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Liu Young [] Wong
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Weinan

[] Parzen Maidment
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Maidment

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Box-Jenkins

Stark

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$$S_{ij} = \frac{\partial y_i}{\partial x_j} \cdot \frac{\partial x_j}{\partial y_i} = \frac{\partial y_i}{\partial x_j} \cdot \frac{x_j}{y_i}$$

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(i)

: S_{ij}

: x

: y (j)

() SPSS

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SPSS

No.	Parameter	Correlation Coefficient		Model Input Parameters	
		Cold Months	Hot Months	First Step	Second Step
1	Year	0.431	0.254	✓	✗
2	Month	-0.216	0.424	✓	✗
3	Week Days	0.440	0.066	✓	✗
4	Weekend	0.379	0.016	✓	✗
5	Yesterday Water Consumption	0.577	0.921	✓	✓
6	Water Consumption of 2 Days Ago	0.390	0.886	✓	✗
7	Water Consumption of 3 Days Ago	0.435	0.883	✓	✗
8	Water Consumption of 7 Days Ago	0.704	0.858	✓	✓
9	Dry Temperature	0.454	0.850	✓	✓
10	Yesterday Dry Temperature	0.396	0.851	✓	✓
11	Dry Temperature of 2 Days Ago	0.368	0.835	✓	✗
12	Dry Temperature of 3 Days Ago	0.342	0.816	✓	✗
13	Wet Temperature	0.434	0.793	✓	✓
14	Yesterday Wet Temperature	0.407	0.794	✓	✓
15	Wet Temperature of 2 Days Ago	0.375	0.784	✓	✗
16	Minimum Temperature	0.360	0.820	✓	✗
17	Yesterday Minimum Temperature	0.358	0.815	✓	✗
18	Minimum Temperature of 2 Days Ago	0.339	0.795	✓	✗
19	Maximum Temperature	0.489	0.852	✓	✓
20	Yesterday Maximum Temperature	0.408	0.848	✓	✓
21	Maximum Temperature of 2 Days Ago	0.371	0.830	✓	✗
22	Average Temperature	0.442	0.850	✓	✓
23	Yesterday Average Temperature	0.396	0.845	✓	✓
24	Average Temperature of 2 Days Ago	0.365	0.826	✓	✗
25	Average Temperature of 3 Days Ago	0.338	0.808	✓	✗
26	Absolute Humidity	0.241	0.428	✓	✗
27	Relative Humidity	-0.200	-0.541	✓	✗
28	Surface Temperature	0.312	0.827	✓	✗
29	Sunshine Hours	0.286	0.448	✓	✗
30	Precipitation	-0.184	-0.246	✓	✗
31	Wind	0.017	-0.088	✓	✗
32	Pressure at Station	0.112	-0.445	✓	✗
33	Pressure at Sea Surface	-0.041	-0.690	✓	✗

:(R)

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y x

$$x_{nor} = \frac{x - x_{min}}{x_{max} - x_{min}}$$

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$$R = R(x, y) = \frac{cov(x, y)}{\sigma_x \sigma_y} =$$

X_{nor}

X

X_{min} X_{max}

$$\frac{\frac{1}{n} \sum_{i=1}^n (x_i - \mu_x)(y_i - \mu_y)}{\sqrt{\frac{1}{n} \sum_{i=1}^n (x_i - \mu_x)^2} \cdot \sqrt{\frac{1}{n} \sum_{i=1}^n (y_i - \mu_y)^2}}$$

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y x

:cov(x,y)

: μ_y μ_x y x

: σ_x²

R

y

: σ_y² x

R

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:(MAPE)

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$$MAPE = \frac{1}{n} \sum_{i=1}^n \frac{|Actual_i - Forecast_i|}{Actual_i} \times 100$$

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Actual_i

n

Forecast_i

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Matlab

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Matlab

Matlab

Matlab

LogSig

Model No.	Explanation	Training Time	Testing Time
1	Hot Months (1375-1376)	15.1.1375 to 30.7.1375 15.1.1376 to 31.6.1376	1.7.1376 to 30.7.1376
2	Hot Months (1377-1378)	15.1.1377 to 30.7.1377 15.1.1378 to 31.6.1378	1.7.1378 to 30.7.1378
3	Cold Months (1375-1376)	1.8.1375 to 15.12.1375 1.8.1376 to 15.11.1376	15.11.1376 to 15.12.1376
4	Cold Months (1377-1378)	1.8.1377 to 15.12.1377 1.8.1378 to 10.9.1378	11.9.1378 to 10.10.1378*

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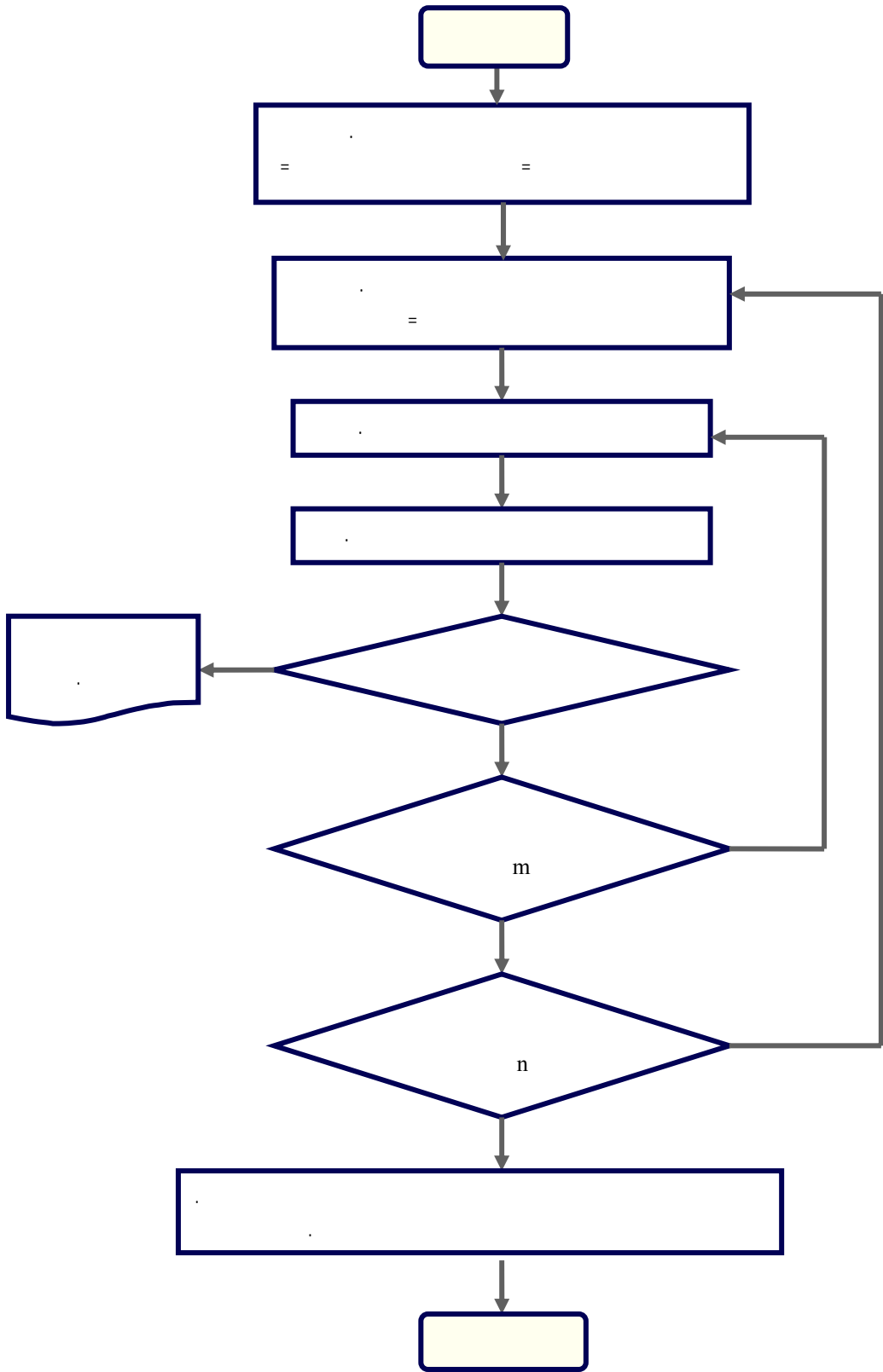
No.	Structure No.	Time of Modeling	MAPE (%)	Max. Error (%)	Min. Error (%)	R
1	2	Hot Months (1375-1376)	1.753	4.10	-6.07	0.433
2	3	Hot Months (1375-1376)	1.643	4.04	-5.54	0.429
3	2	Cold Months (1375-1376)	1.594	7.06	-3.30	0.721
4	3	Cold Months (1375-1376)	1.717	5.67	-4.03	0.816
5	2	Hot Months (1377-1378)	1.633	4.50	-1.66	0.529
6	3	Hot Months (1377-1378)	1.647	4.63	-2.15	0.552
7	2	Cold Months (1377-1378)	0.886	3.62	-1.17	0.416
8	3	Cold Months (1377-1378)	0.930	4.21	-1.04	0.376

No.	Time of Modeling	MAPE (%)	Max. Error (%)	Min. Error (%)	R
1	15.9.1377 to 30.10.1377	2.207	14.70	-20.11	0.890
2	1.11.1377 to 15.12.1377	2.950	15.54	-21.88	0.751
3	16.1.1378 to 31.2.1378	2.558	15.08	-20.06	0.948
4	1.3.1378 to 15.4.1378	2.669	14.22	-20.02	0.945
5	16.4.1378 to 31.5.1378	2.716	14.85	-20.41	0.942
6	1.6.1378 to 15.7.1378	2.658	14.75	-20.59	0.945
7	16.7.1378 to 30.8.1378	2.115	7.56	-7.64	0.766
8	1.9.1378 to 15.10.1378	1.996	5.59	-7.40	0.799

No.	Time of Modeling	MAPE (%)	Max. Error (%)	Min. Error (%)	R
1	15.9.1377 to 30.10.1377	2.426	4.95	-2.30	0.829
2	1.11.1377 to 15.12.1377	4.478	13.41	-19.95	0.755
3	16.1.1378 to 31.2.1378	2.830	13.06	-11.99	0.693
4	1.3.1378 to 15.4.1378	1.986	4.73	-5.91	0.858
5	16.4.1378 to 31.5.1378	1.715	5.47	-4.91	0.808
6	1.6.1378 to 15.7.1378	1.914	5.62	-4.29	0.880
7	16.7.1378 to 30.8.1378	2.201	5.35	-5.40	0.680
8	1.9.1378 to 15.10.1378	2.019	6.74	-2.77	0.505

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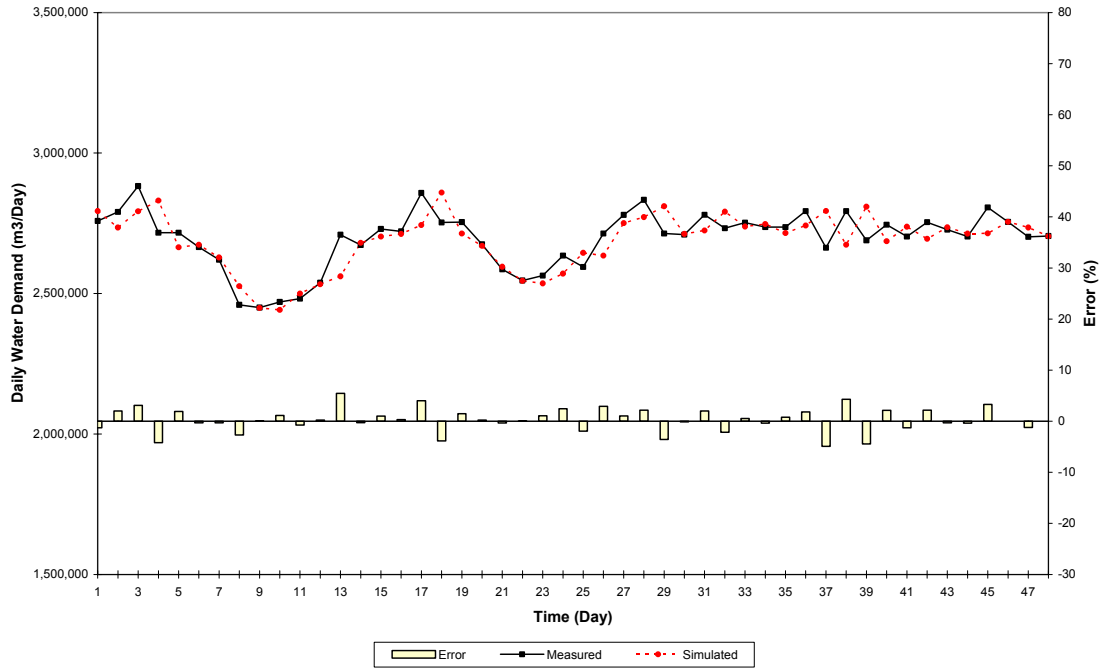


Figure 1: Comparison of Measured and Simulated Daily Water Demand (m³/Day) and Error (%) over Time (Day) for Case 1.

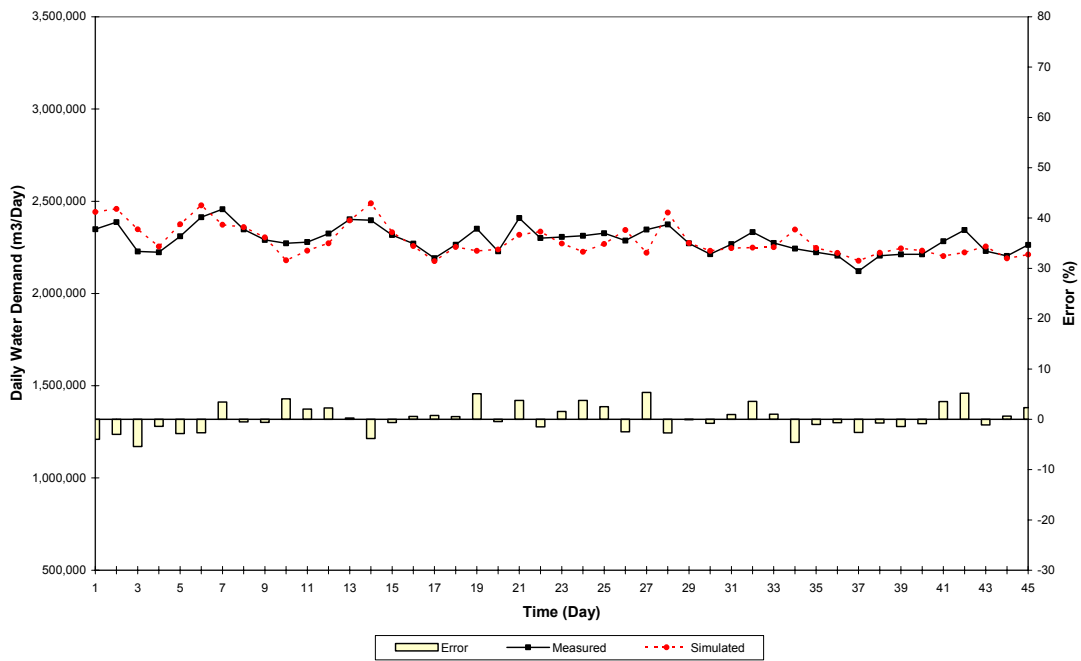


Figure 2: Comparison of Measured and Simulated Daily Water Demand (m³/Day) and Error (%) over Time (Day) for Case 2.

Table 1: Comparison of Measured and Simulated Daily Water Demand (m³/Day) and Error (%) over Time (Day) for Case 1.

Type of Model	Index	Case 1	Case 2	Case 3	Case 4
ANN	MAPE (%)	1.986	1.715	1.919	2.201
	R	0.857	0.808	0.880	0.680
Fuzzy [18]	MAPE (%)	6.740	5.682	6.357	6.410
	R	0.878	0.874	0.859	0.837

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LogSig

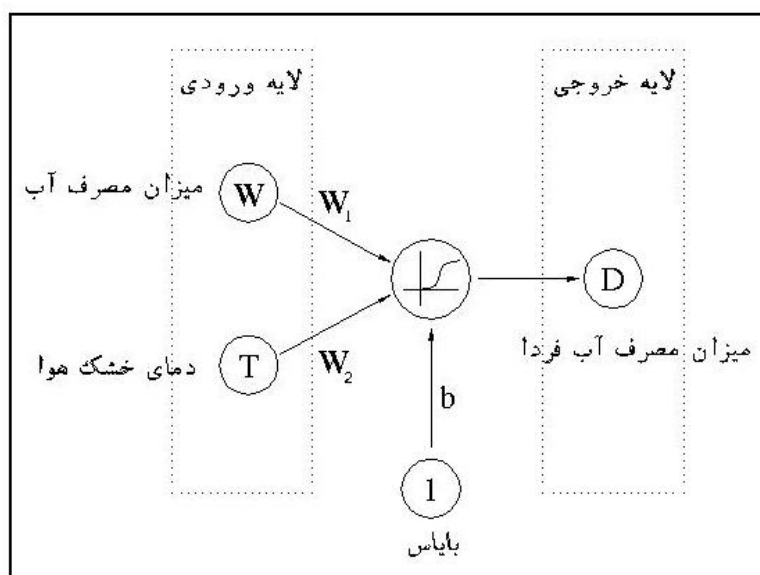
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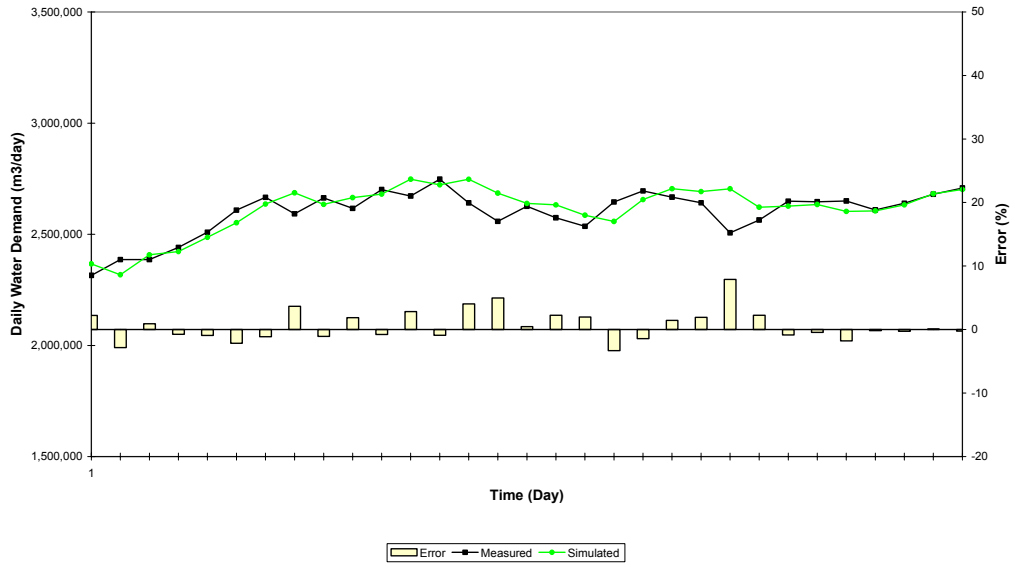
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$$\text{LogSig}(W_1.T + W_2.W + 1.b) = D$$

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W_2 W_1 b





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- 1 - Monzavi, M. T. (1999). *Water supply, University of Tehran Press*, 10th Edition, 379 p. (in Farsi).
 - 2 - Taebi, A. and Chamani, M. R. (2000). *Urban water distribution networks*, Isfahan University of Technology Press, 628 P. (in Farsi).
 - 3 - Zhou, S.L., McMahon, T. A., Walton, A. and Lewis, J. (2000). "Forecasting daily urban water demand: a case study of Melbourne." *J. of Hydrology*, Vol. 236, PP. 153-164.
 - 4 - Zhou, S. L., McMahon, T. A., Walton, A. and Lewis, J. (2001). "Forecasting operational demand for an urban water supply zone." *J. of Hydrology*, Vol. 259, PP. 189-202.
 - 5 - Wong, S. T. (1972). "A model on municipal water demand: a case study of northeastern Illinois." *Land Econ.*, Vol. 48, No.1, PP. 34-44.
 - 6 - Young, R. A. (1973). "Price elasticity of demand for municipal water: a case study of Tucson and Arizona." *J. of Water Resources Research*, Vol. 9, No. 4, PP. 1068-1072.
 - 7 - Willsie, R. H. and Pratt, H. L. (1974). "Water use relationships and projection corresponding with regional growth." *Water Resources Bulletin*, Vol.10, No. 2, PP. 360-371.
 - 8 - Maidment, D. R. and Parzen, E. (1984). "Cascade model of monthly municipal water use." *J. of Water Resources Research*, Vol. 20, No. 1, PP. 15-23.
 - 9 - Maidment, D. R., Miaou, S. P. and Crawford, M. M. (1985). "Transfer function models of daily urban water use." *J. of Water Resources Research*, Vol. 21, No. 4, PP. 425-432.
 - 10 - Stark, H. L., Stanley, J. S. and Buchanan, I. D. (2000). *Water demand forecasting using artificial neural networks*, University of Alberta.
 - 11- Yu, M. J., Joo, C. N. and Koo, J. Y. (2002). "Application of short-term water demand prediction model to Seoul." *J. of Water Science & Technology*, Vol. 46, No. 6-7, PP. 255-261.
 - 12 - Liu, J., Savenije, H. G. and Xu, J. (2002). "Forecast of water demand in Weinan city in China using WDF-ANN model." *Physics and Chemistry of the Earth*, Vol. 28, PP. 219-224.
 - 13 - Buchberger, G. and Wells, G. J. (1996). "Intensity, duration and frequency of residential water demands." *Journal of Water Resources Planning and Management, ASCE*, Vol. 122, No. 11, PP. 11-18.
 - 14 - Buchberger, G. and Wu, L. (1995). "Model for instantaneous residential water demand." *J. of Hydraulic Engineering*, Vol. 121, No. 3, PP. 232-246.
 - 15 - Chatterjee, A. K. (2001). *Water supply, waste disposal and environmental engineering*, Seventh Edition, KHANA Publishers, 900 P.
 - 16 - Management and Budget Organization and Ministry of Energy, (1992). *Urban water supply design codes*, Report No. 117-3, Technical Standards, (in Farsi).
 - 17 - Merritt, F. S. (1983). *Standard Handbook for Civil Engineers*, Third Edition, McGraw-Hill, 1492 P.
 - 18 - Karimi, D. (2001). *Application of Fuzzy systems on Tehran short term water consumption*, MSc Thesis, Tarbiat Modares University, Tehran, Iran, (in Farsi).
 - 19 - Devore, J. L. (2000). *Probability and statistics*, Fifth Edition, California Polytechnic State University, 755 P.
 - 20 - Fausett, L. (1994). *Fundamental of neural networks*, Florida Institute of Technology, 461 P.

1 - Transfer Function
3 - Correlation Coefficient
5 - Graphical User Interface

2 - The Mean Average Percentage Error
4 - Self-Adaptive
6 - Initialize
