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Land Price Prediction using Artificial Intelligence

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Abstract - *The prediction of land prices and conditions has always been a very complex process. It is one of the most competitive in terms of pricing and same tends to vary significantly based on numerous factors and also it is a challenging task because of highly non-linear nature of the market flow. Forecasting the land price is an important module in decision making for both the buyers and investors in supporting budget allocation. This necessitates the use of Artificial Intelligence (AI) prediction models that can be used to map any non-linear function without prior assumptions to predict the nature of land values. Even if there are a number of artificial intelligent systems, Artificial Neural Networks (ANN) and Expert Systems (ES) are the ones presently applied for land valuation. Thus, this paper will examine the current trends of ANN and ES and considers suitable applications in land valuation. Comparison of various techniques shows that Artificial Neural Network (ANN) and fuzzy logic are better suited if attributes and model parameters are appropriately selected. This study highlights the use of artificial neural networks and other possible methods of predicting the land prices. By this research, it is possible to help the decision-makers to expect the land price of interested area.*

Key Words: *Prediction, Forecasting, Artificial Intelligence (AI), Artificial Neural Network (ANN), Expert systems (ES), fuzzy logic.*

1. INTRODUCTION

Land price prediction is the place where investors can legally gamble on the values of land to gain some kind of benefit or sometimes can lose to the plummeting wave of the highly volatile market. It gives investors the chance to make more money if they know how to play smart in this game of land price prediction. Market evidences shows that the analysis of land data over time has always faced difficulties to predict the land prices based on certain parameters. An accurate prediction of land price is important to prospective owners, developers, investors, appraisers, tax assessors and other land market stakeholders. [2] The various changing factors that affect the land price have to be studied to prepare a prediction model. To cater this need, soft computing techniques with higher data handling capabilities may be an optimum choice. These techniques have facilitated the study of complicated relationship between land price and the affecting factors.

Over the last two decades [7] there has been a proliferation of empirical studies analyzing land values. The use of computer for land valuation began in the early 1980s, coinciding with the development of information systems technology. Subsequently, different statistical techniques were incorporated to process market data, among which the method of MRA proved especially relevant. Nowadays, besides Multiple Regression Analysis (MRA) models the use of AI systems for land valuation becomes better alternative.

The objective of prediction research has been largely beyond the capability of traditional AI research which has mainly focused on developing intelligent systems that are supposed to emulate human intelligence. Artificial intelligence can process both structured and unstructured data with exponentially more speed and accuracy than any human could. Artificial Neural Networks (ANN) are one of the most widely used technique for land price prediction. By using the back-propagation algorithm, it is possible to train the network by error correction and adjusting the weights based on these corrections. Neural Networks has the ability for arbitrary non-linear function approximation and information processing which other methods do not have. Artificial Neural Networks are well applied to the problems in which reproducing the relationships among data is really difficult provided that on the other hand there exists a large enough training data set. Using AI systems for land price prediction is more recent and becoming practical. Since then there have been numerous experiences, and the creation of new models is on the increase. Even if there are a number of AI systems, ANN and ES are presently applied for land valuation.

2. LITERATURE SURVEY

The field of artificial intelligence has developed very rapidly as computing power has increased. Artificial intelligence refers to the ability to perform the intelligent functions of the human brain. Various artificial intelligence techniques include ANN, fuzzy logic, neuro- fuzzy, genetic algorithm, expert system etc. When the objective is to construct a model

directly from a set of measurements of the system's behavior, data-derived AI models are preferred which give qualitative outputs [3]. Application of various techniques in value forecasting and their respective results are discussed in the study.

2.1 *Use of ANN*

Tay D. and Ho D. [4] used the back-propagation ANN model in reckoning sale prices of apartments and compared it with the traditional MRA model for residential apartment properties in Singapore. The study revealed an absolute error of 3.9% for ANN model and 7.5% for the MRA model. Evans A., et al [6] tested neural networks for accuracy in valuation for estimating residential property prices in England and Wales. The study investigated the effects on the average prediction error when outliers in the data set were removed and obtained an average absolute error ranging from 5% to 7% for neural network models. Nguyen N., et al [7] compared the predictive performance of these techniques for single family residential property and found neural network's performance to be better. Xin J. Ge and Runeson G., [8] employed back propagation neural networks to produce four different housing price models by varying the contributing variables and compared their performance for Hong Kong. Varying results for these models showed the effect of relevancy of the variables on the predictability of the model.

2.2 Use *of Fuzzy logic*

Gonzalez M., et al [10] compared fuzzy logic and MRA models and revealed that fuzzy logic can handle the vagueness or imprecision present in the real estate market and give better estimates than conventional methods. The study by Guan J., et al [11] explored the use of fuzzy inference systems, ANFIS, to assess real estate property values and the use of neural networks in creating and fine-tuning the fuzzy rules used in the fuzzy inference system. It showed that ANFIS can yield results that are comparable to those obtained using the traditional regression approach and hence can be considered as a viable approach in real estate value assessment, worthy of further exploration. Krzystanek M., et al [12] implemented evolving fuzzy models giving high correlation between actual and predicted prices of properties.

2.3 *Use of expert system*

Rossini P. [2] examined the use of expert systems and neural network to real estate forecasting. Analyzing applicability of expert system to real estate forecast suggested it as an ideal method for dealing with qualitative forecasting and can be typically used for new products and in situations where there is no long-term series that might assist in giving a forecast. There are numerous other areas within real estate practice where expert systems can be usefully employed. Wilson I.D. et al [3] showed an approach to attribute selection and dependence modelling using Gamma Test by means of genetic algorithm application to the problem of house price forecasting.

2.4 *Use of other techniques*

Fan G., et al [14] tested decision tree approach to assist the prediction process by finding the determinants of house price. Zurada J., et al [15] presented a comparative study where several regression and AI-based methods were applied to the assessment of real estate properties in Louisville, Kentucky, U.S.A. Four regression-based methods namely traditional MRA, and three non-traditional regression-based methods such as support vector machines using sequential minimal optimization regression, additive regression, and M5P trees; and three AI-based methods such as neural network, radial basis function neural network, and memory-based reasoning have been applied and compared under various simulation scenarios. The results obtained using a very large data sample, indicate that non-traditional regression-based methods perform better in all simulation scenarios, especially with homogeneous data sets whereas AI-based methods perform well with less homogeneous data sets under some simulation scenarios. More recently, hedonic pricing model (not an AI technique) has also been used to identify the real estate price.

3. TECHNIQUES USED

3.1 *Hidden Markov Model:*

An HMM is a statistical Markov model in which the system being modelled is assumed to be a Markov process with unobserved (hidden) states. An HMM can be presented as the simplest dynamic Bayesian network.

3.2 *Natural Language Processing:*

NLP is a field of computer science, artificial intelligence, and computational linguistics concerned with the interactions between computers and human (natural) languages. As such, NLP is related to the area of human computer interaction.

3.3 *Support Vector Machine:*

A Support Vector Machine (SVM) is a discriminative classifier formally defined by a separating hyperplane. In other words, given labelled training data (supervised learning), the algorithm outputs an optimal hyperplane which categorizes new examples.

3.4 *Artificial Neural Networks (ANN):*

Artificial Neural Networks is a complex network. It is a system widely interconnected by a large number of simple processing units which is analogous to a neuron. It is an artificial construction of network which is capable of

achieving some kind of function based on humans understanding of their brain's neural networks. It is designed to do a lot of complex logic operations such as finding out patterns in nonlinear relationship by the help of numerous interconnected processing units.

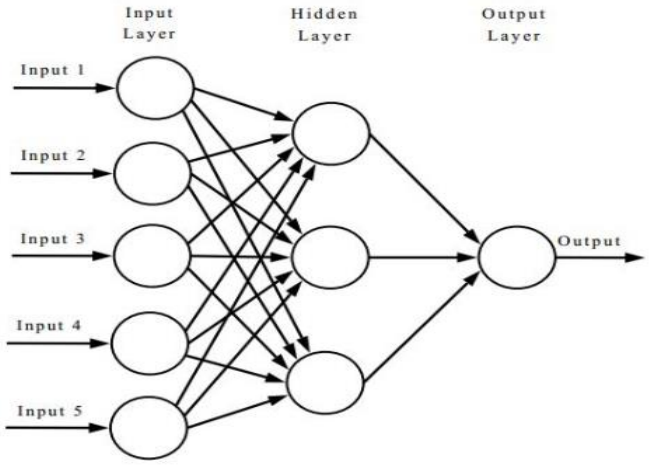

Fig -1: **Artificial Neural Network**

3.5 Back *Propagation Algorithm:*

Back Propagation Neural Network, which can alternatively be called Multilayer Feed-forward Neural Network, is composed of one input layer, one or more hidden layer and one output layer. It can be used to simulate nonlinear mapping model, solve some real-world problems, such as classification, valuation, prediction, and so on. Three-layer Feed-forward Neural Network is a single hidden layer network generally used in the complex problem solving. The backpropagation algorithm falls [8] into the general category of gradient descent algorithms, which intend to find the minima/maxima of a function by iteratively moving in the direction of the negative of the slope of the function to be minimized/maximized. The main goal is to minimize the error function.

4. IMPLEMENTATION AND SYSTEM DESIGN

ANNs are often used for a statistical analysis and data modelling, in which their role is perceived as an alternative to standard nonlinear regression or cluster analysis techniques. Thus, they are typically used in problems that may be couched in terms of classification or forecasting. Since land valuation is forecasting process ANNs can be used for land valuation. It features an input layer with the same number of neurons, likewise the second hidden layer (although this can vary between half and double the number of variables), and an output layer containing a single neuron [15]. Feedforward ANNs are most commonly trained using a back-propagation algorithm for training and have been widely used for several civil engineering applications.

Indeed feedforward /back-propagation network models are the most common form of ANN models used for land valuation. ANN algorithms typically begin with randomly determined or equal default weights for each of the nodes in each of the hidden layer(s). In each model-training,[5] each attribute is entered into the model, the network sums and transforms the values of the input variables into the predicted output value(s). The model then compares [13] the ANN's estimated price to the actual price. If a discrepancy exists, then the software works backwards to adjust the hidden layer weights to minimize the prediction error. While training, ANN models repeat these steps as the data for each new land values are added, always adjusting the hidden layer weights to minimize the total prediction error. ANN stops training when it reaches a present internal error threshold, either the software's default error level or the researcher's pre-designated error threshold. Such a threshold is needed because without one, an ANN would effectively memorize, or "over-train" on the training data.

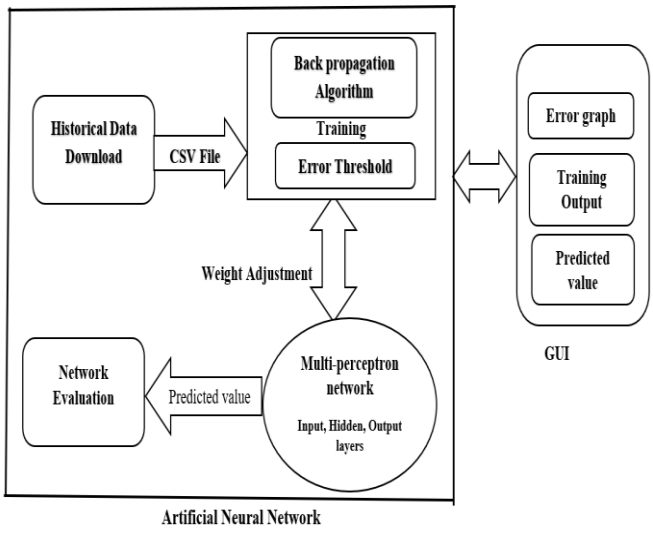

Fig -2: Architectural Diagram

5. CONCLUSION

Land valuation is no longer a traditional business that relies only on expert opinions of value. The profession is now facing greater transformation in the valuation process and methodology, along with innovations in information technology. Technology is having profound effect on the profession, as well as influence on the land valuation process, largely pressured by the needs of today's clients who demand quick, easy and more objective process to arrive at the opinion of value. The needs somehow motivate dependency on intelligent valuation system that allows clients to get faster and accurate value. With the help of ANN with Back-Propagation algorithm it has been made possible to approximately predict the present land values based upon their past values and variations. And this is going to be a

stepping stone in future prediction technologies. Thus, we can see that Neural Networks are an effective tool for land price prediction and can be used on real world datasets.

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