FIG WORKING WEEK 2008

APPLICATION OF A MULTI-LAYER PERCEPTRON FOR MASS VALUATION OF REAL ESTATES

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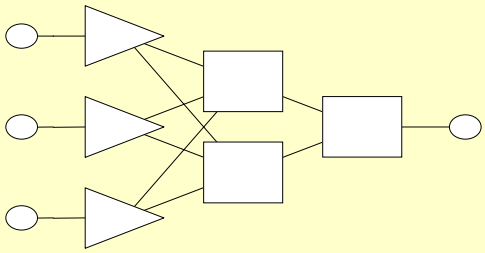
Artificial neural networks

- the highly sophisticated modelling technique, which allows project functions of a very high level of complexity

Architecture of the multi-layer perceptron



Teaching the multi-layer perceptron

- software routines which simulate activities of neural networks
- not ”programmed”, rather „taught” (trained) using various examples
- examples:
  - features of real estates,
  - selling prices,
  - the level of rent.

Teaching the multi-layer perceptron

- processing of input data (examples)
- successive passes of series of data through the multi-layer perceptron result in adjustment of weights of particular connections and threshold values of the neurone, in such a way, that differences between the results of work of the network (the real estate value) and the expected result (the real estate price) are minimised

The multi-layer perceptron design

- the number of hidden layers
- the number of neurones in particular layers

Training of the multi-layer perceptron

- the stage of teaching
- the stage of testing
- the stage of analysis of results

Teaching the multi-layer perceptron teaching algorithms

- the back propagation of errors algorithm (BP)
- the conjugate gradient descent algorithm(CG)
- the quasi-Newton algorithm (QN)
- the Levenberg-Marquardt algorithm (LM)

Investigations

- Accuracy of determination of real estate values using the multi-layer perceptron taught by means of four mentioned above teaching algorithms

Investigations

- data of 114 transactions of land, non-built-up parcels, planned for one-family houses, located in Otwock
- choice of features which in the essential way influence the price level of land on the local real estate market
- construction of ANN models

Choice of features

- features
  - location
  - neighbourhood
  - technical infrastructure
  - access to public transport
  - parcel size
  - state of developing
- methods
  - the genetic algorithm
  - the backward step method

Construction of ANN models

- All transactions were divided into:
  - the teaching subset – 71 cases,
  - the validation subset – 29 cases,
  - the testing subset – 14 cases.

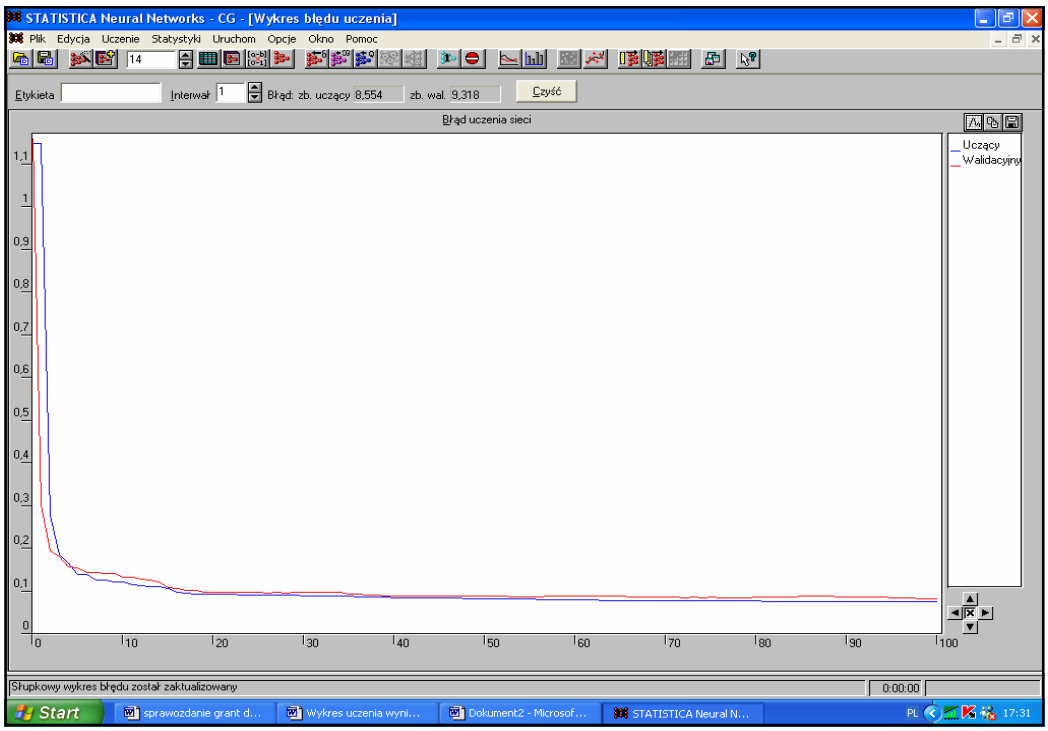
- Those subsets have similar statistical characteristics:
  - the mean value – 60,00 zł/m2 and 60,44 zł/m2, 59,77 zł/m2,
  - the standard deviation values – 31,27 zł/m2 and 33,31 zł/m2, 30,35 zł/m2

Construction of ANN models

- Architecture of a multi-layer perceptron
  - 3 , 4, 5 hidden neurones
- Teaching algorithms
  - back propagation of errors
  - conjugate gradient descent
  - quasi-Newton
  - Levenberg-Marquardt

The total of **1200** multi-layer perceptrons were created.

Number of hidden neurones	Error in teaching subset zł/m^2	Error in validation subset zł/m^2	Error in testing subset zł/m^2	Teaching algorithm, number of teaching epoch
3	9,696718	10,49435	11,76747	BP 97
4	9,643689	10,59871	11,31541	BP 99
5	9,584256	**10,36612**	11,35798	**BP** 92
3	8,553579	9,317702	9,744248	CG 99
4	8,896472	9,180777	11,35737	CG 96
5	8,047045	**9,097722**	10,67246	**CG** 99
3	8,577321	9,251484	10,44241	QN 92
4	8,996874	**9,058687**	10,02242	**QN** 86
5	8,054216	9,437988	10,88689	QN 80
3	7,973481	8,838693	11,05852	LM 95
4	7,460221	**8,534605**	10,97577	**LM** 94
5	7,550017	8,587820	9,388863	LM 28



Conclusions

- Out of investigated teaching algorithms, the Levenberg-Marquardt algorithm allows to construct the best multi-layer perceptron, i.e. the perceptron characterised by the smallest value of the error in the validation subset.

Conclusions

- The conjugate gradient (CG) and the quasi-Newton algorithms allow to achieve lower accuracy of determination of real estate values.
- The back propagation of errors algorithms (BP) turned to be characterised by the lowest efficiency, comparing to other investigated algorithms.

Conclusions

- Those conclusions concern the network of architecture of low complexity level, which consist of several input neurons, several hidden neurons and one output neuron, i.e. the networks constructed for the needs of determination of real estate values.

Conclusions

- Differences in the intensity of teaching the multi-layer perceptron by means of various teaching algorithms for the network of low architectural complexity using about 100 examples become unimportant.

Conclusions

- Increase of the number of hidden neurones in the multi-layer perceptron not always results in decrease of the value of the error of determination of a real estate value.
- In the case of teaching the neural network using the Levenberg-Marquardt (LM) and the quasi-Newton (QN) algorithm the error in the validation subset for the network with 5 hidden neurons was greater than the same error in the network with four neurons in the hidden layer.

Thank you for your attention