

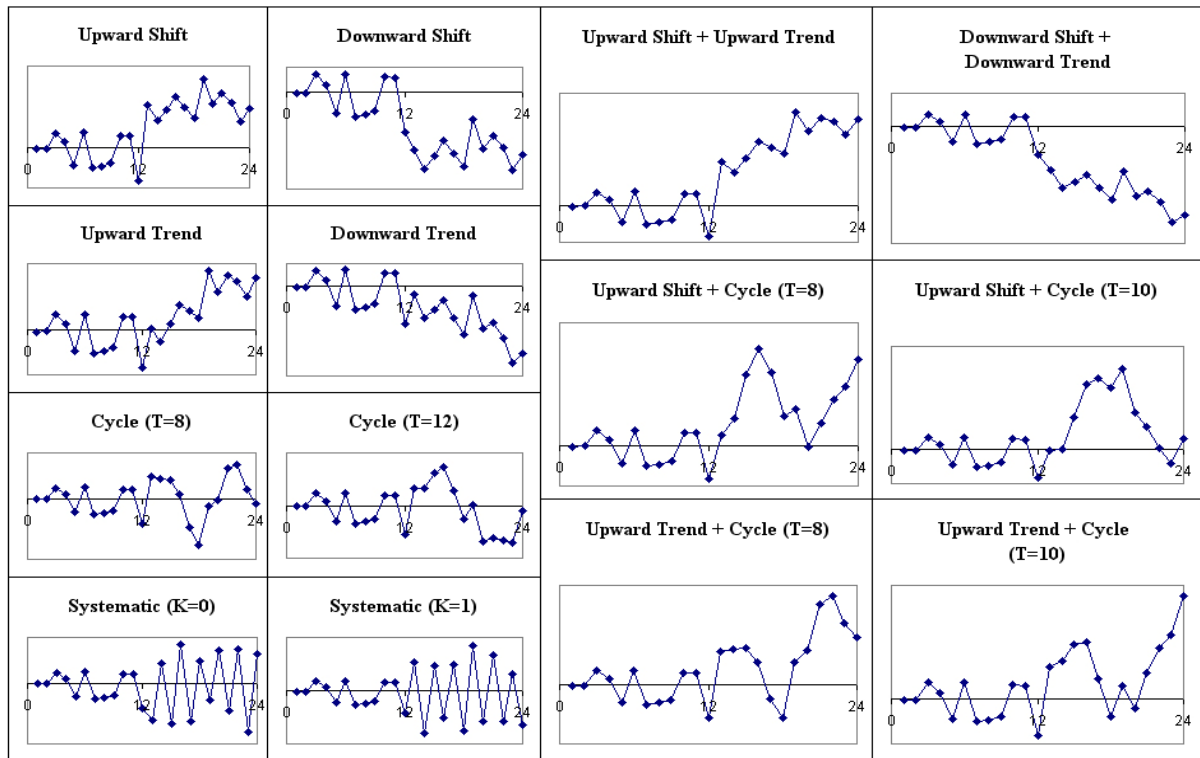
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Cycle (Cyc.) Trend (Tr.) Shift(Sh.)  
Systematic (Sys.)

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Cheng .

O'Brien , Zorriassatine , Ruey Guh

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LVQ

(BP)

Oztemel Pham

Tannock

Ruey Guh

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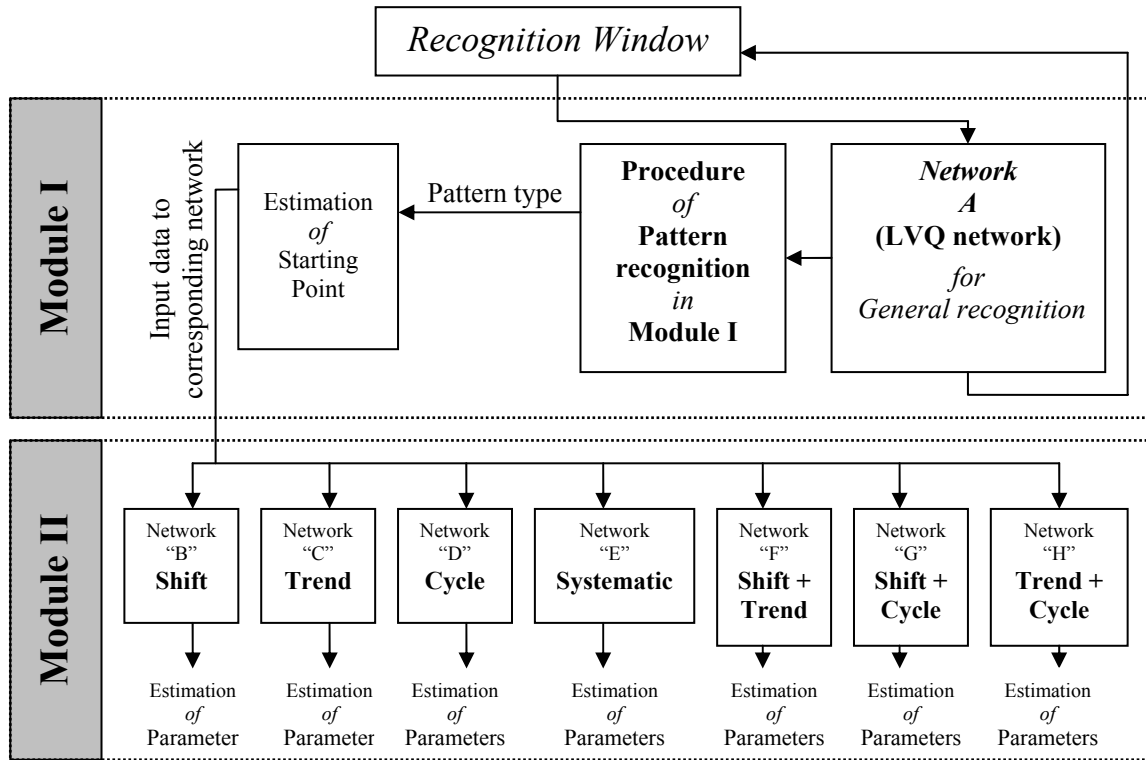
Aw Chang

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BP

Lee Chen Chiu

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Sagiroglu Pham

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Sys. Cyc. Tr. Sh.

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x(t)

(variable)

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(n(t) )

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( x(t) = n(t) )

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$\bar{x}$

$\sigma = 0.75, \mu = 0$

$\sigma$

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		[ n(t) ]	
Variable	$\bar{x}$ ( )	$\sigma, \mu$	
	$R$ ( )	R-Distribution	---
	$s$ ( )	$\beta = \frac{2\sigma^2}{n-1} \quad \alpha = \frac{n-1}{2}$	$\beta \quad \alpha$
	$s^2$ ( )	$\beta = \frac{2\sigma^2}{n-1} \quad \alpha = \frac{n-1}{2}$	$\beta \quad \alpha$
	$x$ ( )		
Attribute	$p$ ( )	$n, \theta$ ( )	
	$np$ ( )	$n, \theta$ ( )	
	$C$ ( )	$\lambda$	
	$u$ ( )	$\frac{\lambda}{n}$	$n$

		$un(t)$	$x(t)$
Natural ( )	1	-----	$x(t) = n(t)$
Shift (Sh.)	2	$u.b$ ( $u = 0$ before shift, $u = 1$ after shift)	$x(t) = n(t) + u.b$
Trend (Tr.)	3	$s.t$	$x(t) = n(t) + s.t$
Cycles (Cyc.)	4	$l * \sin(\frac{2\pi.t}{T} + \frac{2k\pi}{T})$	$x(t) = n(t) + l * \sin(\frac{2\pi.t}{T} + \frac{2k\pi}{T})$
Systematic (Sys.)	5	$g * \cos(\pi.t + k\pi)$	$x(t) = n(t) + g * \cos(\pi.t + k\pi)$
Shift + Trend (Sh.+ Tr.)	6	$[u.b] + [s.t]$	$x(t) = n(t) + u.b + s.t$
Shift + Cycles (Sh.+Cyc.)	7	$[u.b] + [l * \sin(\frac{2\pi.t}{T} + \frac{2k\pi}{T})]$	$x(t) = n(t) + u.b + l * \sin(\frac{2\pi.t}{T} + \frac{2k\pi}{T})$
Trend + Cycles (Tr.+Cyc.)	8	$[s.t] + [l * \sin(\frac{2\pi.t}{T} + \frac{2k\pi}{T})]$	$x(t) = n(t) + s.t + l * \sin(\frac{2\pi.t}{T} + \frac{2k\pi}{T})$

	$x(t)$		
Shift (Sh.)	$x(t) = n(t) + u.b$	$b = [1\sigma \sim 3\sigma] \Rightarrow [0.75, 2.25]$	Sh. ( )
		$b = [-3\sigma \sim -1\sigma] \Rightarrow [-2.25, -0.75]$	Sh. ( )
Trend (Tr.)	$x(t) = n(t) + s.t$	$s = [0.1\sigma \sim 0.3\sigma] \Rightarrow [0.075, 0.225]$	Tr. ( )
		$s = [-0.3\sigma \sim -0.1\sigma] \Rightarrow [-0.225, -0.075]$	Tr. ( )
Cycles (Cyc.)	$x(t) = n(t) + l * \sin(\frac{2\pi.t}{T} + \frac{2k\pi}{T})$	$l = [1\sigma \sim 3\sigma] \Rightarrow [0.75, 2.25].$ $T = 8, 12.$	$k = 0, 1, \dots, T-1$
Systematic (Sys.)	$x(t) = n(t) + g * \cos(\pi.t + k\pi)$	$g = [1\sigma \sim 3\sigma] \Rightarrow [0.75, 2.25]$	$k = 0, 1$
Shift + Trend (Sh.+Tr.)	$x(t) = n(t) + u.b + s.t$	$b = [1\sigma \sim 3\sigma] \Rightarrow [0.75, 2.25]$ $s = [0.1\sigma \sim 0.3\sigma] \Rightarrow [0.075, 0.225]$	( ) Sh. ( ) Tr.
		$b = [-3\sigma \sim -1\sigma] \Rightarrow [-2.25, -0.75].$ $s = [-0.3\sigma \sim -0.1] \Rightarrow [-0.225, -0.075]$	( ) Sh. ( ) Tr.
Shift + Cycles (Sh.+Cyc.)	$x(t) = n(t) + u.b + l * \sin(\frac{2\pi.t}{T} + \frac{2k\pi}{T})$	$b = [1\sigma \sim 3\sigma] \Rightarrow [0.75, 2.25].$ $l = [1\sigma \sim 3\sigma] \Rightarrow [0.75, 2.25].$ $T = 8, 12.$	( ) Sh. Cyc.
Trend + Cycles (Tr.+Cyc.)	$x(t) = n(t) + s.t + l * \sin(\frac{2\pi.t}{T} + \frac{2k\pi}{T})$	$s = [0.1\sigma \sim 0.3\sigma] \Rightarrow [0.075, 0.225].$ $l = [1\sigma \sim 3\sigma] \Rightarrow [0.75, 2.25].$ $T = 8, 12.$	( ) Tr. Cyc.

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Upward Shift [2]				
Downward Shift [2]				
Upward Trend [3]				
Downward Trend [3]				
Cycles(T=8) [4]				
Cycles(T=12) [4]				
Systematic (k=0) [5]		-		
Systematic (k=1) [5]		-		
U. Shift + U. Trend [6]				
D. Shift + D. Trend [6]				
U. Shift + Cycles(8) [7]				
U. Shift + Cycles(10) [7]				
U. Trend + Cycles(8) [8]				
U. Trend + Cycles(10) [8]				

LVQ

Cyc.

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*Tr.*

*Tr.*

*Cyc.(T = 8)*

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(misclassification)



$k = 0, 1, 2, \dots, T - 1$

$$\frac{2\pi}{T}$$

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Cyc. (T = 8)

$$un(t) = l \cdot \sin\left(\frac{2\pi t}{T}\right)$$

Cyc.

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$k$

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$$un(t) = l \cdot \sin\left(\frac{2\pi t}{T} + \frac{2k\pi}{T}\right)$$

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$(|t - a^L|)$

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(Sh.+Tr.

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(Sh.+Cyc.

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Sys.

Cyc.

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Tr.+Cyc.

Sh.+Cyc.

Sh.+Tr.

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$R ((R - S^1 - S^2) )$

$S^2$

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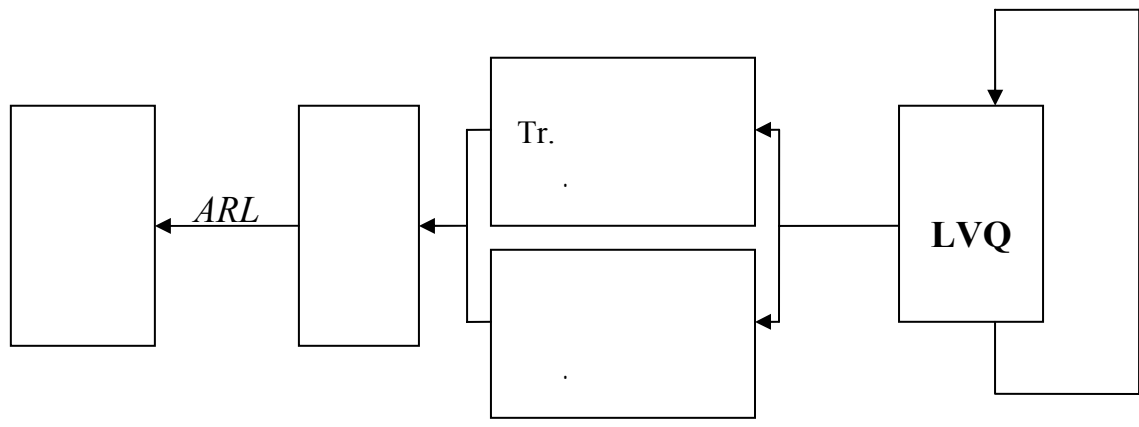
MAD)

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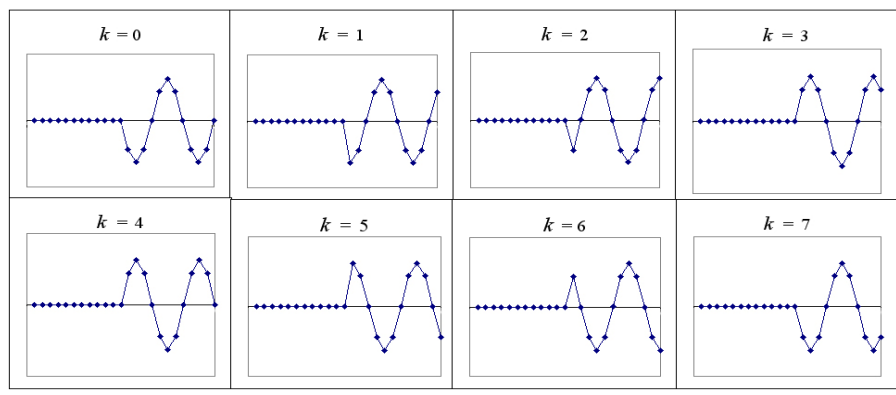
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(t)

(a<sup>L</sup>)



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.Cycle(T=8) :

ARL (% I) :

الگو	شناسایی مستقیم	شناسایی (غیرمستقیم / ناقص)	شناسایی نادرست	میانگین ARL متناظر با هر الگو
Upward Shift (Aggregate)	70.42	22.36	7.22	<b>11.00</b>
Downward Shift (Aggregate)	74.17	20.28	5.56	<b>11.00</b>
Upward Trend (Aggregate)	54.67	31.42	13.92	<b>12.78</b>
Downward Trend (Aggregate)	58.94	25.94	15.11	<b>12.78</b>
Cycle (T = 8) (Aggregate)	91.62	2.75	5.63	<b>9.56</b>
Cycle (T = 12) (Aggregate)	92.50	0.61	6.89	<b>11.22</b>
Systematic (K = 0) (Aggregate)	95.56	0.00	4.44	<b>8.56</b>
Systematic (K = 1) (Aggregate)	96.28	0.00	3.72	<b>8.56</b>
Upward Shift + Upward Trend (Aggregate)	76.31	21.61	2.08	<b>10.56</b>
Downward Shift + Downward Trend (Aggregate)	77.50	21.06	1.44	<b>10.56</b>
Shift + Cycle (T = 8) (Aggregate)	80.09	1.75	18.16	<b>10.00</b>
Shift + Cycle (T = 10) (Aggregate)	86.19	2.56	11.25	<b>11.50</b>
Trend + Cycle (T = 8) (Aggregate)	85.58	11.40	3.03	<b>11.00</b>
Trend + Cycle (T = 10) (Aggregate)	86.03	9.03	4.95	<b>11.60</b>

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<i>Sh.+Tr. (Network F)</i>			<i>Sh. + Cyc. (Network G)</i>				<i>Tr. + Cyc. (Network H)</i>			
<i>Neuron</i>	<i>Parameter "b"</i>	<i>Parameter "s"</i>	<i>Neuron</i>	<i>Parameter "b"</i>	<i>Parameter "l"</i>	<i>Parameter "T"</i>	<i>Neuron</i>	<i>Parameter "s"</i>	<i>Parameter "l"</i>	<i>Parameter "T"</i>
5	0.128	0.0128	5	0.126	0.125	0.009	5	0.013	0.131	0.066
7	0.126	0.0126	10	0.121	0.121	0.007	10	0.013	0.128	0.072
10	0.1	0.01	11	0.128	0.127	0.005	15	0.013	0.127	0.07
12	0.102	0.0102	12	0.122	0.122	0.007	18	0.013	0.126	0.08
15	0.106	0.0106	14	0.122	0.122	0.035	20	0.013	0.127	0.102
18	0.105	0.0105	15	0.122	0.123	0.007	22	0.012	0.124	0.07
20	0.101	0.0101	16	0.123	0.123	0.021	24	0.012	0.126	0.08
21	0.101	0.0101	17	0.119	0.119	0.006	25	0.012	0.123	0.102
22	0.1	0.01	18	0.108	0.108	0.007	28	0.012	0.123	0.09
23	0.099	0.0099	19	0.124	0.124	0.021	30	0.012	0.123	0.089
24	0.099	0.0099	20	0.123	0.123	0.008				
25	0.098	0.0098	22	0.123	0.123	0.016				
26	0.099	0.0099	24	0.115	0.115	0.07				
27	0.098	0.0098	25	0.112	0.112	0.013				
28	0.1	0.01	26	0.113	0.113	0.01				
29	0.1	0.01	28	0.108	0.108	0.005				
30	0.099	0.0099	30	0.133	0.133	0.013				
35	0.1	0.01	35	0.125	0.125	0.004				
40	0.099	0.0099								

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	<i>b</i>		<i>s</i>	
<b><i>Upward Shift + Upward Trend</i></b>	<b>Mean</b>	<b>S.D.</b>	<b>Mean</b>	<b>S.D.</b>
<i>b = 0.75 , s = 0.075</i>	0.804	0.130	0.080	0.013
<i>b = 0.9375 , s = 0.09375</i>	0.962	0.115	0.096	0.011
<i>b = 1.125 , s = 0.1125</i>	1.133	0.116	0.113	0.012
<i>b = 1.3125 , s = 0.13125</i>	1.333	0.132	0.133	0.013
<i>b = 1.5 , s = 0.15</i>	1.510	0.108	0.151	0.011
<i>b = 1.6875 , s = 0.16875</i>	1.668	0.121	0.167	0.012
<i>b = 1.875 , s = 0.1875</i>	1.849	0.127	0.185	0.013
<i>b = 2.0625 , s = 0.20625</i>	2.029	0.107	0.203	0.011
<i>b = 2.25 , s = 0.225</i>	2.190	0.107	0.219	0.011
<b><i>Downward Shift + Downward Trend</i></b>	<b>Mean</b>	<b>S.D.</b>	<b>Mean</b>	<b>S.D.</b>
<i>b = -0.75 , s = -0.075</i>	-0.788	0.115	-0.079	0.012
<i>b = -0.9375 , s = -0.09375</i>	-0.966	0.118	-0.096	0.012
<i>b = -1.125 , s = -0.1125</i>	-1.130	0.114	-0.113	0.011
<i>b = -1.3125 , s = -0.13125</i>	-1.330	0.134	-0.133	0.013
<i>b = -1.5 , s = -0.15</i>	-1.502	0.126	-0.150	0.013
<i>b = -1.6875 , s = -0.16875</i>	-1.661	0.116	-0.166	0.012
<i>b = -1.875 , s = -0.1875</i>	-1.849	0.109	-0.185	0.011
<i>b = -2.0625 , s = -0.20625</i>	-2.030	0.122	-0.203	0.012
<i>b = -2.25 , s = -0.225</i>	-2.197	0.122	-0.219	0.012

		<i>b</i>		<i>l</i>		<i>T</i>	
<b>Shift + Cycle (T = 8)</b>		<b>Mean</b>	<b>S.D.</b>	<b>Mean</b>	<b>S.D.</b>	<b>Mean</b>	<b>S.D.</b>
<i>b = 1, l = 1</i>		1.069	0.087	1.069	0.087	8.017	0.155
<i>b = 1.125, l = 1.125</i>		1.153	0.128	1.153	0.128	8.003	0.061
<i>b = 1.3125, l = 1.3125</i>		1.309	0.109	1.309	0.109	7.997	0.020
<i>b = 1.5, l = 1.5</i>		1.513	0.167	1.513	0.167	7.998	0.004
<i>b = 1.6875, l = 1.6875</i>		1.703	0.131	1.703	0.131	7.999	0.005
<i>b = 1.875, l = 1.875</i>		1.862	0.154	1.862	0.154	8.000	0.004
<i>b = 2.0625, l = 2.0625</i>		2.023	0.124	2.023	0.124	8.001	0.004
<i>b = 2.25, l = 2.25</i>		2.165	0.106	2.165	0.106	8.002	0.003
		<i>b</i>		<i>l</i>		<i>T</i>	
<b>Shift + Cycle (T = 10)</b>		<b>Mean</b>	<b>S.D.</b>	<b>Mean</b>	<b>S.D.</b>	<b>Mean</b>	<b>S.D.</b>
<i>b = 1, l = 1</i>		1.095	0.087	1.095	0.087	9.984	0.151
<i>b = 1.125, l = 1.125</i>		1.171	0.127	1.171	0.126	10.000	0.025
<i>b = 1.3125, l = 1.3125</i>		1.322	0.120	1.322	0.120	10.003	0.005
<i>b = 1.5, l = 1.5</i>		1.498	0.130	1.498	0.130	10.000	0.025
<i>b = 1.6875, l = 1.6875</i>		1.690	0.162	1.690	0.162	10.001	0.004
<i>b = 1.875, l = 1.875</i>		1.861	0.126	1.861	0.126	10.000	0.004
<i>b = 2.0625, l = 2.0625</i>		2.018	0.162	2.018	0.162	10.000	0.004
<i>b = 2.25, l = 2.25</i>		2.150	0.101	2.150	0.101	9.999	0.003
		<i>s</i>		<i>l</i>		<i>T</i>	
<b>Trend + Cycle (T = 8)</b>		<b>Mean</b>	<b>S.D.</b>	<b>Mean</b>	<b>S.D.</b>	<b>Mean</b>	<b>S.D.</b>
<i>s = 0.1, l = 1</i>		0.106	0.014	1.064	0.140	8.159	0.347
<i>s = 0.1125, l = 1.125</i>		0.114	0.014	1.137	0.141	8.140	0.373
<i>s = 0.13125, l = 1.3125</i>		0.130	0.015	1.301	0.155	8.043	0.140
<i>s = 0.15, l = 1.5</i>		0.147	0.020	1.478	0.196	8.047	0.132
<i>s = 0.16875, l = 1.6875</i>		0.167	0.019	1.671	0.194	8.043	0.132
<i>s = 0.1875, l = 1.875</i>		0.186	0.016	1.869	0.157	8.023	0.055
<i>s = 0.20625, l = 2.0625</i>		0.203	0.013	2.041	0.131	8.020	0.046
<i>s = 0.225, l = 2.25</i>		0.215	0.010	2.154	0.096	8.025	0.046
		<i>s</i>		<i>l</i>		<i>T</i>	
<b>Trend + Cycle (T = 10)</b>		<b>Mean</b>	<b>S.D.</b>	<b>Mean</b>	<b>S.D.</b>	<b>Mean</b>	<b>S.D.</b>
<i>s = 0.1, l = 1</i>		0.108	0.011	1.072	0.114	9.865	0.314
<i>s = 0.1125, l = 1.125</i>		0.113	0.013	1.127	0.134	9.876	0.326
<i>s = 0.13125, l = 1.3125</i>		0.131	0.017	1.306	0.173	9.938	0.196
<i>s = 0.15, l = 1.5</i>		0.147	0.021	1.469	0.212	9.945	0.220
<i>s = 0.16875, l = 1.6875</i>		0.169	0.018	1.695	0.181	9.996	0.101
<i>s = 0.1875, l = 1.875</i>		0.187	0.016	1.871	0.163	9.995	0.095
<i>s = 0.20625, l = 2.0625</i>		0.200	0.017	2.008	0.173	9.999	0.084
<i>s = 0.225, l = 2.25</i>		0.215	0.010	2.160	0.104	9.998	0.054

. ARL :

		U. Shift	D. Shift	U. Trend	D. Trend	Cyc. (T=8)	Sys. (K=0)
	Max . of ARL	13	13	15	15	13	12
	Ave . of ARL	11	11	12.78	12.78	9.56	8.56
	Min . of ARL	10	10	12	12	9	7
Ruey Guth	Max . of ARL	9	11	11	10	20	22
	Ave . of ARL	6	7.3	9.78	9.67	12.3	12
	Min . of ARL	5	5	9	9	7	7

. ARL :

	Cyc. (T=12)	Sys. (K=1)	U. Shift + U. Trend	U. Shift + U. Trend	U. Shift + Cyc (8)	U. Shift + Cyc (10)	U. Trend + Cyc (8)	U. Trend + Cyc (10)
Max . of ARL	13	12	12	12	10	12	11	12
Ave . of ARL	11.22	8.56	10.56	10.56	10	11.5	11	11.60
Min . of ARL	11	7	10	10	10	11	11	11

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Sys.

$$un(t) = g \cdot \cos(\pi t + k\pi); k = 0,1$$

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$$un(t) = g \cdot (-1)^t$$

$$un(t) = g \cdot \cos(\pi t)$$

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$$un(t) = l \cdot \sin\left(\frac{2\pi t}{T} + \frac{2k\pi}{T}\right); k = 0,1,2,\dots, T-1$$

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MLP LVQ

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Cyc.

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- 1 - Chang, S. I. and Aw, C. (1996). "A neural fuzzy control chart for detecting and classifying process mean shifts." *International Journal of Production Research*, Vol. 34, No. 8, PP. 2265–2278.
  - 2 - Cheng, C. S. (1995). "A multi-layer neural network model for detecting changes in the process mean." *Computers & Industrial Engineering*, Vol. 28, No. 1, PP. 51–61.
  - 3 - Cheng, C. S. (1997). "A neural network approach for the analysis of control chart patterns." *International Journal of Production Research*, Vol. 35, No. 3, PP. 667–697.
  - 4 - Chiu, C., Chen, M. and Lee, K. (2001). "Shifts recognition in correlated process data using a neural network." *International Journal of Systems Science*, Vol. 32, No.2, PP. 137–143.
  - 5 - Guh, R. S. and Hsieh, Y. (1999). "A neural network based model for abnormal pattern recognition of control charts." *Computers & Industrial Engineering*, Vol. 36, PP. 97–108.
  - 6 - Guh, R. S., Zorriassatine, F. and O'Brien, C. (1999). "On line control chart pattern detection and discrimination \_ a neural network approach." *Artificial Intelligence in Engineering*, Vol. 13, PP. 413–425.
  - 7- Guh, R. S. and Tannock, J. (1999). "Recognition of control chart concurrent patterns using a neural network approach." *International Journal of Production Research*, Vol. 37, No. 8, PP. 1743–1765.
-

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- 8 - Guh, R. S. (2004). "Optimizing feed forward neural networks for control chart pattern recognition through genetic algorithms." *International Journal of Pattern Recognition and Artificial Intelligence*, Vol. 18, No. 2, PP. 75–99.
  - 9 - Guh, R. S. (2005). "A hybrid learning-based model for on line detection and analysis of control chart patterns." *Computers & Industrial Engineering*, Vol. 49, PP. 35–62.
  - 10- Hwang, H. B. (1995). "Proper and effective training of a pattern recognizer for cyclic data." *IIE Transactions*, Vol. 27, No. 6, PP. 746–756.
  - 11- Pham, D. T. and Oztemel, E. (1994). "Control chart pattern recognition using learning vector quantization networks." *International Journal of Production Research*, Vol. 32, No. 3, PP. 721–729.
  - 12 - Pham, D. T. and Sagiroglu, S. (2001). "Training multilayered perceptrons for pattern recognition: a comparative study of four training algorithms." *International Journal of Machine Tools & Manufacture*, Vol. 41, PP. 419–430.
  - 13- Grant, E. L. and Leavenworth, R. S. (1996). *Statistical Quality Control*. 7 th Ed., McGraw-Hill Book Company, New York.
  - 14 - Hagan, M. T., Demuth, H. and Beale, M. (1996). *Neural Network Design*, PWS Pub. Co., Boston, USA.
  - 15 - Montgomery, D. C. (2001). *Introduction to Statistical Quality Control*. 4 th Ed., Wiley Pub. Co., New York.

- 1- On line statistical process control
  - 2- Pattern Recognition
  - 3- Shewhart
  - 4- Single / Concurrent Pattern
  - 5- Back Propagation (BP)
  - 6- Quick-Prop (QP), Delta-Bar-Delta (DBD), Extended-Delta-Bar-Delta (EDBD)
  - 7- Shift magnitude
  - 8- Trend slope
  - 9- Amplitude
  - 10- Period
  - 11- Magnitude of fluctuation
  - 12- In Control – Average Run Length (ARL)
  - 13 - Learning Vector Quantization (LVQ)
  - 14- Mean Absolute Deviation (MAD)
  - 15- Levenberg – Marquardt (LM)
  - 16- Multi Layer Perceptron (MLP)
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