

CS 6110, Spring 2022, Assignment 3
Given 2/3/22 – Due 2/10/22 by 11:59 pm via your Github

NAME:

UNID:

CHANGES: Please look for lines beginning with underlined words when they are made. none yet.

Answering, Submission: Have these on your private Github: a folder Asg3/ containing your submission, which in detail comprises:

- A clear README.md describing your files.
- Files that you ran + documentation (can be integrated in one place).
- A high level summary of your cool findings + insights + learning – briefly reported in a nicely bulleted fashion in your PDF submission.

Start Early, Ask Often! Orientation videos and further help will be available (drop a note anytime on Piazza for help). *I encourage students constructing answers jointly!*

1. (10 points) This is on practicing the use of Murphi. At the end of this assignment, I include the N-Process Peterson protocol for mutual exclusion, described in https://en.wikipedia.org/wiki/Peterson%27s_algorithm. (This comes from the Murphi distribution; pasting it here for your convenience.) Your task is to set-up Murphi or Rumur, run this protocol for 3 processes, and see if you can get an estimate of the state-space of the protocol. I recommend that Murphi be obtained from <http://mclab.di.uniroma1.it/site/index.php/software/18-cmurphi> (latest version) or obtain Rumur from <https://github.com/Smattr/rumur>. Your luck in building these may vary—let's have a dialog next week on this. We will offer help if you get stuck, so please raise it on Piazza. Once you understand the coding of Murphi, kindly develop a bulleted summary of its constructs. I'll be adding more Murphi documentation in the interim.

Your Answer Here

2. (90 points) The main part of this assignment is to debug a locking protocol given in Promela. The protocol written by an expert (my former PhD student) is included with comments in `locking-prot.tex` and `locking-prot.pdf`. Set-up:
 - (a) This protocol, as implemented, has a bug
 - (b) Like almost all bugs, this occurs exactly on one line
 - (c) Like almost all bugs, the fix is also a small change on the line

Your task:

- (a) Discover this bug by a `spin -a` run
- (b) You can discover the bug in a depth of 90 or less by running `pan -a -m90`
- (c) You can simply look at the last state printed by `spin -s -r -t locking-buggy.pml` and spot the bug
- (d) Fix the bug and rerun

(e) Can a node decide to toss requests to a random node rather than along the PO chain? (It might do this to avoid network congestion.) Justify this, and implement + verify in the fixed version of your protocol (make some nodes nondeterministically toss the request to a random PO than its actual PO).

(f) Explain your insights!

Your
Answer
Here

```

-----
-- Copyright (C) 1992 by the Board of Trustees of
-- Leland Stanford Junior University.
--
-- This description is provided to serve as an example of the use
-- of the Murphi description language and verifier, and as a benchmark
-- example for other verification efforts.
--
-- License to use, copy, modify, sell and/or distribute this description
-- and its documentation any purpose is hereby granted without royalty,
-- subject to the following terms and conditions, provided
--
-- 1. The above copyright notice and this permission notice must
-- appear in all copies of this description.
--
-- 2. The Murphi group at Stanford University must be acknowledged
-- in any publication describing work that makes use of this example.
--
-- Nobody vouches for the accuracy or usefulness of this description
-- for any purpose.
-----

-----
--
--
-- File:      muxn.m
--
-- Content:    Peterson's algorithm (mutual exclusion for n-processes)
--
-- Summary of result:
--   1) No bug is discovered
--   2) Details of result can be found at the end of this file.
--
-- References:
-- Peterson, G.L., Myths about the mutual exclusion problem,
-- Information processing letters, Vol 12, No 3, 1981.
--
-- Date created:      28 Oct 92
-- Last Modified:     17 Feb 93
--
-----

Const
  N: 7;

Type
  -- The scalarset is used for symmetry, which is implemented in Murphi 1.5
  -- and not upgraded to Murphi 2.0 yet
  pid: scalarset (N);
  -- pid: 1..N;
  priority: 0..N;
  label_t: Enum{L0, -- : non critical section; j := 1; while j<n do
L1, -- : Beginwhile Q[i] := j
L2, -- : turn[j] := 1
L3, -- : wait until (forall k != i, Q[k] < j) or turn[j] != i ; j++; Endwhile
L4 -- : critical section; Q[i] := 0
  };
Var
  P: Array [ pid ] Of label_t;
  Q: Array [ pid ] Of priority;
  turn: Array [ priority ] Of pid;
  localj: Array [ pid ] Of priority;

Ruleset i: pid Do

  Rule "execute inc j and while"
    P[i] = L0 ==>
  Begin
    localj[i] := 1;

```

```

    P[i] := L1;
End;

Rule "execute assign Qi j"
P[i] = L1 ==>
Begin
    Q[i] := localj[i];
    P[i] := L2;
End;

Rule "execute assign TURNj i"
P[i] = L2 ==>
Begin
    turn[localj[i]] := i;
    P[i] := L3;
End;

Rule "execute wait until"
P[i] = L3 ==>
Begin
    If ( Forall k: pid Do
        ( k!=i ) -> ( Q[k]<localj[i] )
        End --forall
        | ( turn[localj[i]] != i ) )
    Then
        localj[i] := localj[i] + 1;
        If ( localj[i]<N )
        Then
            P[i] := L1;
        Else
            P[i] := L4;
        End; --If
    End; --If
End;

Rule "execute critical and assign Qi 0"
P[i] = L4 ==>
Begin
    Q[i] := 1;
    P[i] := L0;
End;

End; --Ruleset

Startstate
Begin
    For i:pid Do
        P[i] := L0;
        Q[i] := 0;
    End; --For

    For i: priority Do
        Undefine turn[i];
    End; --For

    Clear localj;
End;

Invariant
! Exists i1: pid Do
    Exists i2: pid Do
        ( i1 != i2
        & P[i1] = L4 -- critical
        & P[i2] = L4 -- critical
        )
    End --Exists
End; --Exists

/*****

Summary of Result (using release 2.3):

1) 3 processes

    breath-first search
    29 bits (4 bytes) per state
    771 states with a max of about 54 states in queue
    2313 rules fired
    0.73s in sun sparc 2 station

2) 5 processes

    breath-first search
    63 bits (8 bytes) per state
    576,551 states with a max of about 22,000 states in queue
    2,882,755 rules fired
    1201.66s in sun sparc 2 station

```

```

2.73S

* 3 processes (sparc 2 station)
* The size of each state is 35 bits (rounded up to 5 bytes).

BFS -nosym
882 states, 2646 rules fired in 0.73s.

BFS -sym1
172 states, 516 rules fired in 0.36s.

* 5 processes (sparc 2 station)
* The size of each state is 63 bits (rounded up to 8 bytes).

BFS -sym1
6770 states, 33850 rules fired in 22.55s.
249 states max in the queue.

BFS -nosym
628868 states, 3144340 rules fired in 758.92s.
25458 states max in the queue.

gamma2.9S on theforce.stanford.edu

5 proc
-04 compile 119.7s 2.7Mbytes
(24 bytes per states)
-sym2,3,4 6770 states, 33850 rules 14.35s

6 proc
-04 compile 120.2s 2.7Mbytes
(28 bytes per states)
-sym2,3,4 35,159 states, 210954 rules 117.45s

Release 2.9S (Sparc 20, cabbage.stanford.edu)

7 processes
* The size of each state is 232 bits (rounded up to 32 bytes).
-b * The size of each state is 101 bits (rounded up to 16 bytes).

163298 states, 1143086 rules fired in 341.93s.
-b 163298 states, 1143086 rules fired in 378.04s.
-c 163298 states, 1143086 rules fired in 292.42s.

*****/

```