

SPIN Modeling Language

Kindly paste the screen shot of both program and verification

1. Consider the following program in promela

```

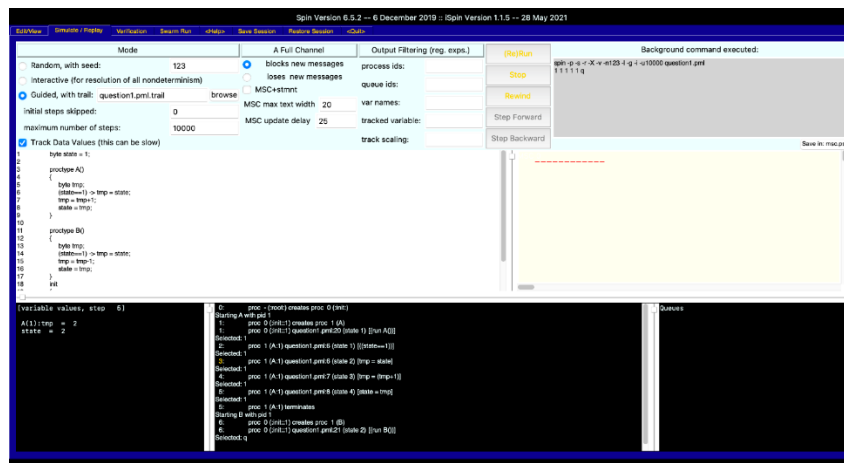
byte state = 1;
proctype A()
{
    byte tmp;
    (state==1) -> tmp = state;
    tmp = tmp+1;
    state = tmp;
}

proctype B()
{
    byte tmp;
    (state==1) -> tmp = state;
    tmp = tmp-1;
    state = tmp;
}

init {
    run A();
    run B()
}

```

- a) Choose the schedules using ispin option such that process A scheduled first and terminates followed by process B



b) What will the possible values of state in random simulation.

The possible value of state in random simulation is 0 & 2.

Spin Version 6.5.2 -- 6 December 2019 :: iSpin Version 1.1.5 -- 28 May 2021

Mode: Random, with seed: 123

Initial steps skipped: 0

Maximum number of steps: 10000

Track Data Values (this can be slow)

A Full Channel: blocks new messages, loses new messages, MSC+stmtnt, MSC max text width: 20, MSC update delay: 25

Output Filtering (reg. exps.): process ids, queue ids, var names, tracked variable, track scaling

(Re)Run, Stop, Rewind, Step Forward, Step Backward

Background command executed: spin -p -s -r -X -v -m123 -f -g -k question1.pml.trail -u10000 question1.pml

```
1 byte state = 1;
2
3 proctype A()
4 {
5   byte tmp;
6   (state==1) -> tmp = state;
7   tmp = tmp+1;
8   state = tmp;
9 }
10
11 proctype B()
12 {
13   byte tmp;
14   (state==1) -> tmp = state;
15   tmp = tmp-1;
16   state = tmp;
17 }
18 init
```

[variable values, step 7]

A(1):tmp = 0
B(2):tmp = 0
state = 0

using statement merging
Starting A with pid 1
1: proc 0 (init::1) question1.pml:20 (state 1) [(run A0)]
Starting B with pid 2
2: proc 0 (init::1) question1.pml:21 (state 2) [(run B0)]
3: proc 2 (B:1) question1.pml:14 (state 3) [(state==1)]
4: proc 2 (B:1) question1.pml:14 (state 2) [tmp = state]
5: proc 2 (B:1) question1.pml:15 (state 3) [tmp = (tmp-1)]
6: proc 2 (B:1) question1.pml:16 (state 4) [state = tmp]
7: proc 2 terminates
spin: trail ends after 7 steps
#processes: 2
7: proc 1 (A:1) question1.pml:6 (state 1)
7: proc 0 (init::1) question1.pml:22 (state 3)
3 processes created
Exit-Status 0

Spin Version 6.5.2 -- 6 December 2019 :: iSpin Version 1.1.5 -- 28 May 2021

Mode: Random, with seed: 123

Initial steps skipped: 0

Maximum number of steps: 10000

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Output Filtering (reg. exps.): process ids, queue ids, var names, tracked variable, track scaling

(Re)Run, Stop, Rewind, Step Forward, Step Backward

Background command executed: spin -p -s -r -X -v -m123 -f -g -u10000 question1.pml

```
1 byte state = 1;
2
3 proctype A()
4 {
5   byte tmp;
6   (state==1) -> tmp = state;
7   tmp = tmp+1;
8   state = tmp;
9 }
10
11 proctype B()
12 {
13   byte tmp;
14   (state==1) -> tmp = state;
15   tmp = tmp-1;
16   state = tmp;
17 }
18 init
```

[variable values, step 10]

A(1):tmp = 2
B(2):tmp = 0
state = 2

0: proc - (root) creates proc 0 (init)
Starting A with pid 1
1: proc 0 (init::1) creates proc 1 (A)
1: proc 0 (init::1) question1.pml:20 (state 1) [(run A0)]
2: proc 1 (A:1) question1.pml:6 (state 1) [(state==1)]
Starting B with pid 2
3: proc 0 (init::1) creates proc 2 (B)
3: proc 0 (init::1) question1.pml:21 (state 2) [(run B0)]
4: proc 2 (B:1) question1.pml:14 (state 3) [(state==1)]
5: proc 1 (A:1) question1.pml:6 (state 2) [tmp = state]
6: proc 2 (B:1) question1.pml:14 (state 2) [tmp = tmp+1]
7: proc 1 (A:1) question1.pml:7 (state 3) [tmp = (tmp-1)]
8: proc 2 (B:1) question1.pml:15 (state 3) [tmp = (tmp-1)]
9: proc 2 (B:1) question1.pml:16 (state 4) [state = tmp]
10: proc 1 (A:1) question1.pml:8 (state 4) [state = tmp]
10: proc 2 (B:1) terminates
10: proc 1 (A:1) terminates
0 processes created

c) change the program to add atomic sequence.

```
byte state = 1;
proctype A()
{
    atomic
    {
        (state == 1) -> state = state+1
    }
}
proctype B()
{
    atomic
    {
        (state == 1) -> state = state-1
    }
}
init
{
    run A();
    run B();
}
```

2. Consider the following program in Promela language

```
byte x,t1,t2;
proctype Thread1()
{
    do :: t1 = x;
        t2 = x;
        x = t1 + t2
    od
}
proctype Thread2()
{
    do :: t1 = x;
        t2 = x;
        x = t1 + t2
    od
}
init
{
```

```

x = 1;
run Thread1();
run Thread2();
assert(x != N)
}

```

for N=1 and N=2 find schedules that cause the assertion to be violated .

At N=1, the schedules that cause assertion violation is

{ x=1 , t1 = 0 , t2 = 0 }

At N=2, the schedules that cause assertion violation is

{ x = 2 , t1 = 1 , t2 = 1 }

```

kumarlaxmikant@Kumars-MacBook-Pro Spin % spin -p -g question3.pml
0:  proc - (:root:) creates proc 0 (:init:)
1:  proc 0 (:init::1) question3.pml:20 (state 1)  [x = 1]
    x = 1
Starting Thread1 with pid 1
2:  proc 0 (:init::1) creates proc 1 (Thread1)
2:  proc 0 (:init::1) question3.pml:21 (state 2)  [(run Thread1())]
Starting Thread2 with pid 2
3:  proc 0 (:init::1) creates proc 2 (Thread2)
3:  proc 0 (:init::1) question3.pml:22 (state 3)  [(run Thread2())]
spin: question3.pml:23, Error: assertion violated
spin: text of failed assertion: assert((x!=N))
#processes: 3
    x = 1
    t1 = 0
    t2 = 0
    N = 1
4:  proc 2 (Thread2:1) question3.pml:12 (state 4)
4:  proc 1 (Thread1:1) question3.pml:5 (state 4)
4:  proc 0 (:init::1) question3.pml:23 (state 4)
3 processes created

```

```

kumarlaxmikant@Kumars-MacBook-Pro Spin % spin -p -g question3.pml
0:  proc - (:root:) creates proc 0 (:init:)
1:  proc 0 (:init::1) question3.pml:20 (state 1)  [x = 1]
    x = 1
Starting Thread1 with pid 1
2:  proc 0 (:init::1) creates proc 1 (Thread1)
2:  proc 0 (:init::1) question3.pml:21 (state 2)  [(run Thread1())]
Starting Thread2 with pid 2
3:  proc 0 (:init::1) creates proc 2 (Thread2)
3:  proc 0 (:init::1) question3.pml:22 (state 3)  [(run Thread2())]
4:  proc 1 (Thread1:1) question3.pml:5 (state 1)  [t1 = x]
    t1 = 1
5:  proc 1 (Thread1:1) question3.pml:6 (state 2)  [t2 = x]
    t2 = 1
6:  proc 1 (Thread1:1) question3.pml:7 (state 3)  [x = (t1+t2)]
    x = 2
spin: question3.pml:23, Error: assertion violated
spin: text of failed assertion: assert((x!=N))
#processes: 3
    x = 2
    t1 = 1
    t2 = 1
    N = 2
7:  proc 2 (Thread2:1) question3.pml:12 (state 4)
7:  proc 1 (Thread1:1) question3.pml:9 (state 5)
7:  proc 0 (:init::1) question3.pml:23 (state 4)
3 processes created

```

3. Write a promela language model for Dining philosopher problem.

```
#define N 5

bit forks[N];
byte count_eating;

init {
    atomic {
        byte i = 0;
        do
            ::(i < N-1) -> run philosopher(i);
            i++;
        ::else -> run reset_philosopher(i);
        break;
    od;
}

proctype philosopher(byte id) {
    thinking:
        atomic {
            forks[id] == 0; -> forks[id] = 1;
        }
    choosing:
        atomic {
            forks[(id + 1)%N] == 0 -> forks[(id + 1)%N] = 1;
            count_eating++;
        };
    eating:
        d_step {
            count_eating--;
            forks[(id + 1)%N] = 0;
        }
        forks[id] = 0;
        goto thinking;
}

proctype reset_philosopher(byte id) {
    thinking:
        atomic {
            forks[id] == 0; ->
                forks[id] = 1;
        }
}
```

choosing:

```
if
::atomic {
    forks[(id + 1)%N] == 0 -> forks[(id + 1)%N] = 1;
    count_eating++;
};
::atomic {
    forks[(id + 1)%N] != 0 -> forks[id] = 0;
}
goto thinking;
fi;
```

eating:

```
d_step {
    count_eating--;
    forks[(id + 1)%N] = 0;
}
forks[id] = 0;
goto thinking;
}
```

a) For given model using spin do random simulation

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Mode: Random, with seed: 123
Initial steps skipped: 0
Maximum number of steps: 10000
Track Data Values (this can be slow) ☒

Full Channel: blocks new messages ☒
loses new messages ☐
MSC+stmnt ☐
MSC max text width: 20
MSC update delay: 25

Output Filtering (reg. exps.): process ids:
queue ids:
var names:
tracked variable:
track scaling:

(Re)Run
Stop
Rewind
Step Forward
Step Backward

Background command executed: spin -p -s -r -X -v -m 123 -i -g -u 10000 philosopher.pml

Save in: msc.ps

```
1 #define N 5
2 bit forks[N];
3 byte count_eating;
4
5 init {
6     atomic {
7         byte i = 0;
8         do
9             ::(i < N-1) -> run philosopher(i);
10             i++;
11         else -> run reset_philosopher(i);
12         break;
13     };
14 }
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```

[variable values, step 10000]

```
init:0:i = 4
count_eating = 0
forks[0] = 1
forks[1] = 1
forks[2] = 0
forks[3] = 1
forks[4] = 0
philosopher(1):id = 0
philosopher(2):id = 1
philosopher(3):id = 2
philosopher(4):id = 3
reset_philosopher(5):id = 4
```

9993: proc 3 (philosopher:1) philosopher.pml:33 (state 1) [forks[id] = 0]
9994: proc 4 (philosopher:1) philosopher.pml:34 (state 12) [goto thinking]
9995: proc 3 (philosopher:1) philosopher.pml:34 (state 12) [goto thinking]
9996: proc 4 (philosopher:1) philosopher.pml:21 (state 1) [(forks[id]=0)]
9997: proc 4 (philosopher:1) philosopher.pml:21 (state 2) [forks[id] = 1]
9998: proc 5 (reset_philosopher:1) philosopher.pml:51 (state 0) [(forks[(id+1)%5]==0)]
9999: proc 5 (reset_philosopher:1) philosopher.pml:51 (state 0) [forks[id] = 0]
10000: proc 3 (philosopher:1) philosopher.pml:21 (state 1) [(forks[id]=0)]

depth-limit (-u10000 steps) reached
#processes: 6
10000: proc 5 (reset_philosopher:1) philosopher.pml:53 (state 1f)
10000: proc 4 (philosopher:1) philosopher.pml:24 (state 7)
10000: proc 3 (philosopher:1) philosopher.pml:21 (state 2)
10000: proc 2 (philosopher:1) philosopher.pml:24 (state 7)
10000: proc 1 (philosopher:1) philosopher.pml:24 (state 7)
10000: proc 0 (init:1) philosopher.pml:16 (state 12)
6 processes created

Queues

b) using spin do verification.

```
kumarlaxmikant@Kumars-MacBook-Pro Spin % spin -a philosopher.pml
gcc -DMEMLIM=1024 -O2 -DXSAFE -DSAFETY -DNOCLAIM -w -o pan pan.c
./pan -m10000

(Spin Version 6.5.2 -- 6 December 2019)
+ Partial Order Reduction

Full statespace search for:
  never claim      - (not selected)
  assertion violations +
  cycle checks     - (disabled by -DSAFETY)
  invalid end states +

State-vector 60 byte, depth reached 316, errors: 0
  393 states, stored
  1100 states, matched
  1493 transitions (= stored+matched)
  16 atomic steps
hash conflicts:      0 (resolved)

Stats on memory usage (in Megabytes):
  0.033    equivalent memory usage for states (stored*(State-vector + overhead))
  0.283    actual memory usage for states
 128.000   memory used for hash table (-w24)
  0.534    memory used for DFS stack (-m10000)
 128.730   total actual memory usage

unreached in init
  (0 of 12 states)
unreached in proctype philosopher
  philosopher.pml:35, state 13, "-end-"
  (1 of 13 states)
unreached in proctype reset_philosopher
  philosopher.pml:63, state 19, "-end-"
  (1 of 19 states)

pan: elapsed time 0 seconds
kumarlaxmikant@Kumars-MacBook-Pro Spin %
```

4. Write a program using PROMELA Language to define following model. Two process do not share any common data.

ProcessA: Computers reverse of a given number 123 digit number.

Process B: Maximum of the given a=3 and b=1.

```
proctype Reverse()
{
  int value=123;
  int reversed=0;
  do
    :: reversed = reversed + (value % 10);
    :: value = value/10;
    :: (value==0) -> break;
  od
  printf("value=%d,reversed=%d\n",value,reversed)
}

proctype Max()
{
  int a=3,b=1;
  int max = (a>=b -> a : b);
}
```

```

    printf("max=%d\n",max);
}
init
{
    run Reverse();
    run Max();
}

```

```

kumarlaxmikant@Kumars-MacBook-Pro Spin % spin -p -g first.pml;
0:  proc - (:root:) creates proc 0 (:init:)
Starting Reverse with pid 1
1:  proc 0 (:init::1) creates proc 1 (Reverse)
1:  proc 0 (:init::1) first.pml:20 (state 1)      [[run Reverse()]]
Starting Max with pid 2
2:  proc 0 (:init::1) creates proc 2 (Max)
2:  proc 0 (:init::1) first.pml:21 (state 2)      [[run Max()]]
3:  proc 1 (Reverse:1) first.pml:6 (state 1)      [reversed = (reversed+(value%10))]
4:  proc 1 (Reverse:1) first.pml:10 (state 6)     [.(goto)]
5:  proc 1 (Reverse:1) first.pml:6 (state 1)      [reversed = (reversed+(value%10))]
    max=3
6:  proc 2 (Max:1) first.pml:16 (state 1) [printf('max=%d\n',max)]
7:  proc 1 (Reverse:1) first.pml:10 (state 6)     [.(goto)]
7:  proc 2 (Max:1) terminates
8:  proc 1 (Reverse:1) first.pml:6 (state 1)      [reversed = (reversed+(value%10))]
9:  proc 1 (Reverse:1) first.pml:10 (state 6)     [.(goto)]
10: proc 1 (Reverse:1) first.pml:7 (state 2)      [value = (value/10)]
11: proc 1 (Reverse:1) first.pml:10 (state 6)     [.(goto)]
12: proc 1 (Reverse:1) first.pml:7 (state 2)      [value = (value/10)]
13: proc 1 (Reverse:1) first.pml:10 (state 6)     [.(goto)]
14: proc 1 (Reverse:1) first.pml:7 (state 2)      [value = (value/10)]
15: proc 1 (Reverse:1) first.pml:10 (state 6)     [.(goto)]
16: proc 1 (Reverse:1) first.pml:8 (state 3)      [((value==0))]
17: proc 1 (Reverse:1) first.pml:8 (state 4)      [goto :b0]
    value=0,reversed=9
18: proc 1 (Reverse:1) first.pml:10 (state 8)     [printf('value=%d,reversed=%d\n',value,reversed)]
18: proc 1 (Reverse:1) terminates
18: proc 0 (:init::1) terminates
3 processes created
kumarlaxmikant@Kumars-MacBook-Pro Spin %

```

5. Write a program using PROMELA Language to define following model. Two process do not share any common data.

ProcessA: Computers whether given number is odd or even.

Process B: Minimum of the given a=3 and b=1.

```

proctype A()
{
    int data = 56;
    if
    :: (data%2==0) -> printf("Data is Even");
    :: else -> printf("Data is Odd");
    fi
}

```



```

proctype B()
{
    int a=3,b=1;
    int min = (a<=b -> a : b);
    printf("min=%d\n",min);
}
init
{
    run A();
    run B();
}

```

```

kumarlaxmikant@Kumars-MacBook-Pro Spin % spin -p -g second.pml;
0: proc - (:root:) creates proc 0 (:init:)
Starting A with pid 1
1: proc 0 (:init::1) creates proc 1 (A)
1: proc 0 (:init::1) second.pml:17 (state 1) [(run A())]
2: proc 1 (A:1) second.pml:5 (state 1) [(((data%2)==0))]
    Data is Even 3: proc 1 (A:1) second.pml:5 (state 2) [printf('Data is Even')]
4: proc 1 (A:1) second.pml:8 (state 6) [.(goto)]
4: proc 1 (A:1) terminates
Starting B with pid 1
5: proc 0 (:init::1) creates proc 1 (B)
5: proc 0 (:init::1) second.pml:18 (state 2) [(run B())]
    min=1
6: proc 1 (B:1) second.pml:13 (state 1) [printf('min=%d\n',min)]
6: proc 1 (B:1) terminates
6: proc 0 (:init::1) terminates
3 processes created
kumarlaxmikant@Kumars-MacBook-Pro Spin %

```

6. Write a program using PROMELA Language to define following model. Two process do not share any common data.

ProcessA: Prints odd number from 1 to 50.

Process B: Prints even number from 1 to 50.

```

proctype Odd()
{
    int i=1;
    do
    :: if
        :: (i<50) -> i++
        :: else -> break
    fi
    :: if
        :: (i%2!=0) -> printf("%d\n",i);
        :: else -> skip
    fi
}

```

```

    od
}
proctype Even()
{
    int i=1;
    do
    :: if
        :: (i<=50) -> i++
        :: else -> break
    fi
    :: if
        :: (i%2==0) -> printf("%d\n",i);
        :: else -> skip
    fi
    od
}
init
{
    run Odd();
    run Even();
}

```

```

720: proc 1 (Odd:1) third.pml:14 (state 14) [.(goto)]
721: proc 1 (Odd:1) third.pml:6 (state 1) [((i<50))]
722: proc 1 (Odd:1) third.pml:6 (state 2) [i = (i+1)]
723: proc 1 (Odd:1) third.pml:9 (state 6) [.(goto)]
724: proc 1 (Odd:1) third.pml:14 (state 14) [.(goto)]
725: proc 1 (Odd:1) third.pml:11 (state 9) [else]
726: proc 1 (Odd:1) third.pml:11 (state 10) [(1)]
727: proc 1 (Odd:1) third.pml:13 (state 12) [.(goto)]
728: proc 1 (Odd:1) third.pml:14 (state 14) [.(goto)]
729: proc 1 (Odd:1) third.pml:11 (state 9) [else]
730: proc 1 (Odd:1) third.pml:11 (state 10) [(1)]
731: proc 1 (Odd:1) third.pml:13 (state 12) [.(goto)]
732: proc 1 (Odd:1) third.pml:14 (state 14) [.(goto)]
733: proc 1 (Odd:1) third.pml:6 (state 1) [((i<50))]
734: proc 1 (Odd:1) third.pml:6 (state 2) [i = (i+1)]
735: proc 1 (Odd:1) third.pml:9 (state 6) [.(goto)]
736: proc 1 (Odd:1) third.pml:14 (state 14) [.(goto)]
737: proc 1 (Odd:1) third.pml:10 (state 7) [(((i%2)!=0))]
    47
738: proc 1 (Odd:1) third.pml:10 (state 8) [printf('%d\n',i)]
739: proc 1 (Odd:1) third.pml:13 (state 12) [.(goto)]
740: proc 1 (Odd:1) third.pml:14 (state 14) [.(goto)]
741: proc 1 (Odd:1) third.pml:6 (state 1) [((i<50))]
742: proc 1 (Odd:1) third.pml:6 (state 2) [i = (i+1)]
743: proc 1 (Odd:1) third.pml:9 (state 6) [.(goto)]
744: proc 1 (Odd:1) third.pml:14 (state 14) [.(goto)]
745: proc 1 (Odd:1) third.pml:6 (state 1) [((i<50))]
746: proc 1 (Odd:1) third.pml:6 (state 2) [i = (i+1)]
747: proc 1 (Odd:1) third.pml:9 (state 6) [.(goto)]
748: proc 1 (Odd:1) third.pml:14 (state 14) [.(goto)]
749: proc 1 (Odd:1) third.pml:6 (state 1) [((i<50))]
750: proc 1 (Odd:1) third.pml:6 (state 2) [i = (i+1)]
751: proc 1 (Odd:1) third.pml:9 (state 6) [.(goto)]
752: proc 1 (Odd:1) third.pml:14 (state 14) [.(goto)]
753: proc 1 (Odd:1) third.pml:7 (state 3) [else]
754: proc 1 (Odd:1) third.pml:7 (state 4) [goto :b0]
754: proc 1 (Odd:1) terminates
754: proc 0 (:init::1) terminates
3 processes created
kumarlaxmikant@Kumars-MacBook-Pro Spin % █

```

7. Write a program using PROMELA Language to define following model

Process incr: Increments the x value by one everytime if x value is less than 200.

Process decr: Decrements the x value by one everytime if x value is greater than 0.

```
byte x=2;
proctype incr()
{
    atomic
    {
        if
        :: (x<200) -> x++
        fi
    }
}
proctype decr()
{
    atomic
    {
        if
        :: (x>0) -> x--
        fi
    }
}
init
{
    run incr();
    run decr();
}
```

```
kumarlaxmikant@Kumars-MacBook-Pro Spin % spin -p -g fourth.pml;
0:  proc - (:root:) creates proc 0 (:init:)
Starting incr with pid 1
1:  proc 0 (:init::1) creates proc 1 (incr)
1:  proc 0 (:init::1) fourth.pml:22 (state 1) [(run incr())]
2:  proc 1 (incr:1) fourth.pml:7 (state 1) [((x<10))]
3:  proc 1 (incr:1) fourth.pml:7 (state 2) [x = (x+1)]
    x = 3
3:  proc 1 (incr:1)          terminates
    timeout
#processes: 1
    x = 3
3:  proc 0 (:init::1) fourth.pml:23 (state 2)
2 processes created
```

