# TD1 - Modelisation

## Exercise 1. Scolarite

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1   CONTEXT
2       Student_Def
3   SETS
4       STUDENTS, DIPLOMAS
5   CONSTANTS
6       License, Master, Doctorat
7   AXIOMS
8       axm1: partition(DIPLOMAS, {License}, {Master}, {Doctorat})
```

$$partition(S, A_0, A_1, \ldots, A_n) \equiv \left\{ \begin{array}{l} \bigcup_{c=0}^{n} A_i = S \\ \forall i,j \quad i \neq j \Rightarrow A_i \cap A_j \end{array} \right\} \qquad \begin{array}{l} (1) \\ (2) \end{array}$$

$$\text{MACHINE} \quad Ecole \tag{3}$$
$$\text{SEES} \quad Student\_Def \tag{4}$$
$$\text{VARIABLES} \quad Student, Old\_Students, D\_e\_C, D\_o \tag{5}$$
$$\text{INVARIANT} \tag{6}$$
$$inv1 : Students \subseteq STUDENT : \mathbb{P}(STUDENT) \tag{7}$$
$$inv2 : Old\_Students \subseteq STUDENT \tag{8}$$
$$inv3 : D\_e\_C \in Students \rightarrow DIPLOMAS, \quad (STUDENT \nrightarrow DIPLOMAS) \tag{9}$$
$$inv4 : D\_e\_C \in Old\_Students \rightarrow DIPLOMAS \tag{10}$$
$$inv5 : Students \cap Old\_Students = \emptyset \tag{11}$$
$$inv6 : \forall d \cdot d \in DIPLOMAS \Rightarrow cord(D\_e\_C^{-1}[\{d\}]) \leq 30 \tag{12}$$
$$\text{INITIACISATION} \triangleq \tag{13}$$
$$act1 : Students, Old\_Students := \emptyset, \emptyset \tag{14}$$
$$act2 : D\_e\_C, D\_o := \emptyset, \emptyset \tag{15}$$
$$\text{Inscreption} \triangleq \tag{16}$$
$$\text{ANY} \quad s, d \tag{17}$$
$$\text{WHEN} \tag{18}$$
$$grd1 : s \notin Students \tag{19}$$
$$grd2 : s \notin Old\_Students \tag{20}$$
$$grd3 : d \in DIPLOMAS \tag{21}$$
$$grd4 : cord(D\_e\_C^{-1}[\{d\} < 30]) \tag{22}$$
$$\text{THEN} \tag{23}$$
$$act1 : Students := Students \cup \{s\} \tag{24}$$
$$act2 : D\_e\_C := D\_e\_C \cup \{s \mapsto d\} \tag{25}$$
$$\text{Obtenir\_Diplome} = \tag{26}$$
$$\text{ANY} \quad s \tag{27}$$
$$\text{WHEN} \tag{28}$$
$$(grd1 : s \in STUDENTS) \tag{29}$$
$$grd2 : s \in Students \tag{30}$$

$$\text{THEN} \tag{31}$$

$$act1 : Students := Students \setminus \{s\} \tag{32}$$

$$act2 : Old\_Students := Old\_Students \cup \{s\} \tag{33}$$

$$act3 : D\_e\_C := \{s\} \lhd D\_e\_C \tag{34}$$

$$act4 : D\_o := D\_o \cup \{s \mapsto D\_e\_c(s)\} \tag{35}$$

$$dom(A \lhd B) = dom(B) \setminus A \tag{36}$$

Abs (37)

$$D\_e\_C \tag{38}$$

$$Students \tag{39}$$

$$D\_o \tag{40}$$

$$Old\_Students \tag{41}$$

Conc (42)

$$L, M, D \subset STUDENTS \tag{43}$$

$$partition(STUDENTS, L, M, D) \tag{44}$$

$$D\_e\_C^{-1}[\{License\}] = L \tag{45}$$

$$D\_e\_C^{-1}[\{Master\}] = M \tag{46}$$

$$D\_e\_C^{-1}[\{Doctorat\}] = D \tag{47}$$

$$D\_e\_C[L] = \{License\} \tag{48}$$

Collage (49)

$$\dots \tag{50}$$

InscriptionLicense (51)

REFIVES    Inscription (52)

ANY    $s$ (53)

WITH    $d : d = \text{License})temoin$ (54)

WHERE (55)

$$grd1 : \quad s \notin L \cup M \cup D \tag{56}$$

$$grd2 : \quad s \in Old\_Student \tag{57}$$

$$grd3 : \quad cord(L) < 30 \tag{58}$$

THEN    $act1 : L := L \cup \{s\}$ (59)

PO: (60)

_INV: (61)

$$D\_e\_C^{-1}[\{L\}] = \{License\} \wedge \tag{62}$$

$$L' = L \cup \{s\} \wedge \tag{63}$$

$$D\_e\_C' = D\_e\_C \cup \{s \mapsto d\} \wedge \tag{64}$$

$$Stud' = Stud \cup \{s\} \wedge d = License \tag{65}$$

$$\Rightarrow D\_e\_C^{-1}[\{L\}] = \{License\} \tag{66}$$

GRD: (67)

$$s \notin L \cup M \cup D \cap S \notin Old\_Stud \tag{68}$$

$$\cap cord(L) < 30 \cap d = License \cap (invariants) \Rightarrow \tag{69}$$

$$s \notin Stud \cap s \notin Old\_Stud \cap \tag{70}$$

$$cord(D\_e\_C^{-1}[\{d\}]) < 30 \tag{71}$$

SIM: (72)

$$(gardes\ A) \cap (gardes\ C) \cap (invariants) \cap d = License \cap L' = L \cup \{s\} \tag{73}$$

$$\Rightarrow D\_e\_C' = D\_e\_C \cup \{s \mapsto d\} \cap Stud' = Stud \cup \{s\} \tag{74}$$

$$L' \cup M \cup D \tag{75}$$

$$= L \cup \{s\} \cup M \cup D \tag{76}$$

$$= \{s\} \cup (L \cup M \cup D) \tag{77}$$

# Exercise 2

Analyse:

- Func :

    - allumer (ON + temp default) + eteindre
    - temperature modifiable
    - "+"/"-" changment temp
    - reset la temp (temp default)
    - temp "par default" = 18 dgree
    - temp min. = 7 degree
    - temp max. = 35 degree
- SAFETY :

    - $7 \leq temp \leq 35$
- ENV :

    - $T_{min} \leq T_{max}$
    - $T_{min} \leq T_{def} \leq T_{max}$

$$\text{CONTEXT} \quad \textit{ThermoCtx} \tag{78}$$
$$\text{SETS} \tag{79}$$
$$\text{ETAT} \tag{80}$$
$$\text{CONSTANTS} \tag{81}$$
$$On, Off, \tag{82}$$
$$T_{min}, T_{max}, T_{def} \tag{83}$$
$$\text{AXIONS} \tag{84}$$
$$axm1 : partition(\text{ETAT}, \{On\}, \{Off\}) \tag{85}$$
$$axm2 : T_{min} \in \mathbb{Z} \tag{86}$$
$$axm3 : T_{max} \in \mathbb{Z} \tag{87}$$
$$axm4 : T_{def} \in \mathbb{Z} \tag{88}$$
$$axm5 \quad (ENV1) : T_{min} \leq T_{max} \tag{89}$$
$$axm6 \quad (ENV2) : T_{min} \leq T_{def} \leq T_{max} \tag{90}$$

MACHINE   *Thermo* (91)
VARIABLES (92)
    *etat, temp* (93)
INVARIANTS (94)
    $inv1:$   $etat \in \text{ETAT}$ (95)
    $inv2:$   $temp \in \mathbb{Z}$ (96)
    $inv3:$   $etat = On$   $\Rightarrow T_{min} \leq temp \wedge temp \leq T_{max}$ (97)
EVENTS (98)
    INITIALISATION $\triangleq$ (99)
        $act1:$   $etat := Off$ (100)
        $act2:$   $temp :\in \mathbb{Z}$ (101)
    Allumer $=$ (102)
        $WHEN$   $etat = Off$ (103)
        $THEN$ (104)
            $act1:$   $etat := On$ (105)
            $act2:$   $temp := T_{def}$ (106)
    Eteindre $=$ (107)
        $WHEN$   $etat = On$ (108)
        $THEN$ (109)
            $act1:$   $etat := Off$ (110)
    Reset $=$ (111)
        $WHEN$   $etat = On$ (112)
        $THEN$ (113)
            $act1:$   $temp := T_{def}$ (114)
    Augmenter $=$ (115)
        $WHEN$   $etat = On$ (116)
          $temp < T_{max}$ (117)
        $THEN$ (118)
          $temp : 1$ (119)
          $temp' > temp \wedge temp' \leq T_{max}$ (120)
    Augmenter$^{*}$ $=$ (121)
        $ANY$   $t$ (122)
        $WHEN$ (123)
          $t \in \mathbb{Z}, t > 0$ (124)
          $temp < T_{max}, etat = On$ (125)
          $temp + t \leq T_{max}$ (126)
        $THEN$ (127)
            $act1:$   $temp' := temp + t$ (128)
        $WITH$ (129)
          $t = 1$ (130)
    Diminuer $=$ (131)
        $WHEN$   $etat = On$ (132)
          $temp > T_{min}$ (133)
        $THEN$ (134)
          $temp : 1$ (135)
          $temp' < temp \wedge temp' \geq T_{min}$ (136)