Artificial Neural Networks and the Mass Appraisal of Real Estate

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Abstract—With the rapid development of computer, artificial intelligence and big data technology, artificial neural networks have become one of the most powerful machine learning algorithms. In the practice, most of the applications of artificial neural networks use back propagation neural network and its variation. Besides the back propagation neural network, various neural networks have been developing in order to improve the performance of standard models. Though neural networks are well known method in the research of real estate, there is enormous space for future research in order to enhance their function. Some scholars combine genetic algorithm, geospatial information, support vector machine model, particle swarm optimization with artificial neural networks to appraise the real estate, which is helpful for the existing appraisal technology. The mass appraisal of real estate in this paper includes the real estate valuation in the transaction and the tax base valuation in the real estate holding. In this study we focus on the theoretical development of artificial neural networks and mass appraisal of real estate, artificial neural networks model evolution and algorithm improvement, artificial neural networks practice and application, and review the existing literature about artificial neural networks and mass appraisal of real estate. Finally, we provide some suggestions for the mass appraisal of China's real estate.

Keywords—artificial neural networks, back propagation neural network, machine learning algorithms, mass appraisal of real estate, tax base valuation

1 Introduction

China appraisal industry was started in the late 1980s, after nearly three decades of development, appraisal industry has grown rapidly. In 2016, the People's Republic of China Appraisal Law was formally promulgated, setting the legal status of the appraisal industry for the first time. By the end of 2016, there were more than 3,300 appraisal firms and over 34,000 appraisers in the country with more than 100,000 employees. The income from appraisal industry reached 12 billion Yuan(RMB) .

Artificial neural networks is a very popular algorithm in machine learning field in the 1980s, but declined in the mid-1990s. Nowadays, with the "deep learning" trend, artificial neural networks become one of the most powerful machine learning algorithms. Artificial neural networks in the economic, engineering, biology, medicine and other fields show good intelligence features. More and more papers about artificial neural networks are published in influential journals as stated in [1].

At present, there is a big gap between our appraisal of the level of industrialization information construction and development needs. The research on artificial neural networks will help us to solve the challenges faced by the appraisal technology. This article defines the concept of mass appraisal of real estate and then reviews the evaluation from artificial neural network and real estate tax base valuation theory, artificial neural networks model evolution and algorithm improvement, artificial neural networks practice and application, in the end provide some useful suggestions for the mass appraisal of China's real estate.

2   The definition of related concepts

2.1   The mass appraisal of real estate

Based on the traditional real estate appraisal theory and model, the mass appraisal of real estate is to introduce mathematical statistics, computer technology and geographic information technology to establish mathematical model, which is a systematic appraisal of a group of real estate and obtains its market value. Real estate tax base valuation is mainly on the tax price of real estate appraisal and estimation. The mass appraisal of real estate in this paper includes the valuation of the real estate transaction and the tax base valuation of the real estate holding. The price warning of the artificial neural networks in the real estate market is beyond the scope of this article.

2.2   Artificial neural networks and back propagation neural network

Artificial neural networks is an information processing system designed to mimic the structure of human brain and its functions. It can be regarded as a powerful and widely used machine learning algorithm. In the practical application of artificial neural networks, most of the neural network models use back propagation neural network and its variation. back propagation neural network emerged in 1986 and is a multi-layer feed-forward neural network trained by error back propagation algorithm. The outstanding advantage of back propagation neural network is that it has strong nonlinear mapping ability and flexible network structure.

3 A review of foreign research work and achievements

3.1 Artificial neural networks and mass appraisal theory

Taxpayers feel that they have been treated fairly and that the automated valuation model (AVM) meets the criteria of efficiency, fairness and public acceptance as stated in [2]. Some Scholars began to study the application of computer in local property tax collection and management as stated in [3]. These studies provide the foundation for the establishment of the appraisal system and the role that artificial neural networks play in mass appraisal.

With the rise of neural network research, some scholars introduce artificial neural networks into property tax valuation as stated in [4], [5], [6] , [7]. Their research reported that compared with the hedonic price model, We can get more effective market analysis data, and the valuation accuracy is higher. Compared multivariate regression analysis with computer-based appraisal method, and using real estate data from Lithuanian countries to verify it as stated in [8]. Provide a real estate valuation method that combines a geographic system (GIS) with a BP neural network as stated in [9]. Analyzed the application of multiple regression analysis (MAR), simultaneous autoregressive model (SAR), geographic weighted regression (GWR) and artificial neural networks (ANNs) in mass appraisal of real estate as stated in [10]. Some scholars designed and operated a new real estate valuation system based in Québec, Canada, as stated in [11]. Reviewed the guidelines and model methods for automatic valuation model (AVM) as stated in [12].

3.2 Artificial neural networks model evolution and algorithm improvement

With the advancement of computer technology and the increasing application in the real estate market, the literature on the improvement of model algorithms has also been enriched in comparison with various models. Empirically compared artificial neural networks with Logistic regression models as stated in [13]. Reviewed the application of artificial neural networks in business (1992-1998), take the valuation and finance as one category, and BP neural network is the most widely used algorithm as stated in [14]. Compared self-organizing neural networks, hedonic price models and multivariate regression analysis, reported that neural networks should be useful complements, not complete replacements as stated in [15]. Some scholar introduced the application of interval valued neural networks, reported that the interval between model error and network weights is more robust as stated in [16]. Used an algorithm that integrates genetic neural networks and fuzzy systems for real estate valuation as stated in [17]. Applied a non-parametric artificial neural network to the real estate market as stated in [18]. Used a modified regression and genetic algorithm model to predict real estate valuations and validated it with real estate data from South Korea as stated in [19]. Compared the three artificial neural network models based on different algorithms, and concluded that the prediction accuracy of the adaptive neural network is the highest as stated in [20]. Aimed at BP neural network can lead to poor generalization and slow convergence. The author has developed a variety of sparse

response BP algorithm, effectively improve the generalization performance as stated in [21]. Some scholar introduced a new model developed by the Real Estate Valuation Center at the Polytechnic of Milan and validated the model over artificial neural networks using real estate data from Italy as stated in [22]. Validated the research and application of machine learning by comparing the predictive accuracy of different machine algorithms in real estate values as stated in [23].

3.3 The application of artificial neural networks and the experience of Chinese cities

The rapid development of China's real estate market also provides good data for scholars to study the application of artificial neural networks. Used real estate data from Hong Kong and Nanjing, verified that Support Vector Machines(SVM) is better than artificial neural networks and multivariate regression analysis as stated in [24]. Applied Particle Swarm Optimization(PSO) based SVM model to real estate price forecasting and validated the data from Chongqing, The results show that the proposed method can be used to solve the finite sample learning, nonlinear regression and better overcome " Dimension disaster " as stated in [25]. Some scholar built the spatial weight matrix by using fuzzy mathematics method, improved the spatial error model and validated the mass appraisal of Shenzhen commercial real estate as stated in [26]. Used artificial neural networks based on Support Vector Machines (SVM) to forecast residential prices in Taipei City. The empirical results verify the high accuracy of SVM's prediction ability as stated in [27].

4 A review of domestic research work and achievements

4.1 Domestic real estate tax base valuation theory

In 1999, some scholar began to study the tax base valuation for the first time in China as stated in [28]. Although the mathematical model of tax base valuation can improve the work efficiency, before establishing a mathematical model, it is necessary to analyze the properties and market environment of the real estate appraisal, the appraisal methods and appraisal procedures as stated in [29]. Some scholars Studied the concept and application of mass appraisal, further reported that Application Research of AVM in Mass Appraisal Systems of Foreign Countries as stated in [30], [31]. Since 2003, drawing lessons from international practice, studying and promoting the property tax reform has gradually become a hot and difficult academic problem as stated in [32], [33]. In addition, Public Finance Research, Taxation research, International Taxation In China etc have been published some articles on tax reform and mass appraisal , Due to the length of the article, will not expand the discussion.

4.2 Domestic mass appraisal of practical applications

In 2003, Shenzhen began to try the mass appraisal of real estate practice. in 2005, Beijing established the AVM technology based on cost method. In 2009, Dandong, Hangzhou and Nanjing as the pilot cities to establish their own mass appraisal housing transaction tax pricing appraisal system, Dandong based on direct comparison method, Nanjing adopt indirect method, Hangzhou choose hedonic price model. In 2011, Chongqing and Shanghai governments impose property taxes on individual non-operating properties respectively.

4.3 Domestic artificial neural networks application and model evolution

In 1988, artificial neural networks first introduced into the field of real estate valuation in china as stated in [34]. Applied BP neural network into urban house rental valuation system as stated in [35]. Later, some scholars continued to combine various models with artificial neural networks to continuously improve and optimize the calculation algorithm: Proposed to improve the BP neural network recognition system using Euclidean distance as stated in 0. Used the Rough Set Theory to eliminate redundant information between real estate price factors and combines them with the BP Neural Network Model as stated in [36]. Constructed an integrated commercial real estate valuation model based on improved Particle Swarm Optimization (PSO)and neural network algorithm as stated in [37]. Used genetic algorithms in combination with neural networks for real estate valuation as stated in [38]. Used the data of Wuhan City to conduct real estate tax base valuation and verification through the improved Particle Swarm Optimization(PSO) algorithm as stated in [39]. Constructed a Spatial BP Neural Network Model and Outperformed Common BP Neural Networks and Spatial Lag Models (SLM)by Data Verification as stated in [40].

5 Conclusions and future prospects

The literature review of this paper mainly includes three aspects: The first is the theoretical research, which combines the artificial neural networks with the real estate tax base valuation theory. The second is the evolution of the artificial neural networks models and the improvement of the computer algorithms. It includes traditional fuzzy mathematics, multiple regression analysis, expert scoring method, and improved research on spatial geographic information model, BP artificial neural network, genetic algorithm, support vector machine and particle swarm optimization. The third is to expand the application of research, artificial neural networks began to be applied to residential real estate, commercial real estate, school district room etc, and through the data from different cities to verify it.

At present, real estate taxes are mainly taxed in the holding part in the world, Automatic valuation model and mass appraisal technology are the keys to the mass appraisal of real estate. With the constant development of China's real estate market and the continuous reform of fiscal and taxation system, as one of the important support-

ing measures for the reform of real estate tax, tax base valuation plays an important role in standardizing real estate tax behavior and enhancing tax credibility.

In the future, how to utilize the advantages of several artificial neural network models, to improve the accuracy and robustness of the appraisal, and to let the public know more information about the appraisal process become the focus of the mass appraisal of real estate .Continue to summarize the useful experience of international mass appraisal of real estate , combined with the valuation of China's pilot cities practice, to absorb the latest research results of artificial neural network to promote the theory and practice of the mass appraisal of real estate forward.

6　　References

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