

DATA

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Ikegami-2shift-DATA1[1]

Table 1 shows the shift constraints and Tables 2 through to 5 show the nurse constraints.

Ikegami-3shift-DATA1[1]

Table 6 shows the shift constraints and Tables 7 through to 10 show the nurse constraints.

Ikegami-3shift-DATA1.1[1]

Add to Ikegami-3shift-DATA1: a night shift should be avoided for the following (nurse i , day j): (2,8), (2,17), (3,1), (4,10), (4,24), (5,21), (6,15), (8,24), (9,11), (9,22), (11,8), (12,6), (13,8), (13,23), (14,26), (15,17), (16,19), (17,19), (18,9), (19,22), (20,8), (20,17), (21,7), (22,8), (23,8), (24,1), (24,24).

Ikegami-3shift-DATA1.2

Add to Ikegami-3shift-DATA1.1: for nurse 19, evening shifts and night shifts should be avoided on day 1~3, 6, 8~10, 13~15, 17, 20~22 and 27~30.

Table 1: Lower and upper bounds for nurses belonging to groups (2shift-DATA1)

(- : day shift, Nn : night shift, L : lower bound, U : upper bound)

Group	All		A		B		C		Skilled		A-ss		B-ss		C-ss		RQ																			
Member (No.)	all		1,...,10		11,...,19		20,...,28		1,2,3,11,12,20,21		1,...,7		11,...,17		20,...,26		8,9,10,18,19,27,28																			
Shift	-		Nn		-		Nn		-		Nn		-		Nn		-		Nn																	
Bound	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U																
1 F	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
2 S	9	10	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
3 S	9	9	4	4	3	3	1	2	3	3	1	2	3	3	1	2	1	3	1	2	2	3	1	2	2	3	1	2	2	3	1	2	0	7	0	1
4 H	9	9	4	4	3	3	1	2	3	3	1	2	3	3	1	2	1	3	1	2	2	3	1	2	2	3	1	2	2	3	1	2	0	7	0	1
5 T	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
6 W	12	14	4	4	4	5	1	2	4	5	1	2	4	5	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
7 T	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
8 F	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
9 S	9	10	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
10 S	9	9	4	4	3	3	1	2	3	3	1	2	3	3	1	2	1	3	1	2	2	3	1	2	2	3	1	2	2	3	1	2	0	7	0	1
11 M	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
12 T	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
13 W	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
14 T	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
15 F	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
16 S	9	10	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
17 S	9	9	4	4	3	3	1	2	3	3	1	2	3	3	1	2	1	3	1	2	2	3	1	2	2	3	1	2	2	3	1	2	0	7	0	1
18 M	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
19 T	12	14	4	4	4	5	1	2	4	5	1	2	4	5	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
20 W	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
21 T	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
22 F	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
23 H	9	10	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
24 S	9	9	4	4	3	3	1	2	3	3	1	2	3	3	1	2	1	3	1	2	2	3	1	2	2	3	1	2	2	3	1	2	0	7	0	1
25 M	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
26 T	12	16	4	4	4	6	1	2	4	6	1	2	4	6	1	2	1	3	1	2	2	5	1	2	2	5	1	2	2	5	1	2	0	7	0	1
27 W	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
28 T	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
29 F	10	11	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1
30 S	9	10	4	4	3	4	1	2	3	4	1	2	3	4	1	2	1	3	1	2	2	4	1	2	2	4	1	2	2	4	1	2	0	7	0	1

Table 2: Lower and upper bounds for consecutive shifts and intervals (2shift-DATA1)

	consecutive shifts		days between shifts	
	LB	UB	LB	UB
/ day off	1	5	1	6
- day shift	1	3	1	∞
Nn night shift	1	1	3	∞

Table 3: Arrangements of shifts that are not permitted (2shift-DATA1)

N	n	-	N	n	+	/	-	/	-	/
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Table 4: Lower and upper bounds for days-off, day shifts and night shifts (2shift-DATA1)

Team	Nurse No.	Skill Level	off		day		night		weekends-off(*)	
			LB	UB	LB	UB	LB	UB	LB	UB
A	1	skilled	9	10	9	12	4	5	1	2
	2	skilled	9	10	10	13	4	5	1	2
	3	skilled	9	10	10	13	4	5	1	2
	4	second-year	9	10	10	13	4	5	1	2
	5	second-year	9	10	10	13	4	5	1	2
	6	second-year	9	10	10	13	4	5	1	2
	7	second-year	9	10	9	12	4	5	1	2
	8	recently qualified	9	10	8	11	4	5	1	2
	9	recently qualified	9	10	9	12	4	5	1	2
	10	recently qualified	9	10	10	13	4	5	1	2
B	11	skilled	9	10	9	12	4	5	1	2
	12	skilled	9	10	10	13	4	5	1	2
	13	second-year	9	10	10	13	4	5	1	2
	14	second-year	9	10	10	13	4	5	1	2
	15	second-year	9	10	9	12	4	5	1	2
	16	second-year	9	10	10	13	4	5	1	2
	17	second-year	9	10	9	12	4	5	1	2
	18	recently qualified	9	10	9	12	4	5	1	2
	19	recently qualified	8	10	18	20	0	0	1	2
C	20	skilled	9	10	10	13	4	5	1	2
	21	skilled	9	10	10	13	4	5	1	2
	22	second-year	9	10	10	13	4	5	1	2
	23	second-year	9	10	9	12	4	5	1	2
	24	second-year	9	10	9	12	4	5	1	2
	25	second-year	9	10	10	13	4	5	1	2
	26	second-year	9	10	9	12	4	5	1	2
	27	recently qualified	9	10	8	11	4	5	1	2
	28	recently qualified	9	10	14	17	2	3	1	2

(*) Every nurse wants at least one full weekend off from a choice of 2nd-3rd, 3rd-4th, 9th-10th, 16th-17th and 23rd-24th of the month (4th was a National Holiday).

Table 5: Schedule from the end of the previous month and nurses’ requests (2shift-DATA1)

Nurse No.	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30		
	S	S	M	T	W	T	F	S	S	H	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	H	S	M	T	W	T	F	S		
A	1	/	/	/	-	N	n	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
A	2	/	/	-	-	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
A	3	-	N	n	/	-	-	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
A	4	N	n	/	/	N	n	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
A	5	-	-	N	n	/	-	-	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
A	6	n	/	-	-	N	n	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
A	7	-	-	+	N	n	/	-	-	/	/	/	+	+	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
A	8	/	/	N	n	/	-	-	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
A	9	N	n	/	-	-	+	+	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
A	10	/	-	-	-	+	+	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
B	11	/	/	/	-	N	n	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
B	12	N	n	/	/	/	-	-	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
B	13	/	/	N	n	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
B	14	-	-	N	n	/	-	-	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
B	15	n	/	-	-	N	n	/	/	/	/	/	+	+	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
B	16	-	N	n	/	-	-	-	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
B	17	/	/	-	-	N	n	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
B	18	-	-	-	-	+	+	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
B	19	-	-	-	/	-	-	-	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
C	20	-	N	n	/	/	-	-	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
C	21	-	-	-	-	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
C	22	/	/	N	n	/	-	-	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
C	23	N	n	/	-	-	-	-	/	/	/	/	+	+	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
C	24	n	/	+	N	n	/	-	-	/	/	/	+	+	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
C	25	/	-	-	+	-	N	n	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
C	26	/	/	/	/	N	n	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
C	27	/	-	-	-	N	n	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
C	28	-	N	n	/	+	-	-	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/

(-:day shift, Nn:night shift, +:other work, /:day-off,
*:unable to work a night shift, x:unable to work a day shift)

Table 6: Lower and upper bounds for nurses belonging to groups (3shift-DATA1)

(- : day shift, Nn : night shift, L : lower bound, U : upper bound)

Group Member (No.)	All						A						B						A-ss						B-ss						B-ss+s'						B-rq+s'													
	all						1,...,13						14,...,25						1,...6						14,...,18						14,...,18,25						19,...,25						1,9							
Shift	-	e	n	-	e	n	-	e	n	-	e	n	-	e	n	-	e	n	-	e	n	-	e	n	-	e	n	-	e	n	-	e	n	-	e	n	-	e	n	-	e	n								
Bound	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U	L	U								
1	W	8	11	4	4	3	3	4	6	2	2	1	2	4	6	2	2	1	2	2	2	1	1	1	1	1	2	1	1	0	1	2	3	1	2	1	1	2	4	1	1	0	2	0	2	0	1	0	1	
2	T	8	11	4	4	3	3	4	6	2	2	1	2	4	6	2	2	1	2	2	3	1	1	1	1	1	3	1	1	0	1	2	3	1	2	1	1	2	6	1	1	0	2	0	2	0	1	0	1	
3	F	8	11	4	4	3	3	4	6	2	2	1	2	4	6	2	2	1	2	2	3	1	1	1	1	1	3	1	1	0	1	2	3	1	2	1	1	2	6	1	1	0	2	0	2	0	1	0	1	
4	S	8	11	4	4	3	3	4	6	2	2	1	2	4	6	2	2	1	2	2	3	1	1	1	1	1	3	1	1	0	1	2	3	1	2	1	1	2	6	1	1	0	2	0	2	0	1	0	1	
5	S	7	11	4	4	3	3	3	6	2	2	1	2	3	6	2	2	1	2	2	2	1	1	1	1	1	2	1	1	0	1	2	2	1	2	1	1	2	4	1	1	0	2	0	2	0	1	0	1	
6	M	8	11	4	4	3	3	4	6	2	2	1	2	4	6	2	2	1	2	2	3	1	1	1	1	1	3	1	1	0	1	2	3	1	2	1	1	2	6	1	1	0	2	0	2	0	1	0	1	
7	T	8	11	4	4	3	3	4	6	2	2	1	2	4	6	2	2	1	2	2	2	1	1	1	1	1	2	1	1	0	1	2	3	1	2	1	1	2	4	1	1	0	2	0	2	0	1	0	1	
8	W	8	11	4	4	3	3	4	6	2	2	1	2	4	6	2	2	1	2	2	3	1	1	1	1	1	3	1	1	0	1	2	3	1	2	1	1	2	6	1	1	0	2	0	2	0	1	0	1	
9	T	7	11	4	4	3	3	4	6	2	2	1	2	3	6	2	2	1	2	2	2	1	1	1	1	0	1	1	1	0	1	1	1	2	1	2	1	1	2	4	1	1	0	2	0	2	0	1	0	1
10	F	7	11	4	4	3	3	4	6	2	2	1	2	3	6	2	2	1	2	2	2	1	1	1	1	0	1	1	1	0	1	1	1	2	1	2	1	1	2	4	1	1	0	2	0	2	0	1	0	1
11	S	7	11	4	4	3	3	4	6	2	2	1	2	3	6	2	2	1	2	2	2	1	1	1	1	0	1	1	1	0	1	1	1	2	1	2	1	1	2	4	1	1	0	2	0	2	0	1	0	1
12	S	7	11	4	4	3	3	3	6	2	2	1	2	3	6	2	2	1	2	2	2	1	1	1	1	1	2	1	1	0	1	2	2	1	2	1	1	2	4	1	1	0	2	0	2	0	1	0	1	
13	M	7	11	4	4	3	3	4	6	2	2	1	2	3	6	2	2	1	2	2	2	1	1	1	1	0	1	1	1	0	1	1	1	2	1	2	1	1	2	4	1	1	0	2	0	2	0	1	0	1
14	T	8	11	4	4	3	3	4	6	2	2	1	2	4	6	2	2	1	2	2	2	1	1	1	1	1	2	1	1	0	1	2	3	1	2	1	1	2	4	1	1	0	2	0	2	0	1	0	1	
15	W	8	11	4	4	3	3	4	6	2	2	1	2	4	6	2	2	1	2	2	3	1	1	1	1	1	3	1	1	0	1	2	3	1	2	1	1	2	6	1	1	0	2	0	2	0	1	0	1	
16	T	8	11	4	4	3	3	4	6	2	2	1	2	4	6	2	2	1	2	2	2	1	1	1	1	1	2	1	1	0	1	2	3	1	2	1	1	2	4	1	1	0	2	0	2	0	1	0	1	
17	F	8	11	4	4	3	3	4	6	2	2	1	2	4	6	2	2	1	2	2	2	1	1	1	1	1	2	1	1	0	1	2	3	1	2	1	1	2	4	1	1	0	2	0	2	0	1	0	1	
18	S	8	11	4	4	3	3	4	6	2	2	1	2	4	6	2	2																																	

Table 7: Lower and upper bounds for consecutive shifts and intervals (3shift-DATA1)

		consecutive shifts		days between shifts	
		LB	UB	LB	UB
/	day off	1	5	2	6
d	day shift	1	4	1	6
e	evening shift	1	3	1	∞
n	night shift	2	2	6	∞

Table 8: Arrangements of shifts that are not permitted (3shift-DATA1)

n	-	n	+	n	e	e	-	e	+	n	/	-	n	/	+
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Table 9: Lower and upper bounds for days-off, shifts and weekends off (3shift-DATA1)

Team	Nurse No.	Skill Level	off		day		evening		night		weekends-off	
			LB	UB	LB	UB	LB	UB	LB	UB	LB	UB
A	1	skilled	9	10	0	15	4	6	2	4	0	2
	2	skilled	9	10	0	14	4	6	3	6	0	2
	3	skilled	9	10	0	14	4	6	3	6	0	2
	4	skilled	9	10	0	14	4	6	3	6	0	2
	5	skilled	9	10	0	14	4	6	3	6	0	2
	6	skilled	9	10	0	14	4	6	3	6	0	2
	7	recently qualified	9	10	0	15	4	6	2	4	0	2
	8	recently qualified	9	10	0	15	4	6	2	4	0	2
	9	recently qualified	9	10	0	15	4	6	2	4	0	2
	10	recently qualified	9	10	0	15	4	6	2	4	0	2
	11	recently qualified	9	10	0	15	4	6	2	4	0	2
	12	recently qualified	9	10	0	17	2	2	2	2	0	2
	13	recently qualified	9	10	0	15	4	6	2	4	0	2
B	14	skilled	9	10	0	14	4	6	3	6	0	2
	15	skilled	9	10	0	14	4	6	3	6	0	2
	16	skilled	9	10	0	14	4	6	3	6	0	2
	17	skilled	9	10	0	14	4	6	3	6	0	2
	18	skilled	9	10	0	14	4	6	3	6	0	2
	19	recently qualified	9	10	0	17	2	4	0	4	0	2
	20	recently qualified	9	10	0	15	4	6	2	4	0	2
	21	recently qualified	9	10	0	15	4	6	2	4	0	2
	22	recently qualified	9	10	0	15	4	6	2	4	0	2
	23	recently qualified	9	10	0	15	4	6	2	4	0	2
	24	recently qualified	9	10	0	15	4	6	2	4	0	2
	25	skilled'	9	10	0	14	4	6	3	6	0	2

Table 10: Schedule from the end of the previous month and nurses' requests (3shift-DATA1)

Nurse No.	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30			
	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T			
A	1	-	e	/	/	-	-																																
	2	-	-	/	-	n	n	/						/						+				/															
	3	n	/	e	e	e	+	-	/																														
	4	+	/	-	n	n	/								/	/										+				/	/								
	5	-	-	/	/	/	/																				+			/	/	/	/						
	6	e	n	n	/	-	e															/	/																
	7	e	/	/	e	e	e	/	-																														
	8	-	-	-	-	/	-									+																			/	/			
	9	-	/	/	-	n	n	/										/	/																/	/			
	10	/	/	-	-	-	+																		+														
	11	-	-	-	/	-	-							/	/										+														
	12	/	-	e	/	/	/							/	/	/								+															
	13	/	e	e	/	/	-						+		/	/	/																	/	/	/			
B	14	-	e	/	/	-	-									+	/	/	/																	/			
	15	e	/	n	n	/	+																		/														
	16	/	-	-	-	e	/												+						/	+													
	17	n	n	/	/	-	e																		+		/	/											
	18	-	-	e	e	n	n	/							/	/										+													
	19	-	/	n	n	/	-						+										+				+			/	/	/	/						
	20	-	-	/	/	/	-							/	/											/	/											+	
	21	+	/	-	-	-	e							/	/																							+	
	22	e	e	e	/	-	-	+						/	/																							+	
	23	/	-	-	e	e	/							/	/																							+	
	24	n	n	/	-	-	-		/	/																								/	/				
	25	-	-	-	/	/	-																																

(-:day shift, e:evening shift, n:night shift, +:other work, /:day-off)

Millar-2shift-DATA1[1][2]

This hospital runs 12-hours shifts (TD: day shift, TN: night shift). The number of nurses is 8 and there should be 2 nurses working at each shift. Each nurse works a maximum of 7 shifts over the two-week period. Each nurse receives at least one of the two weekends off. Work-stretches are restricted to 4 days, there must be at least 12 hours between shifts, and a nurse can work no more 3 consecutive night shifts. Single shift work-stretches should be avoided wherever possible. Avoidance of 4-day work-stretches is desirable. If a nurse is obliged to work 4-day work-stretches, he/she should get at least 2 days rest.

We set the following parameters for this problem.

Table 11: Lower and upper bounds for nurses (Millar-2shift-DATA1)

		TD (day shift)		TN (night shift)	
		LB	UB	LB	UB
1	M	2	2	2	2
2	T	2	2	2	2
3	W	2	2	2	2
4	T	2	2	2	2
5	F	2	2	2	2
6	S	2	2	2	2
7	S	2	2	2	2
8	M	2	2	2	2
9	T	2	2	2	2
10	W	2	2	2	2
11	T	2	2	2	2
12	F	2	2	2	2
13	S	2	2	2	2
14	S	2	2	2	2

Table 12: Lower and upper bounds for consecutive shifts and intervals (Millar-2shift-DATA1)

		consecutive shifts		days between shifts	
		LB	UB	LB	UB
	day off	1	4	2	3*
TD	day shift	1	4	1	∞
TN	night shift	1	3	1	∞

* When the upper bound for the days between 2 days-off is set to 3, Pattern 2 to 9 in the next table become meaningless because 4 consecutive works are not permitted. If 4 consecutive works are permitted, it must be set to 4.

Table 13: Arrangements of shifts that are not permitted (Millar-2shift-DATA1)

1	TN	TD				
2	TD	TD	TD	TD		TD
3	TD	TD	TD	TD		TN
4	TD	TD	TD	TN		TD
5	TD	TD	TD	TN		TN
6	TD	TD	TN	TN		TD
7	TD	TD	TN	TN		TN
8	TD	TN	TN	TN		TD
9	TD	TN	TN	TN		TN

Table 14: Lower and upper bounds for days-off, shifts and weekends off (Millar-2shift-DATA1)

Nurse No.	off		day		night		weekends-off	
	LB	UB	LB	UB	LB	UB	LB	UB
1	7	7	3	4	3	4	1	1
2	7	7	3	4	3	4	1	1
3	7	7	3	4	3	4	1	1
4	7	7	3	4	3	4	1	1
5	7	7	3	4	3	4	1	1
6	7	7	3	4	3	4	1	1
7	7	7	3	4	3	4	1	1
8	7	7	3	4	3	4	1	1

Table 15: Our result for Millar-2shift-DATA1[2]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Off	TD	TN	Weekend	off
1				TD	TD				TD	TD		TN	TN	TN	7	4	3		1
2	TN	TN			TD	TN	TN			TD	TD				7	3	4		1
3	TD	TD	TN			TD	TD			TN	TN				7	4	3		1
4	TD	TD	TD			TN	TN			TN	TN				7	3	4		1
5				TD	TN			TN	TN			TD	TD	TD	7	4	3		1
6			TD	TN	TN			TN	TN			TD	TD		7	3	4		1
7	TN	TN				TD	TD	TD			TD	TN			7	4	3		1
8			TN	TN				TD	TD			TD	TN	TN	7	3	4		1

Table 16: Millar et al's result for Millar-2shift-DATA1[1][2]

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Off	TD	TN	Weekend	off
1			TN	TN		TN	TN		TD	TN		TD			7	2	5		1
2	TN	TN			TD					TN	TN		TD	TD	7	3	4		1
3					TN	TN	TN		TD	TD	TD	TD			7	4	3		1
4			TN	TN		TD	TD	TN			TN	TN			7	2	5		1
5	TN	TN			TD	TD	TD			TD	TN				7	4	3		1
6			TD	TD	TN			TN	TN			TD	TD		7	4	3		1
7	TD	TD	TD					TD	TN			TN	TN		7	4	3		1
8	TD	TD		TD	TD					TD			TN	TN	7	5	2		1

References

- [1] Ikegami, A., Niwa, A. (2003): A Subproblem-centric Model and Approach to the Nurse Scheduling Problem. *Mathematical Programming* **97**, 517-541.
- [2] Millar, H.H., Kiragu, M. (1998): Cyclic and non-cyclic scheduling of 12 h shift nurses by network programming. *European Journal of Operational Research* **104**, 582-592.