Energy Time Series – Genetic Algorithm Prediction

There are manifold methods from different branches that are used for the predictions of time series. Except for the classical methods, it can be mentioned the use of Box-Jenkins methodology, artificial neural networks, fuzzy logic, wavelet analyses and genetic algorithms.

The following pages present the possibility of applying of genetic algorithms to the prediction in the case of heat consumption for the city of Brno in MW measured from 01:00 06.02.1978 to 01:00 25.2.78 within the following two days (hourly sampling, 408+48 values). In this case the prediction indicates the prognoses of rise or decrease of heat consumption for 1 hour ahead. The test was made on the time series used in articles 1,2,3 for the purpose of comparing the results. The graph of time series is on the Fig.1.

The principle has been based on the calculation of optimization task searching the maximum value of fitness function. The fitness function is the sum of values of substraction of previous and following heat consumption provided, that the below mentioned condition is fulfilled, or both partial conditions are. The genetic algorithm makes optimization of this fitness function to the maximum and the best found variant sets up the values O1, O2, O3, O4. This values determine the indexes of values of heat consumption x_{N-t1}, x_{N-t2}, x_{N-t3}, x_{N-t4}, which are chosen for evaluation of conditions. The evaluation of the last condition in the row indicates the prognoses for the rise or the decline of future heat consumption, it means in time N+1.

The rule is as follows: If ((Consump. x_{N-t1} > Consump. x_{N-t2}) And (Consump. x_{N-t3} > Consump. x_{N-t4},)) Then consumption will rise in following time. If the condition is not fulfilled, the consumption will decrease.

The condition in this case, (($x_{N408-129}$ > $x_{408-159}$) And (x_{408-8} > $x_{408-153}$)) by another name ((559,00 > 548,00) And ((542,00 > 582,00)), is not fulfilled. It means that there will be the decrease of heat consumption in the following time. The prediction was made step by step in this case in 1 hour interval for two days ahead, i.e. 48 hours intervals. There were 44 correctly predicted increases or decreases and there were 4 wrong. The accuracy reached 92%. The worse results of accuracy of prediction can be reached in other time series. It depends on the shape of the progress of time series, on the ratio of its deterministic and stochastic components. The evaluation of randomness of time series can be done with the help of calculation of Hurst and Lyapunov coefficient. See article 4. The method can be used for prediction not only of the heat consumption, but also of the corresponding outdoor temperature, pressure, humidity, sunshine, speed and direction of wind or other time series.
Fig.2. presents the graph of real value of heat consumption within a period of 48 hours and a corresponding bar, where the positive one predicted the increase and the negative bar the decrease of heat consumption. The appendix shows the part of the table of calculation of prediction for future time.
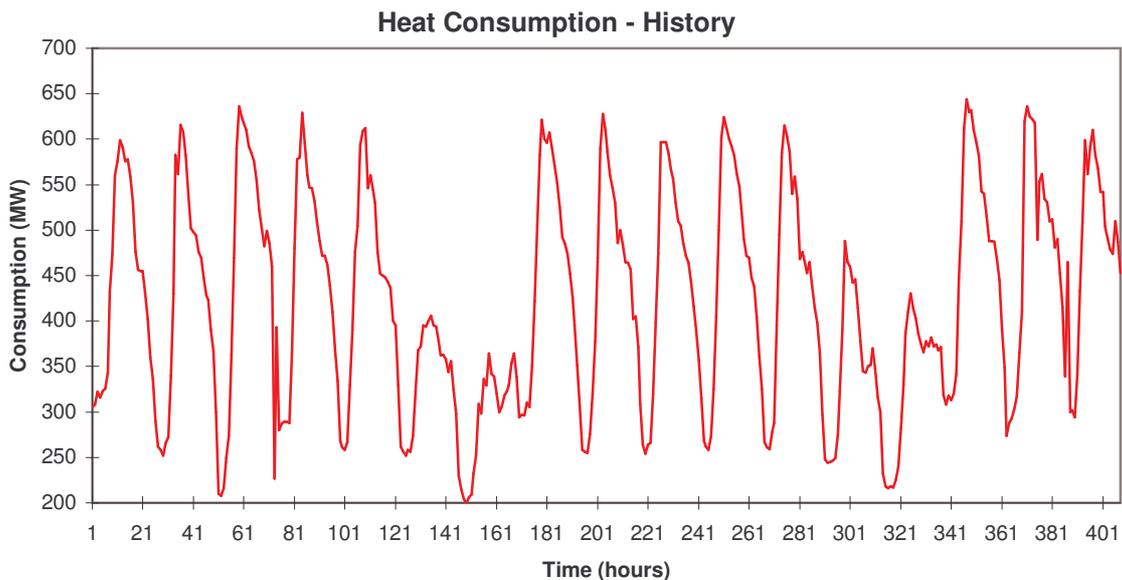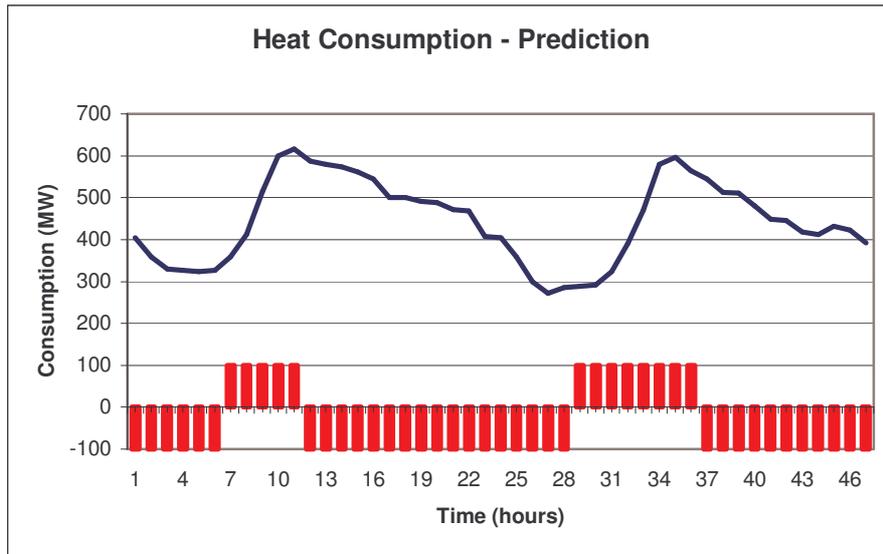

Fig.1. Heat consumption – history

Fig.2. Heat consumption - prediction

The programme GeneHunter of the firm WardSystems Ltd. was used for calculation. See article 5. The prediction enables us to increase the quality of decision-making process.

Order:	Date	Time:	Consump.	Rule												
1	06.02.78	1:00	305,000		I	II	III	IV								**Function**
2	06.02.78	2:00	308,000		O1	O2	O3	O4								**353,00**
3	06.02.78	3:00	322,000		129	151	8	153	<--- **days back (0..380)**							
4	06.02.78	4:00	316,000		1	1		<--- **signum (0..1)**								
5	06.02.78	5:00	323,000													
6	06.02.78	6:00	326,000	**If**	**Cons. 129**	**>**	**Cons. 151**	**And**	**Cons. 8**	**>**	**Cons. 153**					
7	06.02.78	7:00	343,000													
8	06.02.78	8:00	432,000		559,00	>	548,00	**And**	542,00	>	582,00					
9	06.02.78	9:00	473,000			0		0		0	<---Tomorrow					
10	06.02.78	10:00	560,000													
11	06.02.78	11:00	576,000													
12	06.02.78	12:00	599,000													
……..	…………...	………...	………….													
385	22.02.98	1:00	415,000													
386	22.02.98	2:00	339,000													
387	22.02.98	3:00	465,000										Pred.		**Function**	
388	22.02.98	4:00	300,000	I	sign.	II		III	sign.	IV	a	b	Rule	Chan.	**353,00**	
389	22.02.98	5:00	302,000													
390	22.02.98	6:00	294,000	470	>	416,00	**And**	481,00	>	464,00	1	1	**1**	47,00	47,00	
391	22.02.98	7:00	341,000	447	>	389,00	**And**	490,00	>	443,00	1	1	**1**	92,00	92,00	
392	22.02.98	8:00	433,000	438	>	357,00	**And**	452,00	>	416,00	1	1	**1**	75,00	75,00	
393	22.02.98	9:00	508,000	404	>	315,00	**And**	415,00	>	389,00	1	1	**1**	91,00	91,00	
394	22.02.98	10:00	599,000	361	>	268,00	**And**	339,00	>	357,00	1	0	**0**	-37,00	-	
395	22.02.98	11:00	562,000	325	>	262,00	**And**	465,00	>	315,00	1	1	**1**	30,00	30,00	
396	22.02.98	12:00	592,000	267	>	258,00	**And**	300,00	>	268,00	1	1	**1**	18,00	18,00	
397	22.02.98	13:00	610,000	261	>	273,00	**And**	302,00	>	262,00	0	1	**0**	-28,00	-	
398	22.02.98	14:00	582,000	259	>	325,00	**And**	294,00	>	258,00	0	1	**0**	-14,00	-	
399	22.02.98	15:00	568,000	278	>	405,00	**And**	341,00	>	273,00	0	1	**0**	-26,00	-	
400	22.02.98	16:00	542,000	288	>	500,00	**And**	433,00	>	325,00	0	1	**0**	0,00	-	

Order	Date	Time	Consump.	Order	Trend	Predc.	Unity								
401	22.02.98	17:00	542,000	395	>	602,00	And	508,00	>	405,00	0	1	0	-38,00	-
402	22.02.98	18:00	504,000	495	>	624,00	And	599,00	>	500,00	0	1	0	-13,00	-
403	22.02.98	19:00	491,000	585	>	612,00	And	562,00	>	602,00	0	0	0	-12,00	-
404	22.02.98	20:00	479,000	615	>	600,00	And	592,00	>	624,00	1	0	0	-5,00	-
405	22.02.98	21:00	474,000	603	>	592,00	And	610,00	>	612,00	1	0	0	36,00	-
406	22.02.98	22:00	510,000	587	>	582,00	And	582,00	>	600,00	1	0	0	-23,00	-
407	22.02.98	23:00	487,000	540	>	562,00	And	568,00	>	592,00	0	0	0	-34,00	-
408	23.02.78	0:00	453,000	559	>	548,00	And	542,00	>	582,00	1	0	0	**<---Tomorrow**	
409	23.02.78	1:00	404,00	1	0	0	1								
410	23.02.78	2:00	358,00	2	0	0	1								
411	23.02.78	3:00	329,00	3	0	0	1								
412	23.02.78	4:00	327,00	4	0	0	1								
413	23.02.78	5:00	324,00	5	0	0	1								
414	23.02.78	6:00	326,00	6	1	0	0								
415	23.02.78	7:00	358,00	7	1	1	1								
416	23.02.78	8:00	412,00	8	1	1	1								
417	23.02.78	9:00	516,00	9	1	1	1								
418	23.02.78	10:00	600,00	10	1	1	1								
419	23.02.78	11:00	616,00	11	1	1	1								
420	23.02.78	12:00	587,00	12	0	0	1								
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Order	Date	Time	Consump.	Order	Trend	Predc.	Unity								

Appendix: The part of table of calculation of prediction