PRICE JUDGEMENT VIA ARTIFICIAL NEURAL NETWORK

1. Introduction

There are problems that are necessary to solve in decision making process such us the price judgement. The artificial neural network can help us with such problems where there are a lot of criteria and cases. More see [1-10]. One need not embrace such a quantity of information and make the right sense. Some criterion may be omitted or human fault can happen.

The most important task is to obtain the data which are the input of artificial neural network. The input data create the table where the horizontal axis X represents the criteria and vertical axis Y represents single cases.

	X_1	X_2	X_3	…..	…..	X_{M-1}	X_M
Y_1	$A_{1,1}$	$A_{1,2}$	$A_{1,3}$	…..	…..	$A_{1,M-1}$	$A_{1,M}$
Y_2	$A_{2,1}$	$A_{2,2}$	$A_{2,3}$	…..	…..	$A_{2,M-1}$	$A_{2,M}$
Y_3	$A_{3,1}$	$A_{3,2}$	$A_{3,3}$	…..	…..	$A_{3,M-1}$	$A_{3,M}$
…	…..	…..	……	…..	…..	……	……
Y_{N-1}	$A_{N-1,1}$	$A_{A-1,2}$	$A_{N-1,3}$	…..	…..	$A_{N-1,M-1}$	$A_{N-1,M}$
Y_N	$A_{N,1}$	$A_{N,2}$	$A_{N,3}$	…..	…..	$A_{N,M-1}$	$A_{N,M}$
Y_{N+1}	$A_{N+1,1}$	$A_{N+1,2}$	$A_{N+1,3}$	…..	…..	$A_{N+1,M-1}$	$A_{N+1,M}$=?

Input table of artificial neural network

The process, called as a learning of artificial neural network, is done with number of cases N and criteria M. The last column of table X_M stands the selling prices. The artificial neural network is possible to use for price judgement after the process of learning and testing. When we add case Y_{N+1} with criteria from X_1 to X_{M-1}, than the price X_M of case Y_{N+1}, (cell $A_{N+1,M}$) is the price which is estimated by means of neural network.

2. Price judgement of real property

We perform the process of learning of artificial neural network on the cases of realized prices of real properties at first. The input of artificial neural network is the table of values, which presents single parameters. The horizontal axis X represents the criteria: X_1 = selling price. X_2 = district, where the real property is situated, X_3 = type of real property, X_4 = the existence of a pool, X_5 = the number of rooms, X_6 = the number of children's rooms, X_7 = the level of equipment by furniture, X_8 = the number of floors, X_9 = built-up area, X_{10}= the level of indoor equipment of real property. The horizontal axis represents the single cases of sale of real properties, that is Y_1, Y_2, Y_3, …, Y_N, where N is the total number of cases.

The process of testing has been done after the process of learning, when the case N + 1 has been added with its criteria (the particular data of real property) $A_{N+1,1}$, …, $A_{N+1,M-1}$. The suggested price has been calculated by means of artificial neural network (the value of $A_{N+1,M}$ cell).

The process of learning of artificial neural network has been done with 32 cases in our real task. The process of testing has been done on the suggestion of selling price in 3rd case in order. The price 550 000 dollars has been suggested, which was less by 1 725 dollars than the real selling price. That is 0.31 % difference.

A part of the table including the testing case (the prices are in $\$*10^3$) is as follows:

Order	Price	District	Type	Pools	Rooms	Ch. rooms	Furniture	Floors	Area	Equip.
1	600	21	3	1	5	1	0	0	241.5	1
2	1650	12	11	0	4	1	1	0	1043	2
3	**?**	9	3	1	2	1	2	7	113	2
4	1900	10	11	0	5	1	0	2	929	2
5	960	10	8	0	4	1	1	2	446	2
6	1300	16	11	1	4	1	0	2	511	2
7	800	21	8	0	5	3	1	3	366	2
8	360	10	3	0	3	1	1	7	151	0
…..	…..	…..	…..	…..	…..	…..	…..	…..	…..	…..

Type:1 flat, 2 small villa, 3 house, 4 town house, 5 villa, 6 semi-detached house, 7 corner house, 8 half of the semi-detached house, 9 penthouse, 10 detached house, apartment house

The part of estimation of the price of real property

The other tests have similar results. It proves that it is possible to use the mentioned methodology for judgement of prices of real properties.

3. Price judgement of a car

We perform the process of learning of artificial neural network on the cases of realized prices of cars used as a testing ones. The input of artificial neural network is the table of values, which presents single parameters. The horizontal axis X represents the criteria: X_1 = type of a car (only three types of cars were sold), X_2 = the equipment of a car by accessories of four options, X_3 = type of motor (diesel or petrol engine with or without adjustment), X_4 = the type of paint (with or without surface adjustment), X_5 = the power of engine in kWh, X_6 = the year of manufacture of car, X_7 = the number of driven km, X_8 = selling price. The horizontal axis represents the single cases of sale of cars, that is Y_1, Y_2, Y_3, …, Y_N, where N is the total number of cases.

The process of testing has been done after the process of learning, when the case N + 1 has been added with its criteria (particular data of a searched car) $A_{N+1,1}$, …, $A_{N+1,M-1}$. The suggested price has been calculated by means of artificial neural network (the value of $A_{N+1,M}$ cell).

The process of learning of artificial neural network has been done with 38 cases in our real task. The process of testing has been done on the suggestion of selling price in 39th case in order. The price 267 390 Czech crown has been suggested, which was less by 687 Czech crowns than the real selling price. That is 0.26 % difference.

A part of the table including the testing case (the prices are in Czech crown) is as follows:

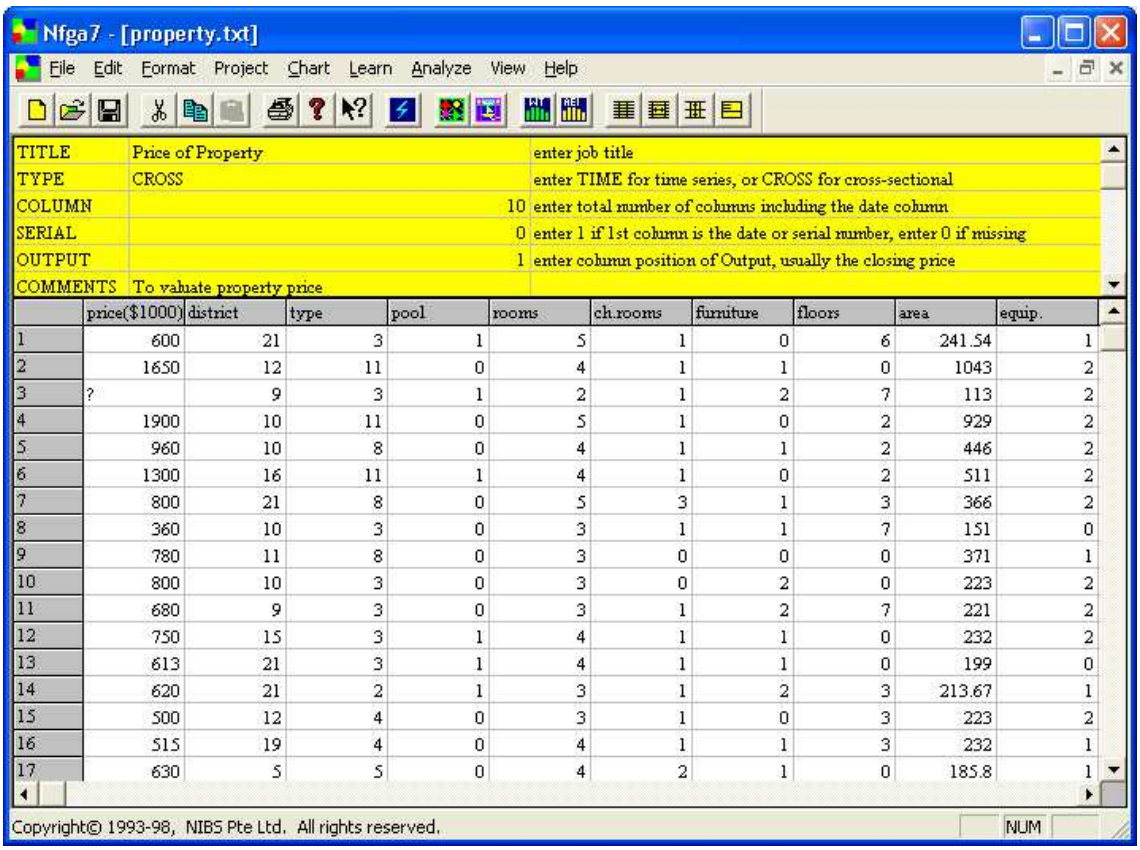
Order	Type	Equip.	Motor	Paint	Power	Year	Km	Price
1	2	2	2	2	55	99	17725	287630
2	2	3	1	1	50	99	9289	287160
3	2	2	2	1	55	99	1879	296520
8	2	2	4	1	47	99	13503	283240
9	1	1	1	1	40	99	4612	205290
10	2	3	1	2	50	99	7311	276500
…	…..	…..	……	…..	…..	……	……	…
38	3	4	4	2	66	99	14807	445760
39	2	2	2	2	55	99	12413	**?**

The part of estimation of the price of a car

The other tests have the similar results. It proves that the mentioned methodology for judgement of prices in real applications is possible to use.

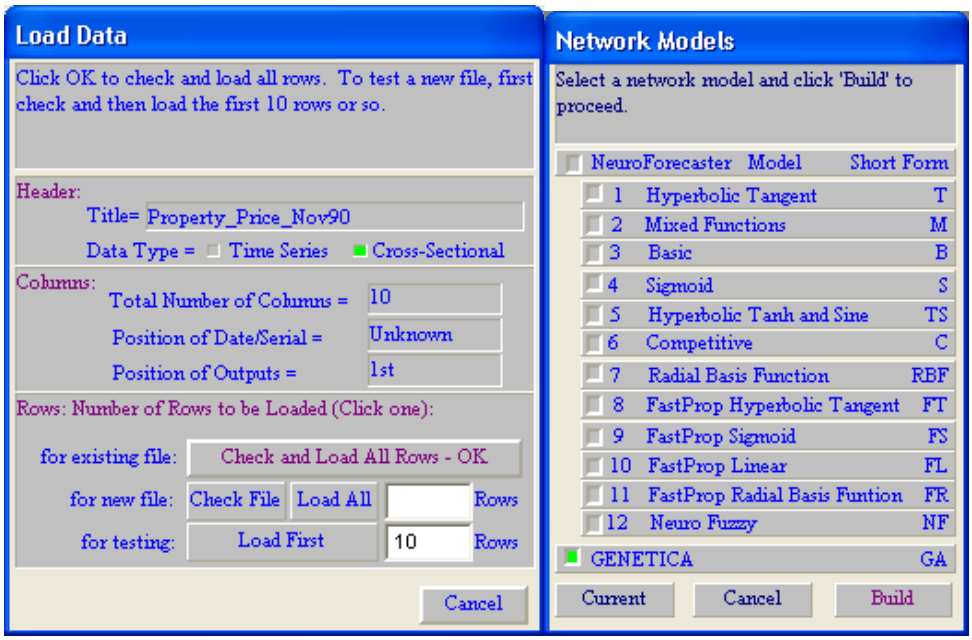
4. Process of calculation

The process of calculation is as follows: At first it is necessary to set up the input information for calculation and fill in the table.



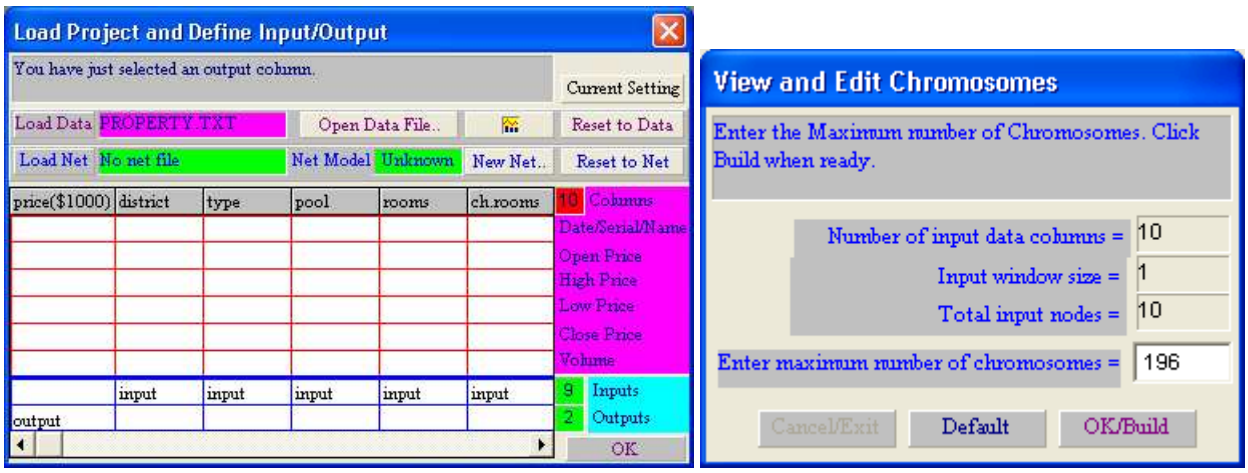
Part of input table

Then the data must be loaded and the model must be chosen. The process of tuning of artificial neural network was done and the best result gives the Genetica model.



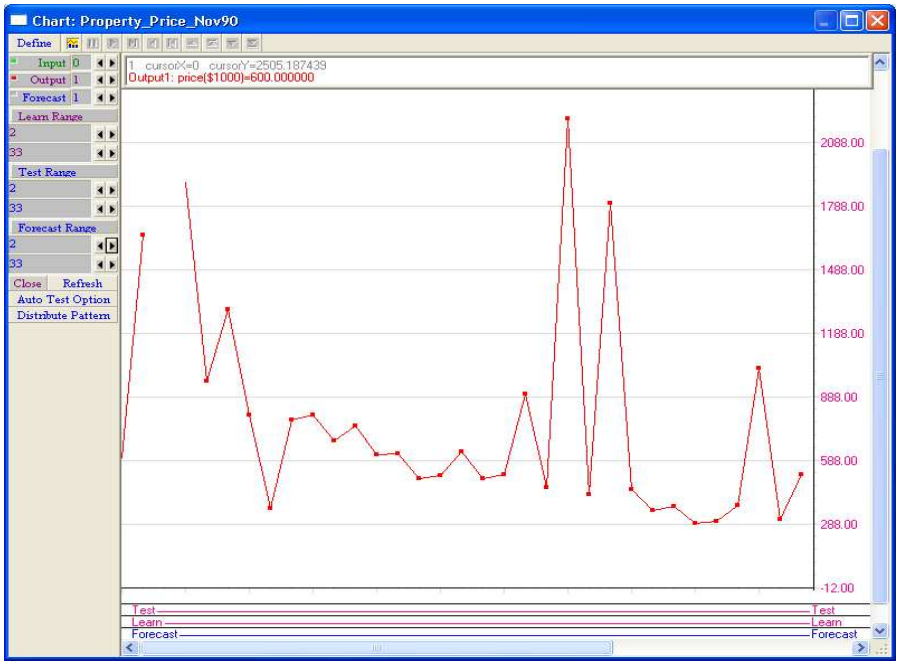
Load of data and choosing of network model

Further the process of set up of inputs and output together with the number of nodes and chromosomes must be done.



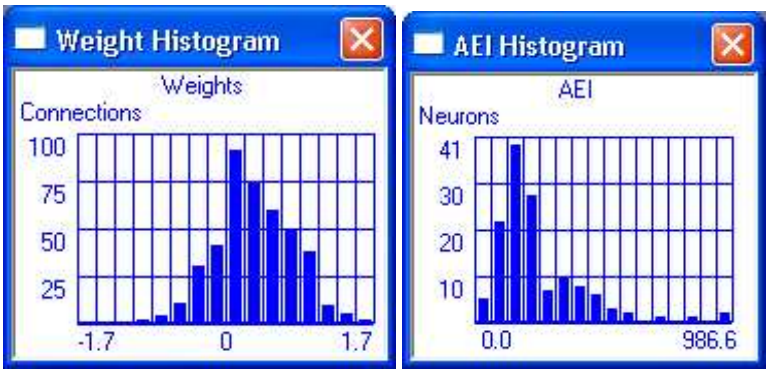
Set up of inputs and output, nodes and chromosomes

It is necessary to set up the ranges for learning and testing. The missing value (third from the left) represents the one which has been predicted.



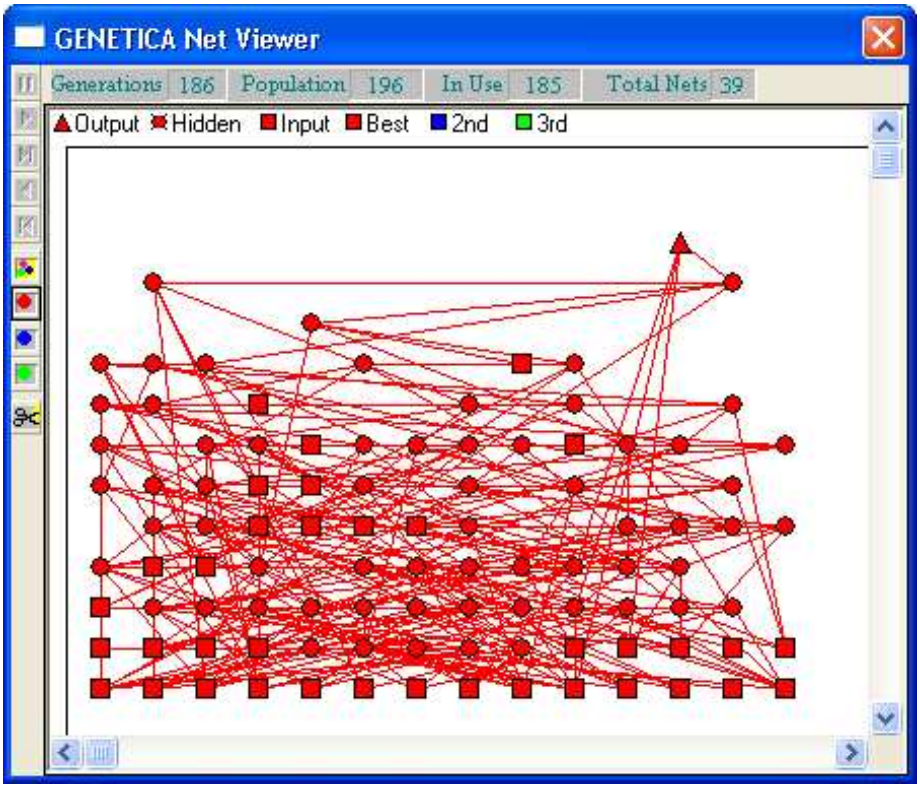
Set up of testing and learning ranges

The process of testing can be checked by watching of Weight histogram and AEI histogram, which show the state of process of calculation of artificial neural network.



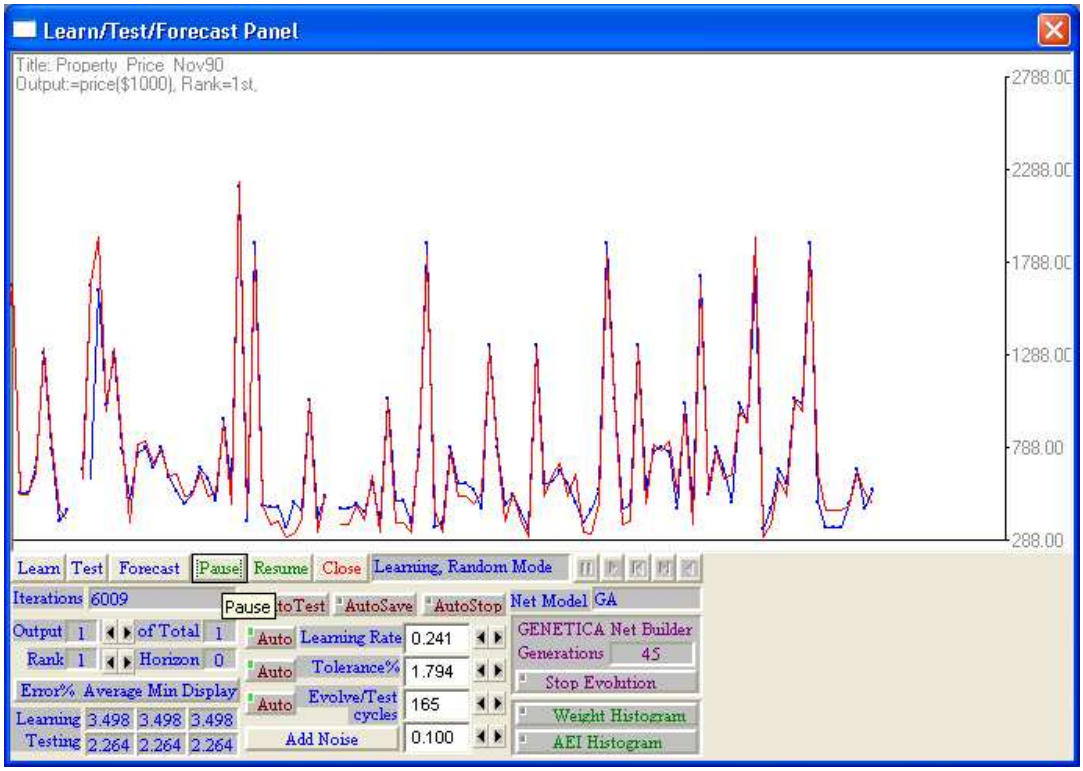
Weight and AEI histogram

The process of testing can be checked by Net viewer, which shows the topology of artificial neural network.



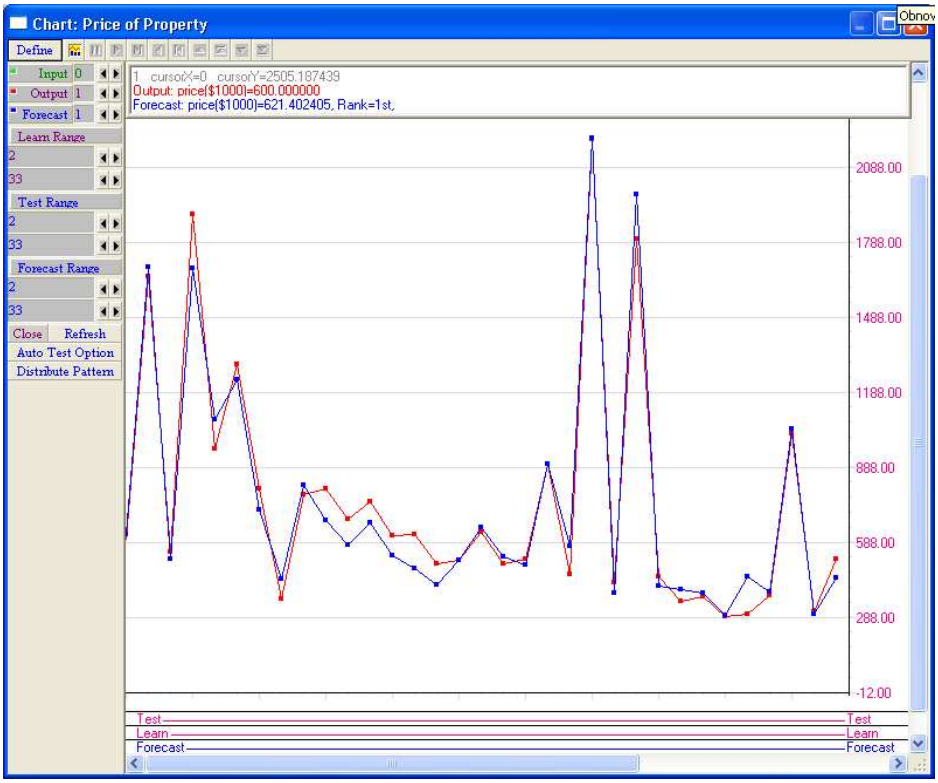
Typology of artificial neural network

All information about the process of testing, learning and forecasting is shown on the display.



Process of learning

It is possible to interrupt the process of calculation and make a comparison of predicted and actual values.



Actual and predicted values

The results can be displayed as a table, where the suggested value is presented.

NeuroForecaster/GA 7.2 - [property.txt]

File Edit Format Project Chart Learn Analyze View Help

TITLE	Price of Property		enter job title
TYPE	CROSS		enter TIME for time series, or CROSS for cross-sectional
COLUMN		4	enter total number of columns including the date column
SERIAL		1	enter 1 if 1st column is the date or serial number, enter 0 if missing
OUTPUT		2	enter column position of Output, usually the closing price
COMMENTS	Forecast generated at: 06/02/104 11:11:13		

	sequence	price($1000)	forecast1	error1	E	F	G	H	I	J	K
1	1	600	590.71	9.29							
2	2	1650	1652.65	-2.65							
3	3	empty	551.72	empty							
4	4	1900	1933.81	-33.81							
5	5	960	985.58	-25.58							
6	6	1300	1353.4	-53.4							
7	7	800	752.99	47.01							
8	8	360	339.21	20.79							
9	9	780	773.85	6.15							
10	10	800	743.42	56.58							
11	11	680	6589.97	20.03							
12	12	750	768.38	-18.38							
13	13	613	597.69	15.31							
14	14	620	609.91	10.09							
15	15	500	485.08	14.92							
16	16	515	478.3	36.7							
17	17	630	579.91	50.09							

NUM

Part of table of actual and predicted values

5. Conclusion

The tuning of artificial neural network of both tasks has been done on the commercially sold software NeuroForecaster of NIBS Ltd. firm. The genetic algorithm was used for pruning of artificial neural network structure. The important condition for the correct process of estimation of prices via artificial neural network is the use of correct data during the process of learning.

The use of artificial neural network seems to be perspective as a mean of estimation of prices. The two mentioned tasks and their tests are the proof of a possible use of methodology in practice. Especially the fact, that one need not embrace such an amount of cases with many criteria makes an evidence of the use of such methodology in practices.