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(SO/MO

NBS

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(SP/MP

(DOD)

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(SI/MI)

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[]	(WOD/WD)	
	(Det/Prb)	◀
()) /	◀
	(SS/MS)	
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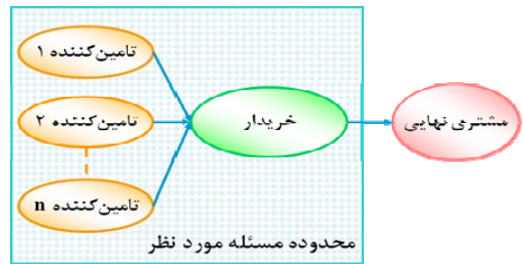
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	$(i=1,2,\dots,n)$	n	
i		$:l_i$	
i		$:\alpha_i$	
	i	$:C_i$	
	i	$:A_i$	
		r	↖
	i	$:z_i$	↖
	i	$:S_i$	↖
	i	$:G_i$	(\quad) ↖
		$:E$	↖
		$:F$	↖
		$:K$	↖
		$:$	↖
	(\quad)	$:T$	↖
		$:Q$	↖
i		$:Q_i$	
	$(\sum_{i=1}^n Q_i = Q \quad Q=DT)$		↖
i		$:x_i$	↖
	$x_i = \frac{1}{T} Q_i \sum_{i=1}^n x_i = D)$		
	$(0 \leq x_i \leq D)$		
i		$:Y_i$	(1)
		Z_1	
		"	
	Z_2	"	
	"	"	
		Z_3	
		$:$	
	(\quad)		$:D$



$$\text{Max } Z_1 = \sum_i \alpha_i x_i \quad ()$$

$$\text{Min } Z_2 = \sum_i l_i x_i \quad ()$$

$$\text{Min } Z_3 = \sum_i (C_i + z_i + (E + F)l_i + K(1 - \alpha_i))x_i + \frac{rQ}{2D^2} \sum_i C_i x_i^2 + \frac{D}{Q} \sum_i (A_i + S_i)Y_i \quad ()$$

s.t.

$$\sum_{i=1}^n x_i = D \quad ()$$

$$0 \leq x_i \leq G_i \quad \forall i = 1, 2, \dots, n \quad ()$$

$$x_i \leq DY_i \quad \forall i = 1, 2, \dots, n \quad ()$$

$$x_i \geq \varepsilon Y_i \quad \forall i = 1, 2, \dots, n \quad ()$$

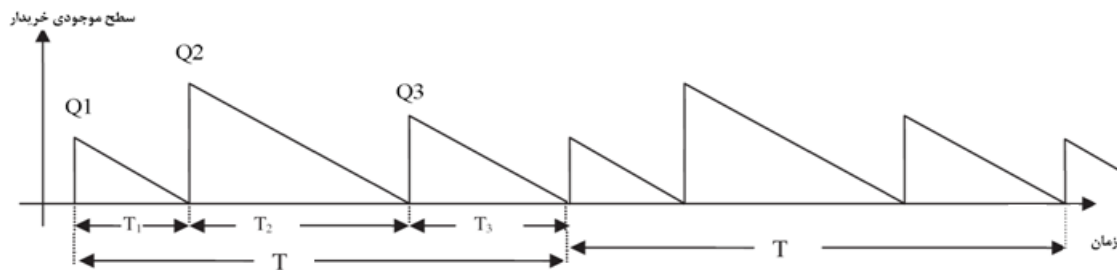
$$Y_i = \{0, 1\} \quad \forall i = 1, 2, \dots, n \quad ()$$

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(SO, MP, SI, WOD, Det, MS)	[]
(SO, MP, SI, WD, Det, MS)	[]
(SO, MP, SI, WD, Prb, MS)	[]
(MO, SP, SI, WD, Prb, MS)	[]
(MO, MP, MI, WD, Det, MS)	[]
(SO, MP, SI, WOD, Det, MS)	[]
(MO, MP, MI, WOD, Det, MS)	[]

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$\sum_i C_i x_i$:	$\sum_i z_i x_i$:
$\frac{D}{Q} \sum_i A_i Y_i$:	$\frac{D}{Q} \sum_i S_i Y_i$:
$\frac{rQ}{2D^2} \sum_i C_i x_i^2$:	$E \sum_i l_i x_i$:
$F \sum_i l_i x_i$:	$K \sum_i (1 - \alpha_i) x_i$:



:

$$\frac{\partial Z_3}{\partial Q} = 0 \Rightarrow Q^* = \sqrt{\frac{2D^3 \sum_i (A_i + S_i) Y_i}{r \sum_i C_i x_i^2}}$$

$$\text{Max } Z_1 = \sum_i \alpha_i x_i \quad (1)$$

$$\text{Min } Z_2 = \sum_i l_i x_i \quad (2)$$

$$\text{Min } Z_3 = \sum_i (C_i + z_i + (E + F)l_i + K(1 - \alpha_i))x_i + \sqrt{\frac{2r}{D} \sum_i (A_i + S_i) Y_i} \times \sqrt{\sum_i C_i x_i^2} \quad (3)$$

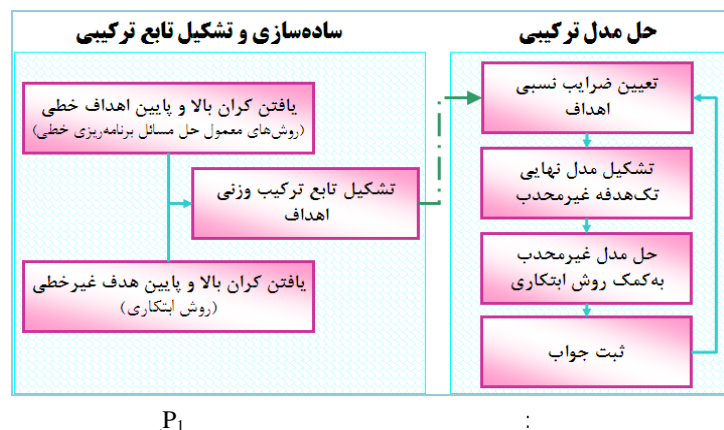
$$s.t. \quad \sum_{i=1}^n x_i = D \quad \text{Problem (P)} \quad (4)$$

$$0 \leq x_i \leq G_i \quad \forall i = 1, 2, \dots, n \quad (5)$$

$$x_i \leq D Y_i \quad \forall i = 1, 2, \dots, n \quad (6)$$

$$x_i \geq \varepsilon Y_i \quad \forall i = 1, 2, \dots, n \quad (7)$$

$$Y_i = \{0, 1\} \quad \forall i = 1, 2, \dots, n \quad (8)$$



x_i
 (y_i)
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 y_i
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 $([] [] [] [] y_i)$

NP-Hard

NP-Hard

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([])

y_i

[]

(w_1, w_2, \dots, w_k)

[]

P_1

Z_i^-

Z_i^+

P_1

$$\text{Min } Z(X) = w_1 \left(\frac{Z_1^+ - Z_1}{Z_1^+ - Z_1^-} \right) + w_2 \left(\frac{Z_2 - Z_2^-}{Z_2^+ - Z_2^-} \right) + w_3 \left(\frac{Z_3 - Z_3^-}{Z_3^+ - Z_3^-} \right) \quad ()$$

s.t.

$$Z_1 = \sum_i \alpha_i x_i \quad ()$$

$$Z_2 = \sum_i l_i x_i \quad ()$$

$$Z_3 = \sum_i (C_i + z_i + (E + F)l_i + K(1 - \alpha_i))x_i + \sqrt{\frac{2r}{D} \sum_i (A_i + S_i)Y_i} \times \sqrt{\sum_i C_i x_i^2} \quad ()$$

$$\sum_{i=1}^n x_i = D \quad \text{Problem } (P_1) \quad ()$$

$$0 \leq x_i \leq G_i \quad \forall i = 1, 2, \dots, n \quad ()$$

$$x_i \leq DY_i \quad \forall i = 1, 2, \dots, n \quad ()$$

$$x_i \geq \epsilon Y_i \quad \forall i = 1, 2, \dots, n \quad ()$$

$$Y_i \in \{0, 1\} \quad \forall i = 1, 2, \dots, n \quad ()$$

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Matlab

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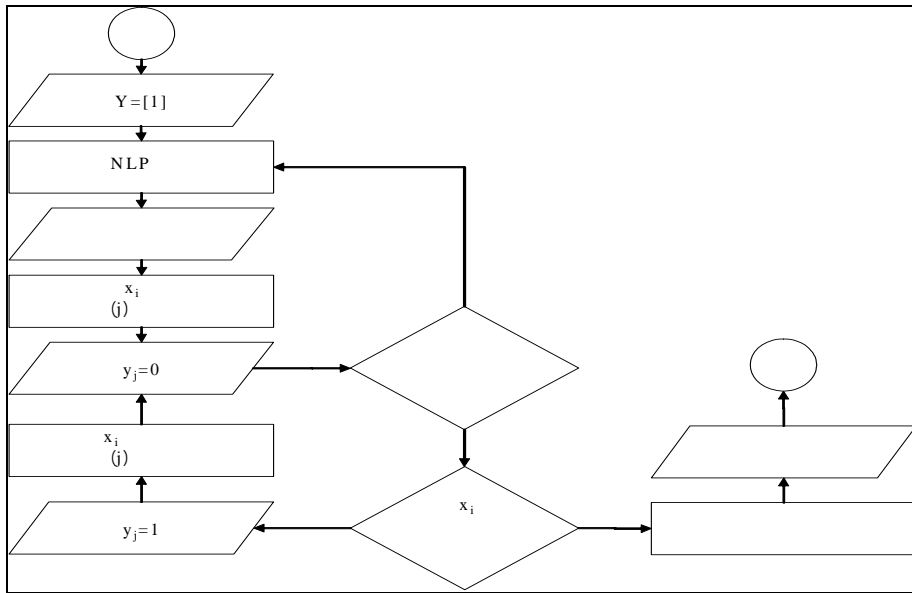
(

) n

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E = 65
F = 35
K = 40

r = 0.25
 $\epsilon = 10^{-14}$



D n

n	D	Feasible Nodes	Elapsed Time (Sec)	
			Exact	Heuristic
3	1000	4	2.79	2.21
4	1600	5	2.97	2.74
5	1800	9	2.42	2.03
6	2000	22	3.12	2.26
7	2300	52	5.37	2.24
9	3000	136	13.752	2.27
11	3600	543	61.45	2.57
13	4100	2436	319.18	2.64
15	4300	13148	1937.4	3.32
17	5000	43977	8114.35	3.7
18	5700	53644	9977.52	3.68

P_1

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P_1

(n=60)

(D=19500)

(Z)

$$\begin{aligned} E &= 65 & r &= 0.25 \\ F &= 35 & \varepsilon &= 10^{-14} \\ K &= 40 \end{aligned}$$

P_1

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(Z)

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(Z)

P_1

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P_1

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(Z)

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$$Z = w_1 \left(\frac{Z_1^+ - Z_1^-}{Z_1^+ - Z_1^-} \right) + w_2 \left(\frac{Z_2 - Z_2^-}{Z_2^+ - Z_2^-} \right) + w_3 \left(\frac{Z_3 - Z_3^-}{Z_3^+ - Z_3^-} \right) ()$$

()

(Z)

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$$\text{Max } Z_1^2 = \sum_i \alpha_i x_i \quad ()$$

$$\text{Min } Z_2^2 = \sum_i l_i x_i \quad ()$$

$$\text{Min } Z_3^2 = \sum_i (z_i + El_i + K(1 - \alpha_i))x_i + \frac{D}{Q} \sum_i S_i Y_i$$

$$\text{s.t.} \quad ()$$

$$\sum_{i=1}^n x_i = D \quad ()$$

$$0 \leq x_i \leq G_i \quad \forall i = 1, 2, \dots, n \quad ()$$

$$x_i \leq DY_i \quad \forall i = 1, 2, \dots, n \quad ()$$

$$x_i \geq \varepsilon Y_i \quad \forall i = 1, 2, \dots, n \quad ()$$

$$Y_i = \{0, 1\} \quad \forall i = 1, 2, \dots, n \quad ()$$

x_i

$$\sum_i (C_i + Fl_i)x_i + \frac{r}{2D} \sum_i C_i x_i^2 + \sum_i A_i Y_i \quad ()$$

$$Q=D$$

$$()$$

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$$\text{Max } Z_1^1 = \sum_i \alpha_i x_i \quad ()$$

$$\text{Min } Z_2^1 = \sum_i l_i x_i \quad ()$$

$$\text{Min } Z_3^1 = \sum_i (C_i + Fl_i)x_i + \frac{rQ}{2D^2} \sum_i C_i x_i^2 + \frac{D}{Q} \sum_i A_i Y_i \quad ()$$

s.t.

$$\sum_{i=1}^n x_i = D \quad ()$$

$$0 \leq x_i \leq G_i \quad \forall i = 1, 2, \dots, n \quad ()$$

$$x_i \leq DY_i \quad \forall i = 1, 2, \dots, n \quad ()$$

$$x_i \geq \varepsilon Y_i \quad \forall i = 1, 2, \dots, n \quad ()$$

$$Y_i = \{0, 1\} \quad \forall i = 1, 2, \dots, n \quad ()$$

x_i

:

$$\sum_i (z_i + El_i + K(1 - \alpha_i))x_i + \frac{D}{Q} \sum_i S_i Y_i \quad ()$$

$$()$$

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$$\bar{D} = -0.05039 \Rightarrow t = -15.5938$$

$$S_D = 0.043711$$

t

α

$$(-\infty, 1.645]$$

() ()

D

n-1

() ()

$$t = \frac{\bar{D}\sqrt{n}}{S_D}$$

S_D

\bar{D}

$$S_D = \sqrt{\frac{\sum_{i=1}^n (D_i - \bar{D})^2}{n-1}} \quad ()$$

A

H

$$H : D = 0$$

$$A : D > 0$$

$$(-\infty, t_{\alpha; n-1}]$$

$t_{\alpha; n-1}$

$$\alpha = 0.05$$

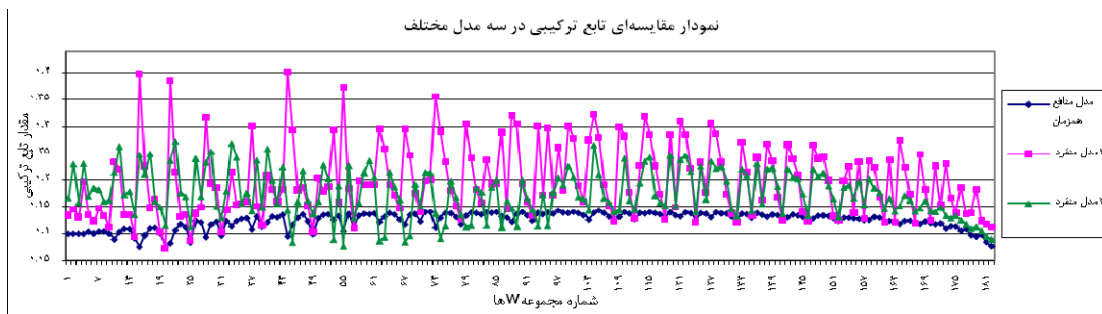
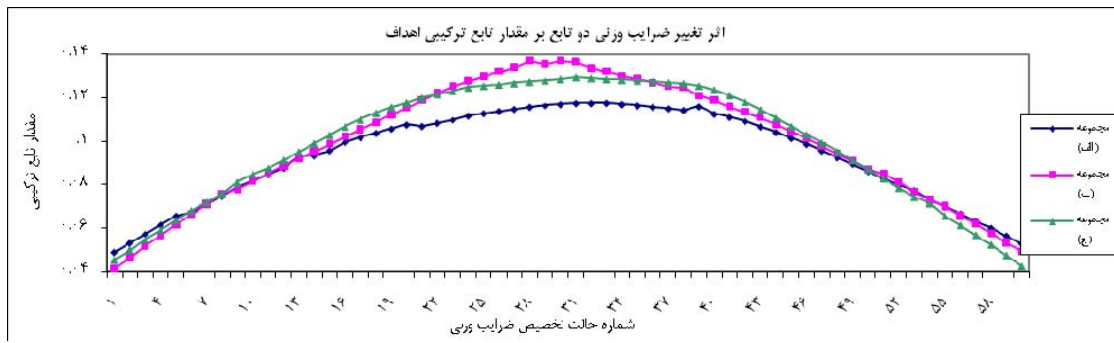
$$t_{0.05, 182} = 1.645$$

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$$\bar{D} = -0.07523 \Rightarrow t = -15.2786$$

$$S_D = 0.066611$$

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- 1- Supplier Selection
2- Vendor Selection
3- National Bureau of Standards
4- Department Of Defense
5- Joint Economic Lot-sizing Problem
6- (CPU: AMD 2800+) & (RAM: 512 MB)
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(i) Supplier Number	C_i	L_i	$Alfa_i$	G_i	z_i	A_i	S_i
1	112	0.05	0.98	570	93	7450	9800
2	118	0.08	0.94	670	89	6120	9400
3	114	0.02	0.96	450	90	6590	8600
4	117	0.04	0.97	590	91	6890	9300
5	119	0.01	0.97	610	90	6410	8970
6	120	0.01	0.99	590	89	6700	9100
7	111	0.07	0.95	640	92	6300	9500
8	115	0.05	0.96	470	86	7100	9210
9	108	0.01	0.98	360	88	7800	9700
10	127	0.01	0.99	680	86	6320	9460
11	113	0.02	0.95	370	85	7430	8920
12	119	0.01	0.98	460	88	6210	9310
13	117	0.04	0.97	640	94	6030	9000
14	117	0.09	0.93	420	91	6320	9530
15	118	0.02	0.96	530	90	6490	9620
16	111	0.06	0.99	610	88	7310	9700
17	125	0.05	0.94	370	87	7000	9900
18	128	0.06	0.92	430	89	7040	9510
19	112	0.08	0.93	510	90	6910	9010
20	110	0.04	0.98	610	92	6520	8510
21	126	0.05	0.96	700	87	6050	8490
22	121	0.02	0.95	630	85	7360	8670
23	126	0.03	0.94	600	93	6710	8930
24	127	0.08	0.92	520	86	6800	9780
25	118	0.07	0.93	500	89	6530	9460
26	115	0.1	0.94	610	93	6490	9810
27	116	0.06	0.95	360	92	7080	9020
28	118	0.1	0.91	380	94	7210	8670
29	120	0.04	0.93	390	87	6620	8460
30	129	0.09	0.98	490	91	7090	9120
31	121	0.01	0.97	470	86	7420	9240
32	127	0.04	0.98	610	98	6260	8620
33	115	0.05	0.95	520	89	7150	9510
34	119	0.09	0.96	460	87	6540	8450
35	115	0.03	0.92	790	97	7480	9840
36	129	0.02	0.91	570	86	6870	9740
37	117	0.04	0.94	390	94	6390	9980
38	114	0.07	0.98	640	95	6330	8360
39	113	0.06	0.96	790	89	7610	9130
40	126	0.02	0.95	460	92	6520	8220
41	128	0.05	0.92	590	85	7580	8840
42	124	0.01	0.93	680	87	6970	8770
43	123	0.08	0.93	540	86	7250	9560
44	120	0.09	0.99	480	98	7530	9320
45	120	0.03	0.96	630	97	7420	8240
46	118	0.01	0.95	540	92	6990	9960
47	129	0.04	0.98	720	93	6640	8830
48	122	0.07	0.94	740	92	7980	9390
49	119	0.08	0.91	730	84	7360	8330
50	116	0.02	0.98	490	95	6230	9620
51	118	0.03	0.96	380	89	7720	9570
52	125	0.06	0.95	540	98	6240	8720
53	116	0.05	0.93	800	87	6270	8920
54	127	0.04	0.98	460	97	6730	9210
55	117	0.07	0.98	690	85	7120	8510
56	115	0.08	0.96	720	96	7340	9430
57	116	0.02	0.93	390	82	6560	8950
58	123	0.03	0.98	710	91	6430	9640
59	124	0.01	0.98	450	89	7220	8220
60	120	0.09	0.96	550	99	6810	9180

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10	1	60	10	31	30
10	2	59	10	32	29
10	3	58	10	33	28
10	4	57	10	34	27
10	5	56	10	35	26
10	6	55	10	36	25
10	7	54	10	37	24
10	8	53	10	38	23
10	9	52	10	39	22
10	10	51	10	40	21
10	11	50	10	41	20
10	12	49	10	42	19
10	13	48	10	43	18
10	14	47	10	44	17
10	15	46	10	45	16
10	16	45	10	46	15
10	17	44	10	47	14
10	18	43	10	48	13
10	19	42	10	49	12
10	20	41	10	50	11
10	21	40	10	51	10
10	22	39	10	52	9
10	23	38	10	53	8
10	24	37	10	54	7
10	25	36	10	55	6
10	26	35	10	56	5
10	27	34	10	57	4
10	28	33	10	58	3
10	29	32	10	59	2
10	30	31	10	60	1
