TD 1 Développement formel de systèmes complexes

STUDENTS, DIPLOMAS } Sets

Licence, Master, Doctorat } Constantes

partition (S, A, B) $\quad A \cup B = S$

axm 1 : partition (DIPLOMAS, {Licence}, {Master}, {Doctorat})
et Licence ≠ Master ≠ Doctorat
(Des constantes peuvent être égales)

VARIABLES Students, Old_Students
D_e_c, D_o

INVARIANTS

inv 1 : Students ⊆ STUDENTS } Students ∈ ℙ(STUDENTS)

inv 2 : Old_Students ⊆ STUDENTS

inv 3 : D_e_c ∈ Students ⟶ DIPLOMAS { D_e_c ∈ STUDENTS ↔ DIP ; dom(D_e_c) = Students

$A \nrightarrow B$ fonction définie pour certains éléments de A

ex : $f : x \mapsto \sqrt{x} \in \mathbb{R} \nrightarrow \mathbb{R}$

$A \rightarrow B$ fonction totale

$F \in \mathbb{R}^+ \rightarrow \mathbb{R}$ (+ les éléments de $\mathbb{R}^+$)

inv 4 : D_o ∈ Old_Students ⟶ DIPLOMAS

inv 5 : Old_Students ∩ Students = ∅

(∀s. s ∈ Old_Students ⇒ s ∉ Students)

inv 6 : ∀d. d ∈ DIPLOMAS ⇒ card (D_e_c^{-1}[{d}]) ≤ 30

x ∈ Students

{x | (x, d) ∈ D_e_c}

{x | D_e_c(x) = d}

R = {(x, y)}

$R^{-1} = \{(y, x) \mid (x, y) \in R\}$

EVENT
↳ ANY → param
↳ WHERE → garde
↳ THEN → actions (modélisent les transformations d'état)

INITIALISATION
Students, Old_Students, D_ec, D_o := ∅

EVENTS
Inscription ≙
ANY s,d
WHERE $s \in STUDENTS \wedge card(D\_e\_c^{-1}[\{d\}]) < 30$
$d \in DIPLOMAS$
$s \notin Students \wedge s \notin Old\_students$
THEN
act1 $Students := Students \cup \{s\}$
act2 $D\_e\_c(s) := d$

Obtenir_Diplome ≙
ANY s,d
WHERE $s \in STUDENTS$
$s \in Students$
$d \neq D\_e\_c(s)$
THEN
act1 $Students := Students \setminus \{s\}$
act2 $Old\_Students := Old\_students \cup \{s\}$
act3 $D\_e\_c := D\_e\_c \setminus \{s \mapsto d\}$
$\{s\} \lhd D\_e\_c$
act4 $D\_o(s) := d$

Q5 : MACHINE Ecole2 REFINES Ecole
VARIABLES LicenceS, MasterS, Doctorats
Old_Students, D_o

INVARIANTS
inv1 $LicenceS \subseteq STUDENTS$
inv2 $MasterS \subseteq STUDENTS$
inv3 $DoctoratS \subseteq STUDENTS$

redefines var of ecole

inv4 : Licences ∩ Masters = ∅ ∧ Masters ∩ Doctorats = ∅
inv5 : Students = Licences ∪ Masters ∪ Doctorats
inv6 : D_e_c[Licences] = {Licence}
inv7 : ——
inv8 : ——

Inscription_Licence ≙ Inscription=
ANY s
WHERE s∈STUDENTS
s∉ Licences ∪ Masters ∪ Doctorats
card(Licences) < 30
THEN
act1 . Licences := Licences ∪ {s}

MACHINE Ecole_2
VARIANTS Licence, Master, Doctorat, old stud, D_o
INVARIANTS
inv 1-3 : Licence ⊆ STUDENTS, Master ⊆ STUDENTS,
Doctorat ⊆ STUDENTS

inv4 : D_e_c[Licence] = LICENSE
inv5 : Master ——
inv6 : Doctorant ——
inv7 : Stud = Licence ∪ Master ∪ Doctorat
inv8 : Licence ∩ Master = ∅
inv9 : Master ∩ Doctorat = ∅

EVENTS
Insc_Licence REFINES
ANY s
WHERE s∈STUDENTS
s∉ Old_Stud
s∉ Lic ∪ Master ∪ Doct
card(Licence) < 30
WITH
d : d=Licence
Stud : Lic ∪ Mast ∪ Doc ∪ {s}
THEN Licence := Licene ∪ {s}

Exercice 3 :

Q1

Variable : Température (T)
Constantes + Hypothèses : $T_{def}, T_{min}, T_{max}$ { $T_{min} \leq T_{max}$; $T_{min} \leq T_{def} \leq T_{max}$
Evenements : Plus, Moins, Reset) ΔT quelconque
Contraintes : $T_{min} \leq T \leq T_{max}$

CONTEXT ThermoCtx
CONSTANTS $T_{def}, T_{min}, T_{max}$
AXIOMS
axm 1-3 : $T_{def}, T_{min}, T_{max} \in \mathbb{Z}$
axm 4 : $T_{min} \leq T_{max}$
axm 5 : $T_{min} \leq T_{def}$
axm 6 : $T_{def} \leq T_{max}$

MACHINE Thermo
SEES ThermoCtx
VARIABLES T
INVARIANTS
inv 1 : $T \in \mathbb{Z}$
inv 2 : $T_{min} \leq T$
inv 3 : $T \leq T_{max}$
EVENTS
- INIT ≙
  THEN $T := T_{def}$
  END

- PLUS ≙ WHERE $T < T_{max}$
  THEN $T :| T' > T \wedge T' \leq T_{max}$
  END
- Moins ≙ WERE $T > T_{min}$
  THEN $T :| T' < T \wedge T' \geq T_{min}$
  END
- RESET ≙
  THEN $T := T_{def}$
  END

Q2 :

PLUS REFINES Plus ≙
ANY n
WHERE $n \in \mathbb{Z} \wedge n > 0$
$T < T_{max}$
$T + n \leq T_{max}$
THEN $T := T + n$
END

PLUS 1 REFINES Plus ≙
WITH n : n = 1
WHERE $T < T_{max}$
THEN $T := T + 1$
END ;