

# Course Project of Algorithmic Methods for Mathematical Models (AMMM)

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# 1 Formulation of problem

## Input data

- *numNurses*: total number of nurses
- *hours*: total hour
- *minHours*: minimum hour should a single nurse be working
- *maxHours*: maximum hour can a single nurse be working
- *maxConsec*: maximum consecutive hour can a single nurse be working
- *maxPresence*: maximum hour can a single nurse be in the hospital
- *demand<sub>h</sub>*: number of nurses required for hour h

## Decision variables

- *works<sub>n,h</sub>*: nurse n is working in hour h
- *working<sub>n</sub>*: nurse n works
- *worksBefore<sub>n,h</sub>*: nurse n works some hour before h
- *worksAfter<sub>n,h</sub>*: nurse n works some hour after h

## Math formulation

$$\boxed{\text{Min} : \sum_{n \in N} \text{working}_n} \quad (1)$$

$$\sum_{n \in N} \text{works}_{n,h} \geq \text{demand}_h \quad \forall h \in H \quad (2)$$

$$\sum_{h \in H} \text{works}_{n,h} \geq \text{working}_n * \text{minHours} \quad \forall n \in N \quad (3)$$

$$\sum_{h \in H} \text{works}_{n,h} \leq \text{working}_n * \text{maxHours} \quad \forall n \in N \quad (4)$$

$$\sum_{i \in [h, h + \text{maxConsec}]} \text{works}_{n,i} \leq \text{maxConsec} \quad \forall n \in N \quad \forall h \in [1, \text{hours} - \text{maxConsec}] \quad (5)$$

$$\text{worksBefore}_{n,h} * \text{hours} \geq \sum_{i \in [1, h-1]} \text{works}_{n,i} \quad \forall n \in N \quad \forall h \in H \quad (6)$$

$$worksBefore_{n,h} \leq \sum_{i \in [1, h-1]} works_{n,i} \quad \forall n \in N \quad \forall h \in H \quad (7)$$

$$worksAfter_{n,h} * hours \geq \sum_{i \in [h+1, hours]} works_{n,i} \quad \forall n \in N \quad \forall h \in H \quad (8)$$

$$worksAfter_{n,h} \leq \sum_{i \in [h+1, hours]} works_{n,i} \quad \forall n \in N \quad \forall h \in H \quad (9)$$

$$\sum_{h \in H} worksAfter_{n,h} + \sum_{h \in H} worksBefore_{n,h} + 2 * hours \leq maxPresence \quad \forall n \in N \quad (10)$$

$$works_{n,h} + works_{n,h+1} + 3 \geq worksAfter_{n,h} + worksBefore_{n,h} + worksAfter_{n,h+1} + worksBefore_{n,h+1} \quad \forall n \in N \quad \forall h \in H \quad (11)$$