Application of artificial neural networks for real estate valuation

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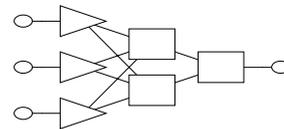
Artificial neural networks

- one of methods which might be an alternative for the commonly applied method of multiple regression

- application:
  - in the process of determination of real estate values,
  - at the stage of selection of those real estate features, which highly influence their prices.

Artificial neural networks

- highly sophisticated modelling technique, which allows project functions of a very high level of complexity
- name originates from a network of brain nervous cells
- consist of many processing points (neurons), arranged in layers and of many mutual connections (synapses) between those points

Types of artificial neural networks

- Multi - Layer Perceptrons (MLP)
- Networks of Radial Basic Functions (RBF)
- General Regression Neural Networks (GRNN)
- Linear Networks

Artificial neural networks

- simulate operations of neural networks
- not programmable, rather „trainable" on particular examples
- examples:
  - features of real estates,
  - selling prices,
  - the level of rent.

Artificial neural networks

- the parallel structure of data processing
- teaching the network is performed by means of input data processing (examples)
- differences between the result of network operation (the real estate value) and the expected result (the real estate price) are as minimum as possible

Testing utilisation of artificial neural networks in real estate valuation

Tests concerning utilisation of ANN in real estate valuation have been performed on the examples of:

- the market of non built-up areas, planned for one-family houses,
- the market of apartments,
- the market located in the city of Otwock near Warsaw.

Testing the ANN networks
Non built-up areas planned for one-family houses

- variant I - several dozens of transactions
- variant II – more than 100 transactions

Non built-up areas planned for one-family houses – variant I

- date on 59 transactions concerning non built-up areas planned for one-family houses built-up real estates, located in the central Otwock
- selection of features, which may influence land prices on the local real estate market
- construction of ANN models

Non built-up areas planned for one-family houses – variant I
selection of features

- features
  - parcel size
  - technical infrastructure
  - access to public transport
  - neighbourhood
  - management conditions
- methods
  - the genetic algorithm
  - the stepping reverse
  - the stepping forward method

Non built-up areas planned for one-family houses – variant I
selection of features

Results obtained for various methods of feature selection

Genetic algorithm	Stepping reverse	Stepping forward
0.0494 00001	0.0478 11111	0.0511 10000
0.0493 00011		0.0502 10100
0.0492 00100		0.0498 10101
0.0490 00101		0.0495 10111
0.0489 00111		0.0494 11111
0.0488 01111		
0.0485 10001		
0.0484 10011		
0.0484 10100		
0.0481 10101		
0.0480 10111		
0.0479 11111		

Non built-up areas planned for one-family houses – variant I
Construction of ANN models

- all transactions were divided into:
  - the teaching set – 40 cases,
  - the valuating set – 19 cases.

- those sets had similar statistical characteristics:
  - the average value - 21,68 €/m2 and 21,30 €/m2,
  - the standard deviation value – 5,38 €/m2 and 5,31 €/m2.

Non built-up areas planned for one-family houses – variant I
Construction of ANN models

- types of networks
  - the multi-layer perceptron (MLP) with one hidden layer,
  - the network of radial basic functions (RBF),
  - the linear network.
- networks were selected for each set of feature out of many designed MLP and RBF networks:
  - the best networks,
  - the network with 2 hidden neurons.

Non built-up areas planned for one-family houses – variant I
Construction of ANN models

Characteristics of ANN

Type	Hidden neurons	Error of teaching [€/m²]	Valuation error [€/m²]
MLP	21	2.25	2.74
MLP	2	3.42	3.47
RBF	4	4.03	3.75
RBF	2	4.35	4.80
Linear	-	3,51	-

Non built-up areas planned for one-family houses – variant I
comparison methods

Model	The average devation [€/m²]
MLP with 2 hidden neurons	3,44
Multiple regression	3,57

Conclusions

1. Artificial neural networks may be applied for real estate valuation. They may be applied both, in the process of determination of real estate values, as well as for selection of real estate features which highly influence the real estate prices.
2. Artificial neural networks are an alternative solution for the multiple regression method used for real estate valuation.

Conclusions

3. The accuracy of determination of real estate values using the ANN method is higher than the accuracy obtained with the use of the multiple regression method for real estate markets of high number of transactions – above 100 transactions. In such a case utilisation of the ANN is highly recommended.
4. On the other hand, for the markets of medium number of transactions – several dozens of transactions – utilisation of the ANN for real estate valuation results in the slightly higher accuracy of estimation of real estate values. Those methods may be interchangeably applied.

Conclusions

5. Out of the analysed ANN models, the highest accuracy of determination of real estate values may be reached with the use of a multi-layer perceptron (MLP).

Conclusions

6. The ANN may be also applied in the process of selection of those real estate features which highly influence their prices. This, among others, is enabled by the genetic algorithm, which allows to look through the high number of combinations (a set of features in the discussed case), in order to find the best solution.

Thank you for your attention