architecture is divided into static and dynamic. The difference between the two lies in whether the weights in the network architecture are updated.

(4) In the artificial intelligence world, the training modes are divided into Offline network and Online network. In the Offline network, the existing data is used to make learning materials, so that the entire system has a certain knowledge background, just like the human brain, first learn the knowledge in the textbook and achieve an inconsistent way in the exam to predict Next answer, find the best solution. In the online network, use the currently known knowledge and continue to use the real-time data that has been generated, so that the learning curve can continue to learn, and constantly adjust the entire system to achieve future predictions in addition to the previous data and continuously obtain new data It will also enable continuous learning, which will further improve the future scalability of the entire system and continuously improve accuracy.

(5) Optimization is divided into two types: line search and confidence interval. The main difference is whether there is a direction, and whether it is a fixed direction for optimization search.

ANN compared with statistical system

TABLE 1
PAPER COMPARISON

Author	ANN method	Accuracy(%)
[1]	ANN-LM	94.7
	DW	92.5
	PNN	94.6
	PNN-LOG	94.5
	LPWI	45.7
	LPWA	94.6
	MF	94.3
	MAX-PNN	94.5
	CNN	92.9
	DT	94.2
	NB	82.0
	ANN-BP	89.8
[2]	ANN-BP	83.5
	OLS	82.9
[3]	ANN-BP	83.0
[4]	ANN-BP	90.1
[5]	ANN-BP	44.5
[6]	ANN-BP	94.0
[7]	ANN-BP	89.5
	LR	67.7
	CART	82.6
[8]	ANN	84.4
	LR	83.6
[9]	ANN	51.1
[10]	ANN-BP	
[11]	PCA/logit	86.3
	ELSA/logit	85.6
	ELSA/ANN	85.0
[12]	ANN-LM	91.5
[13]	ANN-BP	89.0
[14]	ANN-BP	71.0

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[15]	ANN-BP	87.0

Among the keywords mentioned in the article, we collected fifteen related articles for applications that use artificial neural networks to process CBP. Although they are all related applications, most of them only use BP algorithm. Application, the article did not share their detailed parameter settings for the B algorithm.

Table 1 shows the results of the paper that uses ANN to deal with consumer behavior. In the study of [1], he used a variety of different methods to compare with the ANN method, which includes two ANN algorithms, namely BP and LM Method, their accuracy is better than other methods, but unfortunately there is no parameter setting for these two algorithms, but they prove the advantages of ANN through these two algorithms.

Although some of the methods in the table that use ANN to process CBP have an accuracy rate of only 44.5% [5], some accuracy rates are as high as 94.7% [1], where [5] has low accuracy. This may be because most of them use a static network architecture for training, but did not find a more suitable model, or the training model itself is not suitable for CBP applications, or it may be because the data is too complicated.

Although some of them have proposed their own statistical systems or others' methods to obtain better results, this is not to say that the neural network has poor knowledge of these data and data, but that it shows the training parameters, weights and transfers The parameters in the function and algorithm will directly affect the accuracy of the classifier, but most of the results of using neural networks to process CBP are more accurate than other systems. Most of the neural networks in these papers use BP algorithm, mainly because of his fast learning speed, solid theoretical foundation, strict derivation process, clear physical concepts, strong versatility and other advantages, but its accuracy is not high, probably because of training The rate is too low, resulting in a decline in learning rate. The slower convergence speed is directly related to the accuracy of the image. In addition, the BP algorithm will only remember new samples that have learned too much training time during the learning process. Will forget the old samples and eventually lead to bad results.

In order to solve those applications that use statistical systems to process CBP, the neural network is trained by using multiple hidden layers or multiple hidden layer nodes to change the relationship between the weights of each neuron and reduce errors during the learning process. Function and repeat training to get higher accuracy.

Conclusions and Future Works

In many papers, Using artificial neural networks to classify most consumer behaviors can achieve higher accuracy, such as ANN-LM: 94.73%, PNN: 94.63%, ANN-BP: 90.16%, etc.

Back propagation is used in many papers, mainly because of its fast speed, solid theoretical basis, rigorous derivation process, clear physical concepts, strong versatility, etc., but his accuracy is not high, probably because of back propagation It is not necessarily that the accuracy will be improved because of the large number of trainings, but the learning rate will decline due to too many training times, and the convergence speed will be slow. In addition, when he learns new samples during the training process, he will forget the trend of the old samples, which will eventually lead to results not tall.

The final result proves that in most applications that classify consumer behavior, artificial neural networks can have better accuracy.

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