Sets with indices

I	Set of nurses
T	Set of days
S	Set of shifts
r	Index for rosters
$R(i)$	Set of alternative rosters for nurse i

Decision variables MP:

$slack_{ts}$	slack for shift s on day t
$motivation^r_{its}$	Motivation of nurse i in shift s on day t if assigned to roster r
λ_{ir}	if nurse i is assigned to roster r

Decision variables SP:

x_{its}	1 if physician i works shift s on day t, 0 otherwise
$mood_{it}$	mood of nurse i on day t
$motivation_{its}$	Motivation of nurse i in shift s on day t

Parameter:

$demand_{ts}$	Demand in shift s on day t
Max_W	Number of maximum allowed consecutive working days
M	Big number
α	parameter to control

Master Problem:

$$(MP) \quad \min \qquad \sum_t \sum_s \text{slack}_{ts} \tag{1}$$

$$\tag{2}$$

subject to:

$$\sum_i \sum_r \text{motivation}^r_{its} \lambda_{ir} + \text{slack}_{ts} \geq \text{demand}_{ts} \qquad \forall t, s \tag{3}$$

$$\sum_r \lambda_{ir} = 1 \qquad \forall i \tag{4}$$

$$\lambda_{ir} \in \mathbb{Z}^+ \qquad \forall i, r \tag{5}$$

$$\text{slack}_{ts} \geq 0 \qquad \forall t, s \tag{6}$$

The corresponding duals from constraint (3) are π_{ts} and μ_i from constraint (4).

Subproblems:

$$\mathcal{SP}(i) \quad \min -\sum_{t,s} \pi_{ts} \text{motivation}_{ts} - \mu_i \tag{7}$$

$$\tag{8}$$

subject to:

$$mood_t + M \cdot (1 - x_{ts}) \geq motivation_{ts} \qquad \forall t, s \tag{9}$$

$$motivation_{ts} \geq mood_t - M \cdot (1 - x_{ts}) \qquad \forall t, s \tag{10}$$

$$motivation_{ts} \leq x_{ts} \qquad \forall t, s \tag{11}$$

$$\sum_s x_{ts} \leq 1 \qquad \forall t \tag{12}$$

$$\alpha \sum_s x_{ts} + \text{mood}_t = 1 \qquad \forall t \tag{13}$$

$$motivation_{ts} \in [0, 1] \qquad \forall t, s \tag{14}$$

$$_t \in [0, 1] \qquad \forall t \tag{15}$$

$$x_{ts} \in \{0, 1\} \qquad \forall t, s \tag{16}$$

$$\tag{17}$$

Note that the index i is dropped in the subproblem formulation in the code.