Neural Networks and the Shares

Creating predictions is one of the possibilities to make a better decision. This possibility is also used in the financial branch to create prediction of shares, commodities, currencies-rates, etc. The best method used for prediction of the time series, nowadays is the neural network (further NN). The NN enables us to describe non-linear processes created by the most complicated psychological and social phenomena.

The possibility of filtration before the prediction by means of NN was tested to create more precise prediction. The auto-correlation function

$$r_p = \frac{c_p}{c_0}, \quad \text{where} \quad c_p = \frac{1}{N}\sum_{t=1}^{N-p}(z_t - m)*(z_{t+p} - m)$$

$$m = \frac{1}{N}\sum_{t=1}^{N} z_t, \quad \sigma^2 = \frac{1}{N}\sum_{t=1}^{N}(z_t - m)^2$$

is used to find the most important periodicity. Besides, the transformation in the form of

$$w_t = \left\{ \begin{array}{ll} z_t + z_{t-P} & \text{when} \quad P = \min(r_p) \\ z_t - z_{t-P} & \text{when} \quad P = \max(r_p) \end{array} \right\} \quad \text{for} \quad t = P+1, P+2, \ldots, N$$

is made with the periodicity that correspond to maximum or minimum value of auto-correlation function . The value $r_0 = \sigma^2$ is not taken into account. The calculation of prediction is made with the transformed values by NN. Then the backward transformation in the form of

$$z_t^+ = \left\{ \begin{array}{ll} w_t^+ - w_{t-P} & \text{when} \quad P = \min(r_p) \\ w_t^+ - w_{t-P} & \text{when} \quad P = \max(r_p) \end{array} \right\} \quad \text{for} \quad t = N+1, N+2, \ldots, N+L$$

is made for the predicted values for L steps forward.

Fig.1 and Fig.2. present two tested titles USON (American Oncology Res.) and PCMS (P-Com, Inc.) with the prediction of five days ahead. The tables present predicted values and the actual closing prices on the stock market. The lower part of the table is to present the inaccuracy of prediction (prediction - reality/ last real value). The average of values of prediction inaccuracy in five days is shown in line Error.

	No Filter		Yes Filter	
USON	30.VI.99	12.0000	30.VI.99	12.0000
N+1	11.7778	12.3750	11.8006	12.3750
N+2	11.7928	12.7500	11.6799	12.7500
N+3	11.6248	12.6875	12.8145	12.6875
N+4	11.6314	11.8125	12.0110	11.8125
N+5	11.6312	12.4375	11.5632	12.4375
Error	0.0601		0.0474	
N+1	-0.0498		-0.0479	
N+2	-0.0798		-0.0892	
N+3	-0.0886		0.0106	

N+4	-0.0151		0.0165	
N+5	-0.0672		-0.0729	

Fig. 1. Values of title USON

	No Filter		Yes Filter	
PCMS	30.VI.99	5.2344	30.VI.99	5.2344
N+1	5.7508	5.1250	5.8900	5.1250
N+2	5.1305	5.3750	5.1683	5.3750
N+3	5.2095	5.6875	4.2106	5.6875
N+4	5.4304	5.4844	3.8078	5.4844
N+5	4.9048	5.3750	3.4422	5.3750
Error	0.0715		0.2315	
N+1	0.1195		0.1462	
N+2	-0.0467		-0.0395	
N+3	-0.0913		-0.2821	
N+4	-0.0103		-0.3203	
N+5	-0.0898		-0.3693	

Fig. 2. Values of title PCMS

The filtration made prediction precise to 4.7 % (instead of 6.0 %) for USON and worse to 23.2 % (instead of 7.2%) for PCMS. Fig. 3,4,5,6 present the course of share prices of tested values and the auto-correlation functions of these curves. The values correspond to the condition P =min(r_p) are r_{69}=-0.45064 for USON and r_{92}=-0.26335 for PCMS.

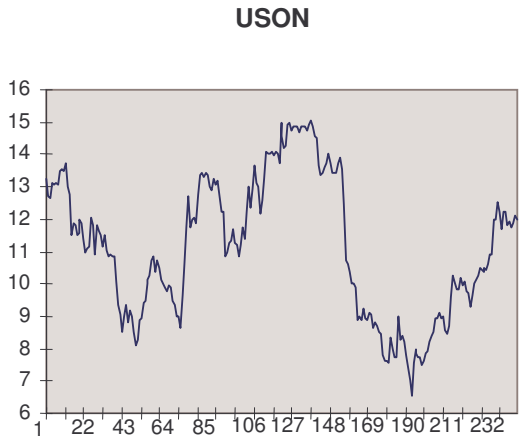

Fig. 3. Graph of function USON

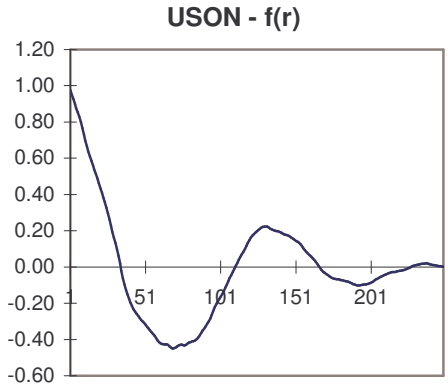

Fig. 4. Graph of function f(r) of USON

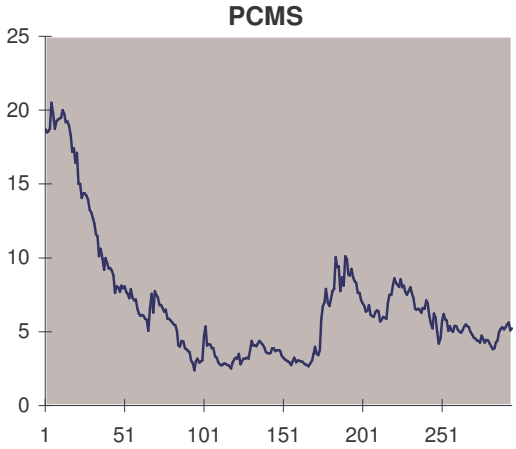

Fig. 5. Graph of function PCMS

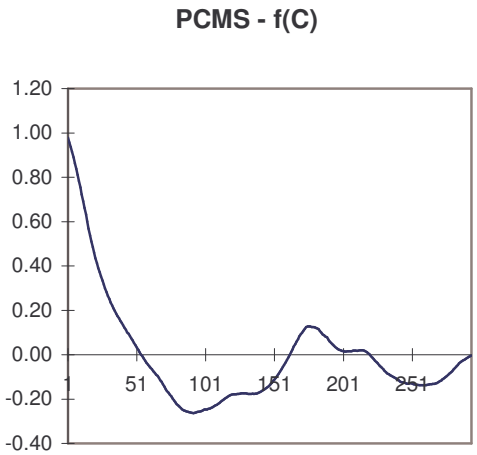

Fig. 6. Graph of function f(r) of PCMS

Analyzing more samples than mentioned here implies that filtration makes prediction more precise in cases when periodicity of time series is evident and significant (high absolute value of auto-correlation function). In other cases there can be seen a worse prediction.

The time series of share prices can be created by the sequence of values with different intervals of sampling. There were tested time series with low, medium and high frequencies, it means the intradaily, daily, weekly, monthly period of sampling. Two titles of American stock market USON (American Oncology Res.) and DDIM (Data Dimension, Inc.) are mentioned here. The same model and input parameters were used for calculation by NN, except the period of sampling.

Fig.7 and Fig.8. present the predicted values five days ahead of tested titles USON and DDIM and their actual closing prices on the stock market for period of sampling intradaily, daily, weekly and monthly. The lower part of the tables present the inaccuracy of prediction. The average values of prediction inaccuracy in five days are shown in line Error. Fig.9 and Fig.10. present the three-dimensional graphs of the dependence of prediction inaccuracy (set in %) on the prediction lag and the period of sampling.

	Hour		Day		Week		Month	
USON.	14.00 - 5.V.99	8.8123	14.VIII.98	11.5	24.V.99	10.1562	XI.98	11.1875
N+1	8.9326	9.0006	11.4600	11.1250	9.1317	10.3750	13.3285	14.5625
N+2	8.9217	8.9389	11.5000	11.5000	9.9060	10.9062	12.2615	13.6875
N+3	8.8798	9.0006	11.5000	11.0300	10.3423	11.6875	12.8064	10.0000
N+4	8.9374	8.8741	11.8400	10.8750	8.6864	11.7500	12.9044	9.0000
N+5	8.8726	8.8741	11.5600	10.9380	9.8097	12.7500	12.5510	8.9375
Error	0.0061		0.0416		0.1889		0.2321	
N+1	-0.0077		0.0291		-0.1224		-0.1103	
N+2	-0.0020		0.0000		-0.0985		-0.1275	
N+3	-0.0137		0.0409		-0.1325		0.2509	
N+4	0.0072		0.0839		-0.3016		0.3490	
N+5	-0.0002		0.0541		-0.2895		0.3230	

Fig. 7. Values and errors of title USON

	Hour		Day		Week		Month	
DDIM	13.00 - 14.IV.99	3.1878	18.XII.98	8.5	17.V.99	3.75	X.98	14.75
A+1	3.2157	3.2188	8.4840	7.8130	3.8339	4.0000	15.6920	12.7500
A+2	3.2184	3.1206	9.1452	7.8750	4.4102	3.9062	12.6510	8.5625
A+3	3.1931	3.1852	7.8401	8.4380	4.2714	3.5000	7.9078	8.0625
A+4	3.1845	3.1206	8.3574	8.5300	4.1537	3.4375	7.1025	4.9375
A+5	3.1929	3.0612	8.8526	8.0630	3.5874	3.3438	4.6318	4.6250
Error	0.0191		0.0824		0.1281		0.1269	
A+1	-0.0010		0.0789		-0.0443		0.1995	
A+2	0.0307		0.1494		0.1344		0.2772	
A+3	0.0025		-0.0703		0.2057		-0.0105	
A+4	0.0200		-0.0203		0.1910		0.1468	
A+5	0.0413		0.0929		0.0650		0.0005	

Fig. 8. Values and errors of title DDIM

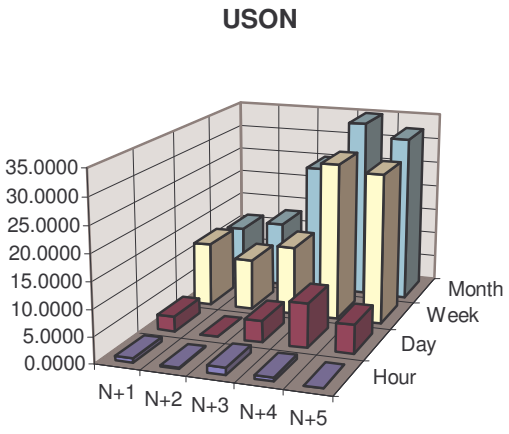

Fig. 9. Graph of USON errors

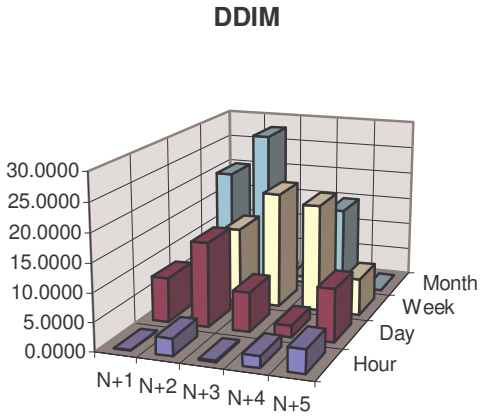

Fig. 10. Graph of DDIM errors

The tests of more samples than mentioned here may imply that the prediction gets worse with the increasing time of sampling. The short-term prediction (intraday) shows better results than the long-term prediction (month) when using NN.

The results of technical, psychological and fundamental analyses are used for decisions whether to buy, sell or to hold the titles. Since results from these analyses can be described only in a vague way or the results of prediction are not precise, the usage of fuzzy logic theory proved to be very useful.

Fig.11. presents the process of decision making. The outputs of technical analyses are processed in the form of vague description from intradaily, daily, weekly and monthly predictions of titles and the index: neutral, high, medium, low increase or decrease. The output of psychological analyses is the prospective trend of time series recognized via Elliot's waves: neutral, high, medium, low increase or decrease. The outputs of fundamental analyses demonstrate the level of news, balance sheet and economic data such as EPS, P/E and ROE: the best, better, good, neutral, bad, worse, the worst. All the inputs of fuzzy logic (output results from all analyses) are processed and the output is the signal of buying, selling or holding the titles.

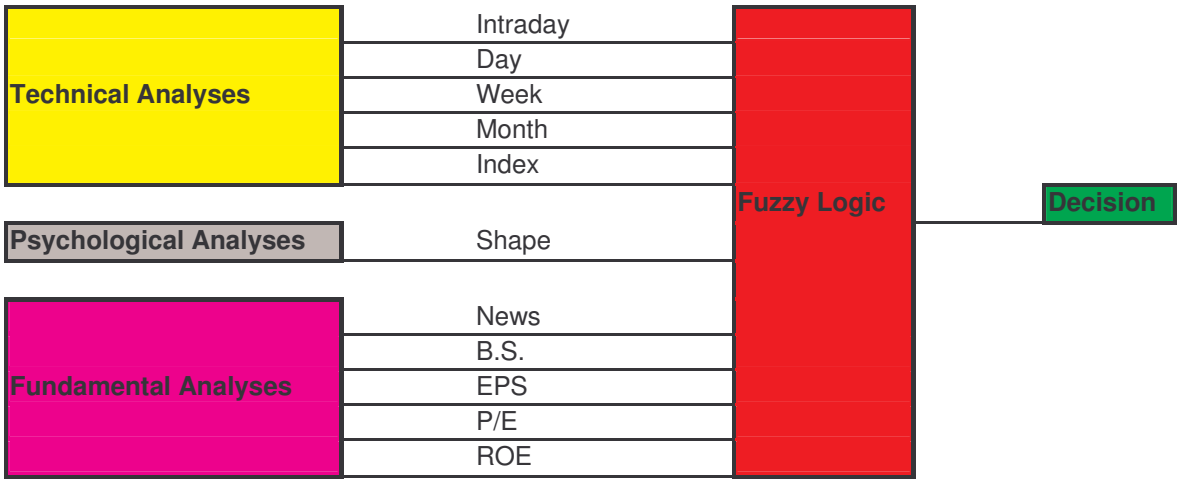

Fig. 11. The algorithm of the process of decision making

Fig.12. presents one of the possible simple realizations of decision making "engine". The result of decision making process is produced in the form of scale in range from +100% to -100% (from immediate buy to immediate sell) or via five ranges: strong buy, buy, hold, sell, strong sell. It is not necessary to set all inputs. The presented model is changing and not complete.

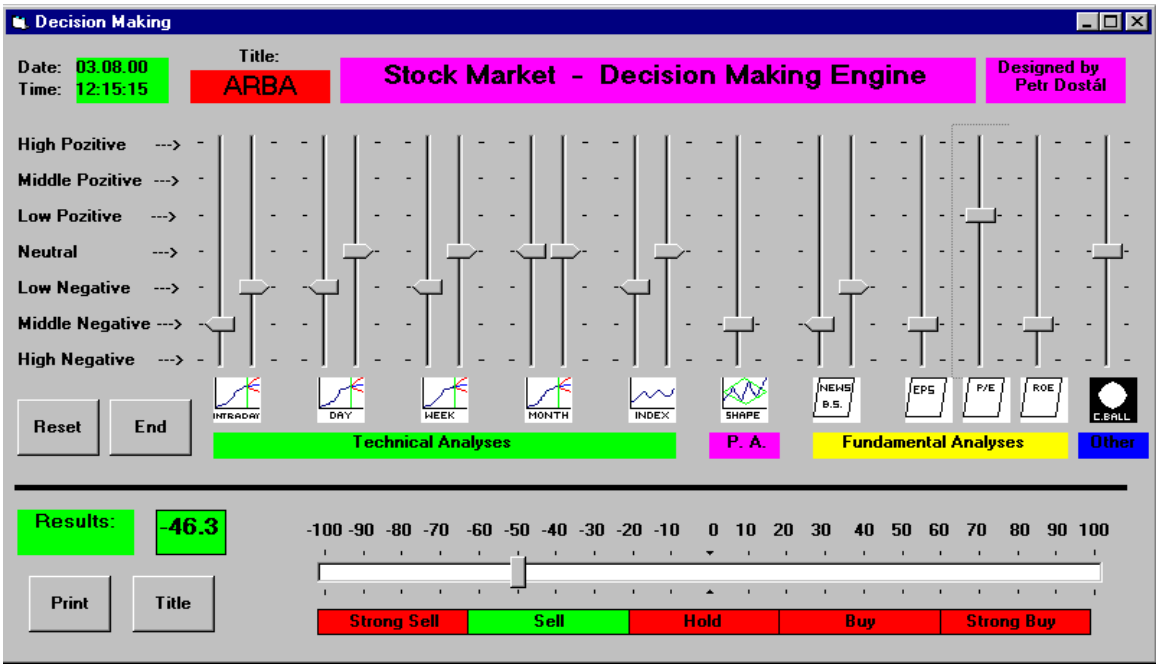

Fig. 12. The possible outlay of decision making engine

The predictions of share prices by NN, together with the use of fuzzy logic enable us to improve our process of decision making during the operation on the world stock markets.