

<p style="text-align: center;">Cours Algorithmique des systèmes parallèles et distribués Exercices Série :PlusCal pour la programmation répartie ou concurrente (I) par Dominique Méry 3 janvier 2026</p>
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**Exercice 1** *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** 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}

```

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**Exercice 3** 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}*

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**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*