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A Neural Network based model for real estate price estimation considering environmental quality of property location

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Abstract

In this paper, a model based on Artificial Neural Network (ANN) has been applied to real estate appraisal. Moreover, an evaluation of ANN performances in estimating the sale price of residential properties has been carried out. Artificial Neural Networks (ANNs) are useful in modelling input-output relationships learning directly from observed data. This capability can be very useful in complex systems like the real estate ones where motivations, tastes and budget availability often do not follow rational behaviours. This study also analyses the impact of such key environmental conditions that represent a problem related to many industrial cities where pollution and landscaping consequences affect the real estate market and residential location choices. We have considered a set of asking price's houses collected in the urban area of Taranto (Italy) where the biggest European steel factory and the 2nd industrial harbour are located.

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1. Introduction

Recent theories on urban economy have highlighted how investments in transport system can improve accessibility to certain locations and affect property values. Moreover, city users are placing greater attention on the quality of the living environment. In polluted cities the environment quality has become an important attribute,

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affecting residential and location choices and, consequently, land-use, mobility and economy of interested areas. This issue is important in industrial cities where people daily face the risk of diseases due to bad environmental conditions related to high pollution levels. In order to reduce this risk, people move to healthier residential areas which could be less accessible in terms of transportation system and/or urban services.

Hedonic studies related to real estate prices subject to transport conditions have completed urban economy theories and tested their hypotheses through different case studies (Ibeas et al., 2012, Chiarazzo et al., 2014).

The main aim of this work is to define a property appraisal model based on Artificial Neural Networks to estimate real estate prices. Moreover, some features affecting the real estate value have been determined paying particular attention to environmental factors such as pollution and noise levels, landscape, etc.

The proposed model could also help analysts in simulating interactions generated in an urban system where location choices for housing or companies strongly depend on the real estate market.

The main input parameters of the proposed model are transportation systems and environmental quality related attributes. In addition, input parameters widely used in the literature such as buildings characteristics and local land-use attributes have been also considered.

The paper is organized as follows. In section 2, the state of the art of the models developed to estimate the impacts on real estate is presented. In section 3, the proposed Artificial Neural Network (ANN) model is defined using a dataset from the urban area of Taranto (Italy). This study explores the impact of such key transport attributes and environmental elements including effects of a big steel factory and an industrial harbour which produce pollution and landscaping problems.

In section 4, the results are discussed. In the last section, some conclusions are carried out highlighting the opportunity introduced by ANN to capitalize environmental issues into housing market prices.

2. Literature review

Artificial Neural Networks (ANNs) are able to learn, to generalize results and to respond adequately to highly incomplete or previously unknown data (Shaw, 1992). ANN methodology was developed to capture functional forms, allowing the uncovering of hidden non-linear relationships between the variables. This method has been developed in the past years, especially using information of the study area showing outstanding performances. It represents a sub-field of computer science concerned with the use of computers in tasks that are normally considered to require knowledge and cognitive abilities (Gevarter, 1985). It has been applied to the property price forecasting in recent years (Lai Pi-ying, 2011).

Borst (1991) has defined a great number of variables in his network to appraise real estate in New York State, demonstrating that ANNs are able to predict the real estate price with 90% accuracy.

ANNs perform better than multi-variate analysis, since networks are nonlinear. They can also evaluate subjective information, such as the transport system and the characteristics of the zone, which are difficult to incorporate into traditional mathematical approaches.

Traditional multiple regression models have focused on the relationship between real estate prices and accessibility until a systematic review of various research works was carried out by Fujita (1989). Research about how transport system can influence real estate prices was initiated by von Thünen (1826) who laid the foundations of a theory about the distribution of land use and rents in urban areas as proposed by Alonso (1964), Muth (1969) and Mills (1972).

Many hedonic studies have specified the role of quality of environment considering the real estate price (Din et al. 2001), accessibility and other local land-use attributes (Ibeas et al., 2012; Chiarazzo et al., 2014).

The results highlight a significant influence of variables such as the distance in kilometres to reach the industrial centre or the value of environmental polluters on the variability of the relationship between accessibility to bus stop and real estate prices. The properties located close to the industrial area also showed significant and negative changes in value (Chiarazzo et al., 2014).

Other studies have focused on the impact resulted by Bus Rapid Transit systems on real estate prices (Rodríguez and Mojica, 2009). These studies showed the impact on property values resulted by introducing a Bus Rapid Transit (BRT) system in a city and found an increase in price.

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