A NEURAL NETWORKS APPLICATION IN DECISION SUPPORT SYSTEM

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Abstract: *This work presents the using of the chosen neural networks for the data classification. The Statistic Neural Networks has been used for the rating. The neural networks have been successfully applied for building one decision support systems for solving managerial problem.*

Keywords*: artificial intelligence, neural networks, classification, decision support*

ACM Classification Keywords*: I. Computing Methodologies, I.2 Artificial Intelligence*

Introduction

The problems of object recognizing and classification are currently the most important, of which the modern science is interested in at present.

Classification is the most frequently solved problems both in technology and economy. Generally one can define that the classification algorithm lies in finding the data mapping into the set of predefined classes:

$$f_c : R^p \supset X \to C, \tag{1}$$

where $C = \{C_1, C_2, ..., C_n\}$ is the finite set of classes, whereas the set $X \subset R^p$ is the attribute space, and the decision about the classification result is based on them. Classification mapping f_c devides space X into n decisive areas, grouping the attribute formulas belonging to one category [Zieliński, 2000]. Input data is the set of examples, observations, samples which are the value list of the descriptive features constituting the model (classifier). On the basis of the data content the model has been built, which is then used to classify new objects. Building a new classifier is the main aim of the classification of data. The classification process consists of few stages: building a model, testing unknown values . Whereas, the classification means assigning an object on the basis of the chosen distinctive features, to one of the model classes. Classification is mentioned when the classes to which we would like to divide the input set, will be defined before the division process. [Hand, Mannila, Smith, 2005], [Adamczak, 2001].

Statistical methods are traditionally used to solve the classification problems [Witkowska, 2002], [StatSoft, 2005]. Moreover there are also used the following methods: Bayes classifiers, decision trees, neural networks, genetic algorithms, rough sets, fuzzy logic and neuro-fuzzy classifiers [Stąpor, 2005], [Rutkowska, Piliński, Rutkowski, 1997].

The aim of this thesis is investigating the possibilities of applying the artificial neural networks in the object classification and evaluation and comparative analysis of these results. As an analysis result there is the choice of the net done, the net with the best classification results with solving the sample problem of the market research analysis.

Methodology and results of the experimental research

There were the following neural networks used in these object classification research, they are different in structure and teaching method:

- Multilayer Perceptron (MLP) ,
- Radial Basis Function (RBF).

These experimental researches have been done on the practical example of the market research analysis of household appliances. The task of this classification is choosing the most prospective market for the produced goods in a chosen factory. We will use the information about hoovers for description of the classified observations, which should be divided into four classes, that is markets. Initial parameters characterizing the particular goods (hoovers) are presented in table 1.

The first column of table 1 includes the verbal description of the feature, a type is presented in the second column. The third column includes the shortened name responding to the parameter, under which it is in the programme package - Statistic Neural Networks (STNN), which will be used to solve the made tasks [Setlak, 2004].

Table1. Characteristic parameters of the products (hoovers)

Description	Type	Shortened name
Engine Power/capacity	number	ENGINE_W
price	number	PRICE
Presence of the air filtration system	{Yes, No}	FILTR_SYS
Presence of automation	{Yes,No}	AUTOFUNC
Automatic cord rolling	{Yes, No}	AUTOCORD
Power regulation and speed switch	{Yes, No}	SPD_CTRL
Noise reducing system	{Yes, No}	NOISSYS
Device moistness function	{Yes, No}	WASH
Aesthetic of the external appearance	{Yes, No}	VIEW
Additional possibilities and improvements (merits)	{Yes, No}	FEATURE
Well known producer	{Yes, No}	BRAND
Service level	{low, average, high}	SERVICE

The shortening CLASS corresponds to initial classification parameters – one of the four classes of the presented market in the STNN package [9]. The market description with the division into classes is presented in the following way:

- Class 1 – market where the highest quality goods are of the most interest, of huge power with additional features and a very good service,
- Class 2 is the average class of purchasers, who are less interested in expensive products, but they still demand good products,
- Class 3 – purchasers paying attention to low price, but not interested in improvements,
- Class 4 – market where the low price is the priority, but other parameters are less important.

All data for this classification were taken from the market analysis of one of the production factories. These data were prepared in advance. This processing phase in the STNN program is called „pre-processing". In this problem the learning set describes 116 models of Hoovers with different parameters.

In order to search for the best architecture and optima teaching method the Intelligent Problem Solver (IPS) has been used in this thesis in the advanced version, included in the STNN package [Statistic Neural Networks,

1999]. IPS is exceptionally useful device that is helpful for the user in the most difficult, laborious and intensive phase of neuron network construction –testing and choosing different models.

IPS formulates and initially evaluates the architecture of neural networks with different initial variable sets. It allows to asses which parameter is the most important one. In classification problems, one can also control the way of classification for particular values. With the IPS use in the analysis of the initial parameters importance, there have been the optima neuron net structures described and only the most important parameters have been used in the research then. In complex problems with the numerous amounts of initial parameters in STNN, one can use the following device to choose the net structure – The Genetic algorithm of the initial variables selection.

IPS for the classification task, creates and tests many nets which are compared and then, with the chosen option from many examples, chooses and keeps some that are different due to the quality, construction and number of hidden layers and conducts the additional tests.

After the research done the following results were presented in table 2 on this initial data set (object „Hoover") and solving the classification problem with the use of different net types MLP and RBF

Table 2. Classification results obtained after using the IPS for the object „hoover"

Net type	Error	Number of the initial parameters	Number of the hidden layers	The most important parameter	Working time in net [s]	Chosen market
MLP	0,099	10	12	10	2	1
MLP	0,111	9	12	1	4	1
MLP	0,175	9	11	1	6	1
MLP	0,126	8	9	10	8	2
MLP	0,088	10	13	1	10	1
MLP	0,102	9	14	9	15	2
MLP	0,185	11	10	1	20	1
MLP	0,211	8	9	1	25	2
MLP	0,266	9	8	2	30	4
MLP	0,299	12	6	1	35	2
RBF	0,098	9	7	3	2	1
RBF	0,095	9	8	1	4	1
RBF	0,127	10	6	3	6	3
RBF	0,131	11	5	3	10	1
RBF	0,175	9	2	3	15	2
RBF	0,155	9	3	3	20	3
RBF	0,191	12	3	1	25	2
RBF	0,130	10	7	1	50	2
RBF	0,093	9	8	3	55	2
RBF	0,116	10	6	3	60	2

Source: own study

Some of these relations achieved during the analysis are presented in the following graphs. Some of the points in the graphs are the average values responding to the error value for the same number of initial parameters or hidden layers.

Conclusions

The research done resulted in working out two types of neuron net s of different architecture, taught with different methods that were used for classification the object „hoover".

The analysis of net work is directed to the division of numerous hoovers model s into four markets. The precision of assignment to the particular classes have been evaluated.

During the classification 116 types of hoovers, more difficult was RBF to teach than MLP, which influenced the final result. The proper variable choice played a very important role in the classification process, and it influenced the classification result. The best result (marked in table 3) was received with the use of MLP net with ten inputs and thirteen hidden layers. The optimal working time of the networks was then 10 seconds.

The most rejected parameter was 5 and 8. These were the least important parameters then. For these parameters the correlation ratio had lower than 1 value. The most chosen parameters for this analysis were 1 and 10. They were chosen for each analysis. They were also the most important parameters of the best value quotient ratio. For RBF networks, the best result was for 9 inputs and 8 hidden layers. Parameter 1 was also the most important and the most chosen parameter too.

Analyzing all results for the particular networks it appears that MLP networks gave worse results in short time of networks working and the working time of the networks was longer of over 15 seconds. The best result was for the working time of 10 seconds. The result was dependent on the initial parameters amount and the number of hidden layers. The best results were for 9-11 parameters at the initial point. The more hidden layers, the best the result was.

RBF networks were behaving similarly, if we take initial parameters and hidden layers into consideration. The more hidden layers, the best the result was.

Depending on which parameter was the most important, the networks were doing the classification for the particular classes (markets). In case of the results with low error, the choice of the market was the accurate one in case of the both networks. If the most important parameter was a huge power and additional improvements, the most chosen class would have been the class 1 and 2. If the important role in the classification was played by the parameter 2, that is the choice price, the market 3 or 4 was chosen.

Comparing two best results for the particular networks, one can state that in such a case, the better classifier was MLP networks.

Summing up, we can state that neural networks, due to their possibilities can be successfully used in solving the classification problems. It is easy to change their architecture, which results in bigger versatility. Looking at the results, one can state that the neural networks are very good classifiers, even if they are not 100% compliant with the model.

The reason that some of the data were incorrectly classified can be the fact that the classes overlap. To gain better results, one should search for additional solutions, among others test networks of different architecture, and as for the teaching, to use bigger teaching set. It can have better results that the one achieved in this study.

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