Tutorial Modelling Software-based Systems
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Tutorial 1 : Specifying a problem using the Eevent-B modelling language
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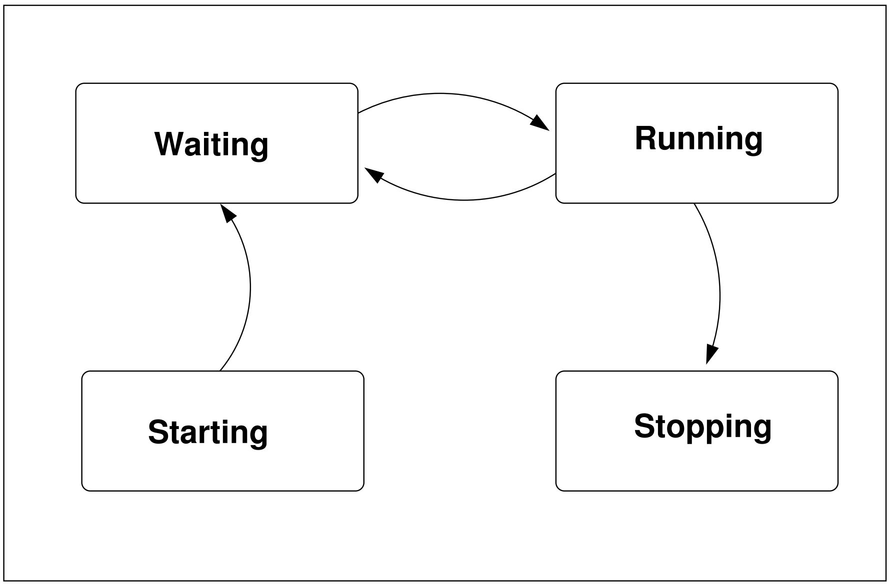
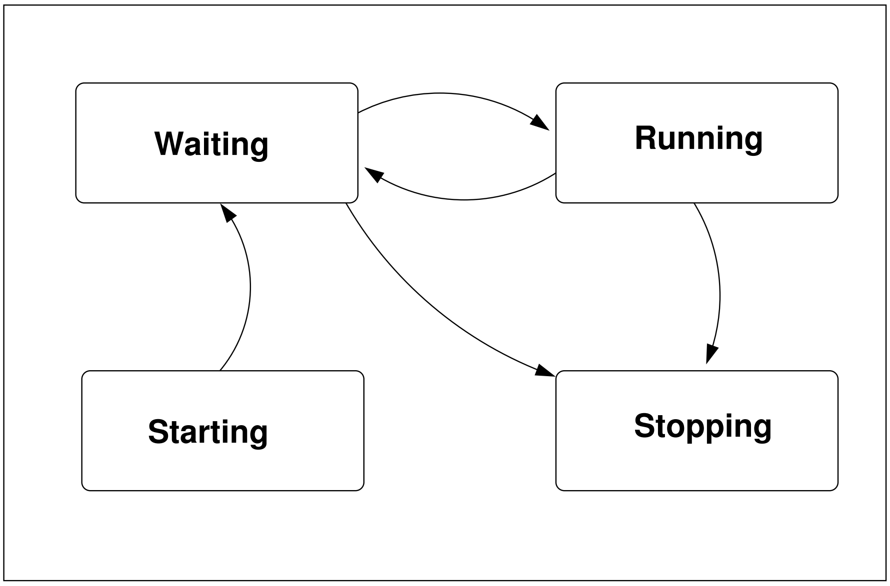
Exercice 1 *ex1-tut1.zip*
Express the following states machine using an Event B machines and check properties on the resulting models.



Exercice 2 *ex2-tut1.zip*
Express the following states machine using an Event B machines and check properties on the resulting models.



Exercice 3 *ex4-tut1.zip*
We consider a finite sequence of integers $v_1, \ldots, v_n$ where n is the length of the sequence and is supposed to be fixed. Write an Event B specification modelling the computation of the value

of the summation of the sequence v. You should define cerafully v, n and the summation of a finite sequence of integers.

Exercice 4 *ex5-tut1.zip*
Express the following property in Event B :
We assume to have p resources which may be shared by n processes. If a process uses a given resource, the resource can not be used by another process. A process can use only at most one resource.

Exercice 5 *ex6-tut1.zip*
A Petri net is a uple R=(S,T,F,K,M,W)

- *S is a finite set of places.*
- *T is a finite set of transitions.*
- *$S \cap T = \varnothing$*
- *F is the flow relation : $F \subseteq S \times T \cup T \times S$*
- *K is expressing the capacity of each place :*
  $K \in S \rightarrow Nat \cup \{\omega\}$
- *M is reprenting the initial marking of each place :*
  $M \in S \rightarrow Nat \cup \{\omega\}$ and satisfies the following condition $\forall\, s \in S : M(s) \leq K(s)$.
- *W is the weight of each edge :*
  $W \in F \rightarrow Nat \cup \{\omega\}$

THe state of a Petri net R is defined by a set of markings :

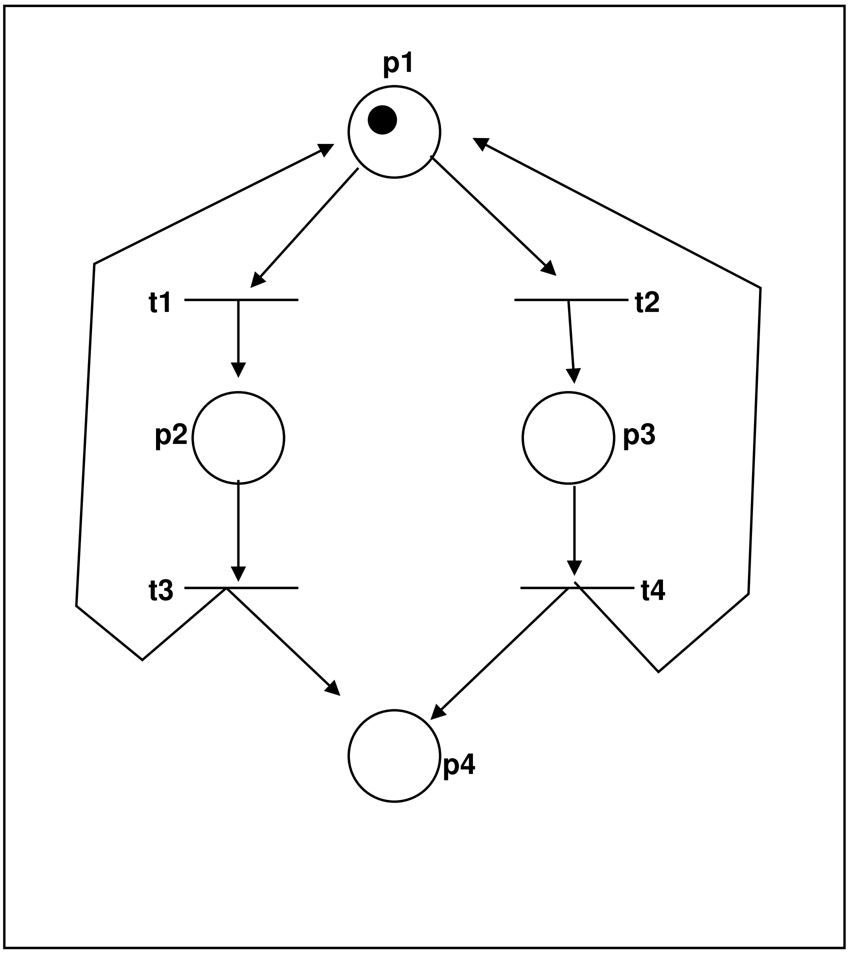
- *a marking M for R is a function from S to $Nat \cup \{\omega\}$:*
  $M \in S \rightarrow Nat \cup \{\omega\}$ and it satisfies the condition $\forall\, s \in S : M(s) \leq K(s)$.
- *a transition t of T is ready to fire for a marking M of R, if*
  1. *$\forall\, s \in \{ s' \in S \mid (s',t) \in F \}$:*
     $M(s) \geq W(s,t)$.
  2. *$\forall\, s \in \{ s' \in S \mid (t,s') \in F \}$:*
     $M(s) \leq K(s) - W(s,t)$.
- *$t \in T : Pre(t) = \{s' \in S : (s', t) \in F\}$ and $Post(t) = \{s' \in S : (t, s') \in F\}$*

The simulation of a Petri net is defined by a relation linking three elements : a marking M, a marking M' and a transition t as follows :

- *the new marking M' is defined as follows from M :*

$$M'(s) = \begin{cases} \text{M(s)}-\text{W(s,t), si s} \in \text{Pre(t) - Post(t)} \\ \text{M(s)}+\text{W(t,s), si s} \in \text{Post(t) - Pre(t)} \\ \text{M(s)}-\text{W(s,t)}+\text{W(t,s), si s} \in \text{Pre(t)}\cap\text{Post(t)} \\ \text{M(s), sinon} \end{cases}$$

We consider the following Petri net :



Question 5.1 *Translate this Petri net in Event B.*

Question 5.2 *Express safety properties that you can discover from the diagram.*

Exercice 6 *(ex7-tut1.zip)*
We consider the following abstract machine/

MACHINE $M1$
VARIABLES
x
INVARIANTS
$\ldots$
EVENTS
EVENT *INITIALISATION*
BEGIN
$act1 : x := -10$
END
EVENT *evt1*
WHEN
$grd1 : x \geq -1$
THEN
$act1 : x := x{+}1$
END
EVENT *evt2*
WHEN
$grd1 : x \leq -1$
$grd2 : x \geq -44$
THEN
$act1$: $x := x{-}1$
END
END

We have possible candidates as invariant. For each question, explain why the assertion is or is not an inductive invariant. For each question, explain why the assertion is or is not a safety property.

Question 6.1 *(M1)*

$inv1 : x \in \mathbb{Z}$
$inv3 : x \leq -1$

Question 6.2 *(M2)*

$inv1 : x \in \mathbb{Z}$
$inv3 : x \leq -3$

Question 6.3 *(M3)*

$inv1 : x \in \mathbb{Z}$
$inv4 : -45 \leq x \wedge x \leq -10$

Question 6.4 *(M4)*

$inv1 : x \in \mathbb{Z}$
$inv3 : x \leq -3$
$inv4 : -45 \leq x \wedge x \leq -10$
$inv2 : x \leq -1$

Exercice 7 *ex8-tut1 .zip*
A semaphore s is a shared variable accessible by two operations : $P(s)$ and $V(s$. Informally, we can describe the effect of these two operations as follows :

- *$P(s)$ is testing if the value of s is greater than 0 and is not equal to 0. Il the value of s is 0, the process which is executing $P(s)$ is inserted in a queue.*
- *$V(s)$ is increasing the value of s by one, if the queue is non empty. If the queue is non empty, the first waiting process of the queue is awaken and becomes a lively process.*

Using the Event B modelling features, describe a system using the primitives.