Computational Models for Embedded Systems
Laboratory Assignment 01

Assignment 1: Model checking

Assignment Objectives:
1. Verification using model checking.
   - JSpin

Theoretical aspects
Model checking

Assignments

Assignment A) Model checking Tool
   Promela modeling and JSpin LTL properties.
Assignment B) Model checking Research
   Research investigation on a topic related to model checking and embedded systems.

Assignment and Delivery date:
   1. Assignment date: laboratory 1
   2. Delivery date (first): laboratory 3 (maximal grade 450XP: 150 XP for UBB-Goes-Green problem,
      150 XP for Embedded System problem, 150XP for Report (B))
   3. Delivery date (last): laboratory 7 (maximal grade 220: 70 XP for UBB-Goes-Green problem, 70 XP for
Embedded System problem, 70 XP for Report (B)) if time available.
   Remark: The solutions must be presented in class.

Assignment A) Sample Problem: A day in a life of … a parent and a child.
- Sample Problem Statement:
  o 2 actors: parent (P) and child (C)
  o At least 2 "signals" between the actors (from P to C and from C to P)
  o Example: P and C both in "sleeping" state; P wakes ups first and "signals" the C to wake up
    (thus, the C wakes up); P and C both "eating" state; C "signals" the P she/he finished the
    breakfast (P and C both "get dressed"); P "signals" the C to go to car (thus, C is in the state "in
    Car"), they both arrive to work/school in 30 minutes; after a period of time the C "signals" the P
    to come and pick her/him from school (thus the P picks her/him) and both go home; at home, P
    "signals" the C she/he has time to "play" (thus, the C comes and plays with the P); after a while
    the C "signals" the P to go to sleep (thus, they both go to sleep).
- Work in teams of 3 members.
- Create your own Problem Statements (you have to create two different problems: One related to UBB-
  Goes-Green and One related to an Embedded System) as described below:
- UBB-Goes-Green – Problem Statement
  o Statement of problem A) must be different (but must have: 2 actors + at least 2 "signals"
    between the actors).
  o Example: Paper Recycle
    - Actors: Teacher (T), UBB-Recycle-Center (UBB-RC)
    - Signals: T to UBB-RC (haveExamPapersToRecycle) and UBB-RC to T
      (doYouHaveOtherPapers?);
  o Read UBBGoesGreen report on 2018
    - http://green.ubbcluj.ro/
  o Read and create for 5 universities in the list - a A4 paper mindmap with key words about
    strategies/solutions for improvement at UBB (in teams of 3 students)
    - http://greenmetric.ui.ac.id/
- Embedded System – Problem Statement
  o Statement of problem A) must be different (but must have: 2 actors + at least 2 "signals"
    between the actors).
  o Example: Air humidifier (Smart Humidifier)
    - Actors: humidity sensor (HS), temperature sensor (TS), humidity controller (HC)
    - Signals: HS to HC and TS to HC; HC adjust by a mist level;
    - Remark: Research and study about how an air humidifier works. Use various colors for
      leds, various (1 to 4) mist output level, various (1 to 3) humidity settings, various time.

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- o Example: Detection on the conveyor (ultrasonic (distance) sensor)
  - if the bottles are too high/small/fallen or checking whether the box is full or empty with bottles
  - Actors: distance sensor (DS), process fallen controller (FC)
  - Signals: DS to FC
  - Remark: Research and study how detection on a conveyor works.
- o Example: Bulb with light sensor (photodiode, Smart Bulb)
- o Example: Soil moisture sensor (Smart Garden)

Turn in:

(a) Problem statement in natural language (specify the actors, the signals and describe the interactions).
(b) Promela *.pml file with the solution.
(c) Write 3 LTL formulas and check them with the JSpin model checker. (sample: The P always waits for the C to finish breakfast before getting to car or The state after "school" is "home", other examples).
(d) The output of the Spin model checker.
(e) An archive with all the above files must be sent by email to avescan@cs.ubbcluj.ro (the name of the archive: TeamXYZ_MC_Tool.zip)

Assignment B) Research report/presentation about using Spin in various domains
Sample research topics
- Work in teams of 3 members.
- Use 1 papers (published in journals or conferences) having the same topic. Use the information in the resource 3) from file student_worksheet.pdf to search for papers.
- Turn in:
  - o student_worksheet.pdf – printed and filled in for the selected paper.
  - o Report of maximum 3 pages with the structure: (introduction + motivation) + (problem statement) + (related work described in the paper) + (proposed approach) + (validation of the approach/case study) + (discussion/conclusions+personal conclusions)
  - o A flat A4 file must contain the printed report + student_worksheet.
  - o An archive with all the used references and final report must be sent by email to avescan@cs.ubbcluj.ro (the name of the archive: TeamXYZ_MC_Report.zip)

- Sample topics
  - o Topic 1) Model checking used in Air traffic control systems
    - 2016_Assuring safety in air traffic control systems with argumentation and model checking.pdf (20 pages)
  - o Topic 2) Model checking in Electronic payment protocols
    - 2017_ Model checking the i KP electronic payment protocols.pdf (11 pages)
  - o Topic 3) Model checking for Avionics
    - 2012_Symbolic Model Checking for Avionics.pdf (28 pages)
  - o Topic 4) Architecture evolution with model checking
    - 2017_ Self-adaptive architecture evolution with model checking: A software cybernetics approach.pdf (19 pages)
  - o Topic 5) System safety assessment and model checking
    - 2018_System safety assessment based on STPA and model checking.pdf (14 pages)
  - o Topic 6) Model checking in Software engineering
    - 2018_The role of model checking in software engineering.pdf (27 pages)
  - o Topic 7) MARTE and model checking (+search another one related to this topic)
    - 2018_Model checking of MARTE.pdf (6 pages)
  - o Topic 8) Model checking software architecture
    - 2010_A classification and comparison of model checking software architecture techniques.pdf (22 pages)
  - o Topic 9) Model checking embedded systems
    - 2005-Model checking embedded systems with PROMELA.pdf (9 pages)
  - o Topic 10) Model checking in the nuclear engineering domain

- 2012_Model checking of safety-critical software in the nuclear engineering domain.pdf (10pages)
  - Others
    - Automatic Generation of SPIN Model Checking Code from UML Activity Diagram
    - SPIN Model Checking for the Verification of Clinical Guidelines
    - Design Verification of Web Applications Using Symbolic Model Checking
    - Bandera: A tool set for model checking Java source code