Genetic and Shares

There are problems that are solved by the nature itself, while the algorithms proposed by humankind fail. Problems of this kind can be found in complicated and changing environments, which can be the case of economics, too. Based on the analogy found in nature, two approaches have been formulated, namely artificial neural nets and genetic algorithms. Genetic algorithms are used where the search for accurate solutions based on systematic exploration would take an almost infinite period of time.

Among the methods of the financial cybernetics used for the decision making process of buying, selling or holding the shares one finds the classical methods (curves, graphs, indexes, testers, explorers, regression analysis), Box-Jenkins methodology, Elliott waves, fuzzy logic, chaos and fractals, artificial neural nets and genetic algorithms.

Genetic algorithms describe the way how to cope with a problem by means of a computer and the solving process basically imitates population development of animal species. Every new solution generation consists of selected individuals who have survived and the offspring of the parents of other selected individuals, while the old generation perishes. The process was observed for hundreds and thousands of generations until most individuals within a generation have interbred to such a point that they are not substantially different, and there is no point of going on. The undesirable state when there are no differences between individuals within a generation is prevented by means of mutations. Mutations represent the way to adapt a population to changing environment, e.g. changes in natural conditions.

The whole process, which is called the generation, includes three steps: selection, crossover and mutation. See fig.1.
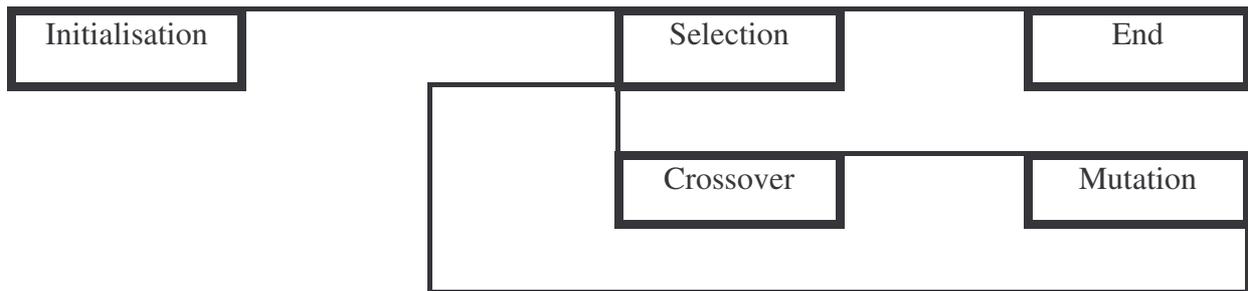

Fig.1. Process of reproduction

Selection: The selection of two chromosomes in the process of reproduction is done in such a manner, that the chromosomes with higher power have higher probability to participate in further process of reproduction
Crossover: The crossover assigns to pair of chromosomes a new pair of chromosomes. The crossover is done by mutual change of equally same long parts of two bits.
Mutation: The mutation is done in such a way, that we change the bits for their components with low probability. The newly created chromosomes (offspring) are returned to the population in such a way, that they displace the chromosomes with low power from the population. Thus it ends one stage of evaluation of population. This process is repeated n-times, or it ends when the population becomes enough homogenous, e.g. the process of crossover does not provide different chromosomes. The quality of the solved problem is given by the output value of optimized fitness function in computer.

Nowadays, the great amount of software products exists for the solution of tasks by means of genetic algorithms. Some of them communicate with known Excel spreadsheets. E.g. Genehunter can be found among them. See the article 10.

The progress of solution of these tasks by means of genetic algorithms is as follows:

1) set up of fitness function, e.g. the equation which will be optimized to min., max. or concrete value
2) set up the adjustable cells (chromosomes), which will be optimized
3) set up of additional fitness functions – ranges, constraints, functions
4) set up the parameters of optimization: chromosome type, population size, chromosome length, crossover rate, mutation rate, generation gap, etc.

The shortened table 1. presents the prediction of NASDAQ index by means of genetic algorithm.

Date	Open	High	Low	Close	NASDAQ						
20.08.01	1866,29	1881,62	1854,96	1881,35	I	II	III	IV			
21.08.01	1883,44	1893,39	1831,28	1831,3	3	3	0	2	<--- Row code (0..3)		**Function** 35589,0
22.08.01	1851,75	1860,02	1817,7	1860,01	7	9	20	2	<--- Days back (0..40)		
23.08.01	1857,52	1883,48	1842,51	1842,97	1	0			<--- signum (0..1)		
24.08.01	1863,32	1916,83	1857,73	1916,8							
27.08.01	1912,7	1933,94	1897,63	1912,41	**If** Open 7 > Open 9 **and** Close 20 <= High 2						
28.08.01	1912,67	1916,28	1864,72	1864,98	**Then "Close" :** Falls tomorrow						
29.08.01	1875,44	1879,76	1833,65	1843,17	1837,5 > 1793,7 And 1644,5 <= 1875,3 1 1 1						
30.08.01	1817,19	1833,29	1777,11	1791,68							
……….	………	………	..……..	…………							
18.10.01	1648,69	1668	1634,72	1652,72							

Date	Open	High	Low	Close	Rules									Pred.	Change	Function
19.10.01	1644,49	1675,2	1628,24	1671,31	I	sign	II		III	sign.	IV	1	2			$ 35589,00
22.10.01	1666,08	1708,09	1660,22	1708,08												
23.10.01	1720,54	1739,47	1695,22	1704,44	1703,4	>	1626,3	And	1505,5	<=	1628,2	1	1	1	2,47	$ 247,00
24.10.01	1707,52	1736,17	1697,69	1731,54	1696,3	>	1701,5	And	1514,8	<=	1660,2	0	1	0	-14,08	-
25.10.01	1708,49	1775,51	1683,61	1775,47	1722,1	>	1703,4	And	1456,8	<=	1695,2	1	1	1	79,39	$ 7939,00
26.10.01	1763,78	1792,87	1763	1768,96	1646,3	>	1696,3	And	1472,6	<=	1697,7	0	1	0	-63,60	-
29.10.01	1763,42	1767,97	1699,4	1699,52	1652,7	>	1722,1	And	1491,5	<=	1683,6	0	1	0	-53,10	-
30.10.01	1682,3	1686,68	1646,3	1667,41	1671,3	>	1646,3	And	1479,0	<=	1763,0	1	1	1	31,41	$ 3141,00
31.10.01	1690,12	1721,69	1677,71	1690,2	1708,1	>	1652,7	And	1479,3	<=	1699,4	1	1	1	6,28	$ 628,00
01.11.01	1705,52	1746,65	1683,99	1746,3	1704,4	>	1671,3	And	1602,6	<=	1646,3	1	1	1	42,62	$ 4262,00
02.11.01	1741,37	1759,65	1726,61	1745,73	1731,5	>	1708,1	And	1586,4	<=	1677,7	1	1	1	41,68	$ 4168,00
05.11.01	1768,29	1801,55	1768,29	1793,65	1775,5	>	1704,4	And	1582,9	<=	1684,0	1	1	1	9,62	$ 962,00
06.11.01	1786,92	1835,49	1777,91	1835,08	1769,0	>	1731,5	And	1604,1	<=	1726,6	1	1	1	42,37	$ 4237,00
07.11.01	1821,04	1868,31	1820,28	1837,53	1699,5	>	1775,5	And	1564,0	<=	1768,3	0	1	0	-3,72	-
08.11.01	1855,68	1888,39	1816,56	1827,77	1667,4	>	1769,0	And	1649,6	<=	1777,9	0	1	0	-7,27	-
09.11.01	1824,73	1838,38	1809,29	1828,48	1690,2	>	1699,5	And	1690,2	<=	1820,3	0	1	0	-26,81	-
12.11.01	1826,25	1848	1782,48	1840,13	1746,3	>	1667,4	And	1684,0	<=	1816,6	1	1	1	84,79	$ 8479,00
13.11.01	1871,47	1893,92	1867,27	1892,11	1745,7	>	1690,2	And	1704,8	<=	1809,3	1	1	1	8,00	$ 800,00
14.11.01	1910,45	1922,45	1875,27	1903,19	1793,7	>	1746,3	And	1752,9	<=	1782,5	1	1	1	7,57	$ 757,00
15.11.01	1891,36	1922,12	1882,84	1900,57	1835,1	>	1745,7	And	1648,7	<=	1867,3	1	1	1	-0,31	$ -31,00
16.11.01	1903,48	1908,21	1882,53	1898,58	1837,5	>	1793,7	And	1644,5	<=	1875,3	1	1	1		

Tab.1. The realisation of prediction of future value of NASDAQ index by means of genetic algorithm

The values of Open, High, Low and Close are the inputs and the confirmation or failure of hypothesis of increase of NASDAQ index are the outputs which means the signal for buying or not buying of index, eventually the title. The method is based on the optimalization of maximum of profit by means of genetic algorithms. The optimalization sets up the rules on the principles of last values in such a way, that the profit is maximum for searched period with the application of these rules. The final rule is used for the following day. The rule is defined by follows condition:

$$\text{If } (O,H,L,C)x_1 > (O,H,L,C)x_2 \text{ And } (O,H,L,C)x_3 > (O,H,L,C)x_4 \text{ Then the index or title will rise.}$$

Note: O=Open, H=High, L=Low, C=Close, x_1, x_2, x_3, x_4 are the calculated values by optimalization and they set up how many steps backward of O, H, L, C values of indexes will be taken for the evaluation of validity of condition.

The presented case is evaluated as follows: If value Open 7 days ago is greater then the value Open 9 days ago and together if the value Close 20 days ago is lower or equal to the value High 2 days ago, then the value Close of tomorrow will be higher then today value Close (when the condition is not fulfilled it is vice versa).

The solution above is no limited by any rule (another rule can be applied), or the number of inputs (the input can be any index, Volume of titles, etc.,) or the length of history of data.

The table 2. presents the actual values of index NASDAQ and the titles MSFT and DELL. The values of increases „1" and falls „0" correspond to the presented actual values. The other sells present the profit or loss per one share. (The title is bought when the increase is predicted. The profit or loss is calculated from the difference of previous and following values of Close. The trade is not made, when the fall is predicted). The presented case shows the profit created by trade on index and titles with the help of optimization by genetic algorithms. It is the proof of the genetic algorithms helping us in decision making process.

Genetic - Prediction									
Date	NASDAQ	T	MSFT	T	DELL	T	NASDAQ	MSFT	DELL
05.11.01	1793,65		63,27		25,3				
06.11.01	1835,08	1	64,78	0	26,24	1	41,43	0,00	0,94
07.11.01	1837,53	1	64,25	1	26,25	1	2,45	-0,53	0,01
08.11.01	1827,77	0	64,42	1	26,14	0	0,00	0,17	0,00
09.11.01	1828,48	0	65,21	1	25,75	1	0,00	0,79	-0,39
12.11.01	1840,13	0	65,79	1	25,79	0	0,00	0,58	0,00
13.11.01	1892,11	1	67,9	1	26,82	0	51,98	2,11	0,00
14.11.01	1903,19	0	65,95	0	27,46	1	0,00	0,00	0,64
15.11.01	1900,57	1	66,12	1	27,69	1	-2,62	0,17	0,23
16.11.01	1898,58	0	65,75	1	26,6	0	0,00	-0,37	0,00
19.11.01	1934,42	1	66,54	0	26,29	0	35,84	0,00	0,00
						Profit:	129,08	2,92	1,43

Tab.2. Evaluation of prediction by means of genetic algorithms

The optimalization of portfolio is another possibility of applying the genetic algorithms. See shortened table 3.

The principle is as follows: we try to choose the portfolio so it would correspond to the shape of course of chosen index, e.g.: NASDAQ. The daily values Close of index NASDAQ and the daily values Close of titles, which we want to have in portfolio are the inputs. The optimization by genetic algorithms means finding the minimum of sum of squares of deviation of normalised values of NASDAQ and normalised values of titles of portfolio. (The portfolio is normalised by division of all their values by maximum. In this case we can compare index NASDAQ and chosen portfolio of titles. Thus we obtain the values in the range from 0.0 to 1.0. The chosen portfolio is calculated as a sum – the value of title multiplied by division to the total portfolio in single days.).

The fig.2. on the left presents the values of normalised portfolio and normalised index NASDAQ in a graphical way. The fig.2. on the right presents the spread of portfolio in per cents (i.e. the portfolio contains only the following titles in presented case: MSFT, OPWV and DELL, others were excluded).

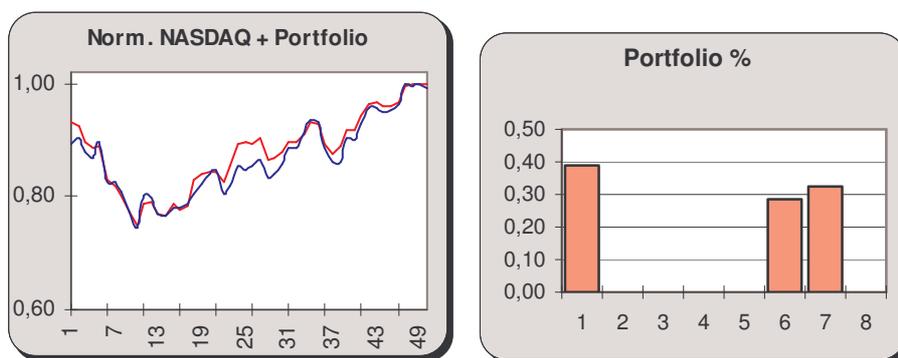| Portfolio optimalization														
RMSE:			0,0182		Portf.%:	0,39	0,00	0,00	0,00	0,00	0,29	0,32	0,00	
						0	1	2	3	4	5	6	7	8
	Portf.:	N.P.:	N.N.:	Square:	Date	NASDAQ	MSFT	INTC	QCOM	QLGC	BRCD	OPWV	DELL	KANA
1	33,88	0,89	0,93	0,0015	4.09.01	1770,78	56,10	26,85	54,30	28,59	22,85	16,73	22,31	0,78
2	34,35	0,90	0,92	0,0004	5.09.01	1759,01	57,74	27,47	53,21	26,70	20,24	16,07	22,38	0,75
3	33,38	0,88	0,90	0,0003	6.09.01	1705,64	56,02	26,10	48,51	25,40	21,05	16,02	21,50	0,74
4	32,93	0,87	0,89	0,0004	7.09.01	1687,70	55,40	25,89	49,18	26,76	20,04	15,21	21,55	0,71
5	33,98	0,89	0,89	0,0000	10.9.01	1695,38	57,58	26,07	50,54	26,78	20,40	14,77	22,57	0,64
6	31,33	0,82	0,83	0,0000	17.9.01	1579,55	52,91	23,59	45,79	25,78	20,23	13,98	20,70	0,64
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44	36,01	0,95	0,96	0,0001	8.11.01	1827,77	64,42	28,28	56,29	44,28	29,92	8,50	26,14	1,02
45	36,15	0,95	0,96	0,0001	9.11.01	1828,48	65,21	27,88	55,42	46,00	30,24	8,35	25,75	1,05
46	36,55	0,96	0,97	0,0000	12.11.01	1840,13	65,79	28,38	56,23	47,01	29,94	8,92	25,79	1,07
47	37,98	1,00	0,99	0,0000	13.11.01	1892,11	67,90	30,05	57,56	48,09	30,64	9,86	26,82	1,40
48	37,75	0,99	1,00	0,0000	14.11.01	1903,19	65,95	31,32	58,07	47,30	29,81	11,00	27,46	1,71
49	37,98	1,00	1,00	0,0000	15.11.01	1900,57	66,12	30,78	58,96	47,77	29,98	11,29	27,69	1,89
50	37,71	0,99	1,00	0,0000	16.11.01	1898,58	65,75	30,63	60,08	46,66	29,47	12,09	26,60	1,70

Tab.3. Optimalization of portfolio

Fig.2. The optimalization of portfolio

The results means that the portfolio is set together so the shape of the curve of common portfolio could copy the shape of the curve of index NASDAQ. If we are convinced that the index will increase, thus the portfolio is optimalized in such a way, that the increase is rationally the same.

The genetic algorithms contribute to the solution of various problems, which is necessary to solve in economy. It leads to improve the quality of decision making process.