

# Course project

Shams Methnani & Rodrigo Arias Mallo

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## 1 Problem statement

### 1.1 Parameters

TODO: Describe params...

### 1.2 Decision variables

For the problem, 3 matrices are needed as decision variables. The last one is auxiliary.

Symbol	Type and size
$P$	Binary matrix of size $N \times H$ .
$W$	Binary matrix of size $N \times H$ .
$T$	Binary matrix of size $N \times H$ .

The matrix  $P$  has the element  $P_{n,h} = 1$  if the nurse  $n$  is at the hospital at hour  $n$ , also if is working,  $W_{n,h} = 1$ , otherwise 0. The matrix  $T$  is an auxiliary matrix, with the element  $T_{n,h} = 1$  if the nurse  $n$  is travelling to the hospital at the hour  $h$ , otherwise 0.

### 1.3 Constraints

**Constraint 1** At least  $\text{demand}_h$  nurses should be working at the hour  $h$ .

$$\forall h \in H, \sum_{n \in N} W_{n,h} \geq \text{demand}_h$$

**Constraint 2** Each working nurse should work at least minHours.

$$\forall n \in N, \sum_{h \in H} W_{n,h} \geq \text{minHours} * \sum_{j \in H} T_{n,j}$$

**Constraint 3** Each nurse should work at most maxHours.

$$\forall n \in N, \sum_{h \in H} W_{n,h} \leq \text{maxHours}$$

**Constraint 4** Each nurse should work at most maxConsec consecutive hours.

$$\forall n \in N, \forall h \in [1, \text{nHours} - \text{maxConsec}],$$

$$\sum_{k \in [0, \text{maxConsec}]} W_{n,h+k} \leq \text{maxConsec}$$

**Constraint 5** No nurse can stay at the hospital for more than maxPresence hours.

$$\forall n \in N, \sum_{h \in H} P_{n,h} \leq \text{maxPresence}$$

**Constraint 6** No nurse can rest for more than one consecutive hour.

$$\forall n \in N, \forall h \in [1, \text{nHours}-1],$$

$$W_{n,h} + W_{n,h+1} \geq P_{n,h+1}$$

**Constraint 7** Working nurses can travel to hospital at most once.

$$\forall n \in N,$$

$$\sum_{h \in H} T_{n,h} \leq 1$$