

Cours Algorithmique des systèmes parallèles et distribués
Exercices

Série :PlusCal pour la programmation répartie ou concurrente (I)
par Dominique Méry
14 janvier 2026

Exercice 1 (*pluscaltut1.tla*)

Etudier le programme PlusCal suivant :

```
----- MODULE pluscaltut1 -----
EXTENDS Integers , Sequences , TLC, FiniteSets
(*
--wf
--algorithm Tut1 {
variables x = 0;

process (one = 1)
{
A: assert x \in {0,1};
x := x - 1;
B: assert x \in {-1,0} ;
x := x * 3;
BB: assert x \in {-3,-2,0,1};
};

process (two = 2)
{
C: assert x \in {-3,-2,-1,0,1};
x := x + 1;
D:
assert x \in {-2,-1,0,1,2};
};

}
end algorithm;

*)
/* BEGIN TRANSLATION (chksum(pcal) = "a26cf6c4" /\ chksum(tla) = "72d02274")
VARIABLES x, pc

vars == << x, pc >>
ProcSet == {1} \cup {2}
```

```

Init == (* Global variables *)
  /\ x = 0
  /\ pc = [self \in ProcSet |-> CASE self = 1 -> "A"
            [] self = 2 -> "C"]

A == /\ pc[1] = "A"
  /\ Assert(x \in {0,1}, "Failure of assertion at line 11, column 6.")
  /\ x' = x - 1
  /\ pc' = [pc EXCEPT ![1] = "B"]

B == /\ pc[1] = "B"
  /\ Assert(x \in {-1,0}, "Failure of assertion at line 13, column 6.")
  /\ x' = x * 3
  /\ pc' = [pc EXCEPT ![1] = "BB"]

BB == /\ pc[1] = "BB"
  /\ Assert(x \in {-3,-2,0,1},
            "Failure of assertion at line 15, column 8.")
  /\ pc' = [pc EXCEPT ![1] = "Done"]
  /\ x' = x

one == A \ / B \ / BB

C == /\ pc[2] = "C"
  /\ Assert(x \in {-3,-2,-1,0,1},
            "Failure of assertion at line 20, column 6.")
  /\ x' = x + 1
  /\ pc' = [pc EXCEPT ![2] = "D"]

D == /\ pc[2] = "D"
  /\ Assert(x \in {-2,-1,0,1,2},
            "Failure of assertion at line 23, column 5.")
  /\ pc' = [pc EXCEPT ![2] = "Done"]
  /\ x' = x

two == C \ / D

(* Allow infinite stuttering to prevent deadlock on termination. *)
Terminating == /\ \A self \in ProcSet: pc[self] = "Done"
               /\ UNCHANGED vars

Next == one \ / two
      \ / Terminating

Spec == Init /\ [] [Next]_vars

```

```
Termination == <>(\A self \in ProcSet: pc[self] = "Done")
```

```
\* END TRANSLATION
```

```
=====
```

Exercice 2 (*pluscaltut2.tla*)

Etudier le programme PlusCal suivant :

```
----- MODULE pluscaltut2 -----
EXTENDS Integers, Sequences, TLC, FiniteSets

(*
--algorithm Tut2 {
variables x = 0;

process (one = 1)

variables temp
{

A:
    temp := x + 1;

    x := temp;

};

process (two = 2)

variables temp
{
    CC:
        temp := x + 1;

        x := temp;
};

}
end algorithm;

*)
\* BEGIN TRANSLATION (chksum(pcal) = "b54fa406" /\ chksum(tla) = "e84b4125")
\* Process variable temp of process one at line 10 col 11 changed to temp_
```

```

CONSTANT defaultInitValue
VARIABLES x, pc, temp_, temp

vars == << x, pc, temp_, temp >>

ProcSet == {1} \cup {2}

Init == (* Global variables *)
  /\ x = 0
  (* Process one *)
  /\ temp_ = defaultInitValue
  (* Process two *)
  /\ temp = defaultInitValue
  /\ pc = [self \in ProcSet |-> CASE self = 1 -> "A"
            [] self = 2 -> "CC"]

A == /\ pc[1] = "A"
  /\ temp_' = x + 1
  /\ x' = temp_'
  /\ pc' = [pc EXCEPT ![1] = "Done"]
  /\ temp' = temp

one == A

CC == /\ pc[2] = "CC"
  /\ temp' = x + 1
  /\ x' = temp'
  /\ pc' = [pc EXCEPT ![2] = "Done"]
  /\ temp_' = temp_

two == CC

(* Allow infinite stuttering to prevent deadlock on termination. *)
Terminating == /\ \A self \in ProcSet: pc[self] = "Done"
  /\ UNCHANGED vars

Next == one \ / two
  \ / Terminating

Spec == Init /\ [] [Next]_vars

Termination == <>(\A self \in ProcSet: pc[self] = "Done")

\* END TRANSLATION

```

```

test == (\A i \in ProcSet : pc[i] = "Done") => x \in {2}
=====

```

Exercice 3 (*pluscaltut3.tla*)

Etudier le programme PlusCal suivant :

```

----- MODULE pluscaltut3 -----
EXTENDS Integers, Sequences, TLC, FiniteSets
(*
--algorithm Tut3 {
variables x = 0;

process (one = 1)
{
  A:
    x := x + 1;
  B:
    await x = 1;
  C:
    print <<"x=",x>>;
};

process (two = 2)
{
  D:
    await x = 1;
  E:
    assert x = 1;
  F:
    x := x -2;
};

}
end algorithm;

*)
\* BEGIN TRANSLATION
VARIABLES x, pc

vars == << x, pc >>

ProcSet == {1} \cup {2}

```

```

Init == (* Global variables *)
  /\ x = 0
  /\ pc = [self \in ProcSet |-> CASE self = 1 -> "A"
            [] self = 2 -> "D"]

A == /\ pc[1] = "A"
  /\ x' = x + 1
  /\ pc' = [pc EXCEPT ![1] = "B"]

B == /\ pc[1] = "B"
  /\ x = 1
  /\ pc' = [pc EXCEPT ![1] = "C"]
  /\ x' = x

C == /\ pc[1] = "C"
  /\ PrintT(<<"x=",x>>)
  /\ pc' = [pc EXCEPT ![1] = "Done"]
  /\ x' = x

one == A \ / B \ / C

D == /\ pc[2] = "D"
  /\ x = 1
  /\ pc' = [pc EXCEPT ![2] = "E"]
  /\ x' = x

E == /\ pc[2] = "E"
  /\ Assert(x = 1, "Failure of assertion at line 22, column 5.")
  /\ pc' = [pc EXCEPT ![2] = "F"]
  /\ x' = x

F == /\ pc[2] = "F"
  /\ x' = x -2
  /\ pc' = [pc EXCEPT ![2] = "Done"]

two == D \ / E \ / F

(* Allow infinite stuttering to prevent deadlock on termination. *)
Terminating == /\ \A self \in ProcSet: pc[self] = "Done"
  /\ UNCHANGED vars

Next == one \ / two
  \ / Terminating

Spec == Init /\ [] [Next]_vars

```

```
Termination == <>(\A self \in ProcSet : pc[self] = "Done")
```

```
\* END TRANSLATION
```

```
test == (\A i \in ProcSet : pc[i] = "Done") => x \in {1, 2}
```

=====

Exercice 4 pluscalex1.tla

Ecrire un programme PlusCal qui traduit le protocole suivant : S envoie une valeur à R

Exercice 5 pluscalex2.tla

Ecrire un programme PlusCal qui calcule la fonction factorielle de la façon suivante :

- Un processus calcule $1 \times 2 \times 3 \dots \times k_1$
- Un processus calcule $k_2 \times (k_2+1) \times \dots \times N$
- Les processus stoppent quand la condition $k_1 < k_2$ est fausse

Exercice 6 pluscalex3.tla

Ecrire un programme PlusCal qui calcule la fonction L^K la façon suivante :

- Un processus calcule $L \times \dots \times L$ k_1 fois.
- Un processus calcule $L \times \dots \times L$ k_2 fois.
- Les processus stoppent quand la condition $k_1 + K_2 < L$ est fausse