

# HEI Scheduling constraints problems

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## Notations

- $G$  denotes the set of all group  $g$ ;  $T$  denotes the set of all teacher,  $C$  denotes the set of all course.
- All element of the set of all awarded courses  $AC$  will be indexed. In other words :

$$ac_i \in AC, i \in \mathbb{N}$$

- Let  $t_{ac_i}$  and  $c_{ac_i}$  be the corresponding teacher and the corresponding course resp. to  $ac_i$ .
- Let  $SCT_{t,c} \subset AC$  be the set of all awarded course which has same teacher and course (Same Course and Teacher):

$$\forall i, j \in \mathbb{N} : (ac_i, ac_j \in SCT_{t,c}) \iff (t_{ac_i} = t_{ac_j} = t) \text{ and } (c_{ac_i} = c_{ac_j} = c)$$

- Let  $STDC_t \subset AC$  be the set of all awarded course which has same teacher but different course (Same Teacher but Different Course) :

$$\forall i, j \in \mathbb{N} : (ac_i, ac_j \in STDC_t) \iff (t_{ac_i} = t_{ac_j} = t) \text{ and } (c_{ac_i} \neq c_{ac_j})$$

- Let  $p_{d,SCT_{t,c}} \in \{-1; 1\}$ , be a an indicator constant.

$$p_{d,SCT_{t,c}} = \begin{cases} 1, & \text{if all } ac_i \text{ related to } SCT_{t,c} \text{ are presentials at a given day } d \\ -1, & \text{otherwise} \end{cases}$$

- Let  $AC_g \subset AC$ , the set of all awarded course related to a group  $g$ .

## About the Constraints

**Constraint 1** *A teacher can't teach two or more different groups at the same time for a same course if it is face-to-face session but can if it is a video conference session.*

$\forall s \in S, \forall d \in D, \forall t \in T, \forall c \in C :$

$$2p_{d,SCT_{t,c}} \cdot \left( \sum_{r \in R} \left( \sum_{ac_i \in SCT_{t,c}} o_{ac_i,d,r,s} \right) \right) \leq 3p_{SCT_{t,c}} - 1 \quad (1)$$

**Otherwise :** if  $p_{d,SCT_{t,c}}$  is the binary variable such as :

$$p_{d,SCT_{t,c}} = \begin{cases} 1, & \text{if all awarded course related to } SCT_{t,c} \text{ are presential} \\ 0, & \text{otherwise} \end{cases}$$

which marks whether all awarded courses related to  $SCT_{t,c}$  are presentials or not.

Let  $M \in \mathbb{N}^*$  be a majoration constant.

Therefore :

$$\sum_{r \in R} \left( \sum_{ac_i \in SCT_{t,c}} o_{ac_i,d,r,s} \right) \leq 1 + M(1 - p_{SCT_{t,c}}) \quad (2)$$

**Constraint 2** *A teacher cannot simultaneously teach two or more different courses.*

$\forall s \in S, \forall d \in D, \forall t \in T :$

$$\sum_{r \in R} \left( \sum_{ac_i \in STDC_t} o_{ac_i,d,r,s} \right) \leq 1 \quad (3)$$

**Constraint 3** *A group cannot simultaneously have two or more different course sessions.*

$\forall g \in G, \forall s \in S, \forall d \in D :$

$$\sum_{r \in R} \left( \sum_{ac_i \in AC_g} o_{ac_i,d,r,s} \right) \leq 1 \quad (4)$$

**Constraint 4** *A group should have 2 hours of break per day.*

$\forall g \in G, \forall d \in D :$

$$\sum_{ac_i \in AC_g} \left( \sum_{r \in R} \sum_{s \in S} o_{ac_i, d, r, s} \right) \leq 3 \quad (5)$$

**Constraint 5** *Only one session per course in a day.*

$\forall ac_i \in AC, i \in I, \forall d \in D :$

$$\left( \sum_{r \in R} \sum_{s \in S} o_{ac_i, d, r, s} \right) \leq 1 \quad (6)$$

**Constraint 6** *Give one day without the same course after a session of this course.*

$\forall d \in D, \forall ac_i \in AC, i \in I :$

$$\left( \sum_{r \in R} \sum_{s \in S} o_{ac_i, d+1_d, r, s} \right) + \left( \sum_{r \in R} \sum_{s \in S} o_{ac_i, d, r, s} \right) \leq 1 \quad (7)$$

where  $1_d$  is the unit of day.

**Constraint 7** *Suitable room for every course session.*

- Let  $g_{ac_i}$  be the corresponding group to a  $ac_i$ .
- Let  $s_{g_{ac_i}}$  be the group size of a group  $g_{ac_i}$ .
- Let  $rc_r$  be the room capacity of a room  $r$ .

$\forall ac_i \in AC, i \in I, \forall r \in R, \forall s \in S, \forall d \in D$

$$o_{ac_i, d, r, s} rc_r \geq s_{g_{ac_i}} \quad (8)$$

**Constraint 8** *Finish the total hour of every course.*

Let  $D(ac_i, d_q)$  be the total duration of a  $ac_i$  within a time interval  $[d_0, d_q] \subset D$ ,  $d_0 \leq d_q$ .

$\forall ac_i \in AC, i \in I :$

$$\sum_{d=d_0}^{d_q} \sum_{r \in R} \sum_{s \in S} o_{ac_i, d, r, s} = D(ac_i, d_q) \quad (9)$$