

CS 6910 – Verification and Testing of Concurrent Programs

Fall 2008

Instructor: Dr. Zijiang James Yang
Course Website: <http://www.cs.wmich.edu/~zjiang/CS6910>

Description of CS6910

Today, it is almost impossible to buy a computer with a single processor. The availability of inexpensive multiprocessor hardware presents tremendous opportunities as well as serious challenges for software developers. In order for software applications to benefit from the continued exponential throughput advances in multi-core processors, the applications must be well-written concurrent software programs. Unfortunately, writing concurrent software programs that can unleash the full potential of present and future hardware systems is very difficult. Most people realize that parallel computers are easy to build - it is the software that takes work. One of the most challenge issues in concurrent programming is how to verify the correctness of a concurrent program. This course is about finding and preventing errors not only in concurrent programs, but also in other concurrent systems such as hardware devices, embedded systems.

It is a 3 credit hours course.

Prerequisites

The course requires basic knowledge of algorithms, data structures, automata theory, computational complexity, and propositional logic (CS 531, CS 580, or equivalent). Knowledge of operating systems, communication protocols, and hardware is useful.

Objectives

1. Understand the challenges in testing and verification of concurrent programs
2. Learn formal verification and various informal testing techniques that address the challenges
3. Learn important data structures such as Binary Decision Diagrams (BDDs).
4. Learn how to specify property formally using temporal logic.
5. Learn how to traverse state space symbolically.
6. Learn techniques used in solving SAT problem.
7. Learn state-of-the-art testing and verification algorithms through research papers.

Performance Objectives

1. Student will understand the need for formal verification to ensure correctness of concurrent programs.
2. Student will be able to specify property formally using logic.
3. Student will be able to design and implement tools to do invariant checking.

4. Student will be able to apply various testing and verification techniques.

Text

There are no required text books. Relevant papers will be posted on the course website during the course.

Course Topics

This course is divided into two parts. During the first half of the semester the instructor will cover the following topics

- Overview of program testing techniques
- introduction to logic
- Property specification using Computation tree logic (CTL)
- Concurrency
- Explicit state model checking
- Binary Decision Diagrams (BDDs)
- Symbolic model checking
- Boolean satisfiability problem and satisfiability modulo theory
- Abstraction and compositional reasoning
- Introduction to verification/testing tools

The students are required to read and present research papers during the 2nd half of the semester. Relevant papers will be posted on course website during the semester.

Grading

The major component of the evaluation will be the class project. There will be no exams. Pop-quizzes may be given at anytime in lecture without prior notification. Presentations on relevant topics are required. Your grade will be computed from your performance on these components using the following weights:

Project	50%
Presentation	30%
Participation	20%

Class Project

The project can be done by single person or in groups of two or three, and will require written proposal before the project and a presentation in the final week. Projects can be of various forms:

- Programming: Implementation of algorithms outlined in a research paper, modify open-source tools, etc.
- Case study: analysis of an application (e.g. linux core)
- Tool Comparison: Using different tools to analyze the same application and present differences between various approaches
- Surveys: Read a group of papers on a related topic and write a detailed technical report
- Theory: Exploratory research

Students must discuss with the instructor before start the projects.

Incomplete Grades

Please note that the incomplete grade - *I* - is intended for the student who has missed a relatively small portion of work due to circumstances beyond his/her control. In general, performance on work done must be at a level of C or better in order to qualify for an incomplete. An *I* grade will not be given to replace an otherwise low or failing grade in the class.

Academic Honesty

The following statement has been approved and distributed by the Western Michigan University Faculty Senate:

You are responsible for making yourself aware of and understanding the policies and procedures in the Undergraduate and Graduate Catalogs that pertain to Academic Honesty. These policies include cheating, fabrication, falsification and forgery, multiple submission, plagiarism, complicity and computer misuse. [The policies can be found at <http://catalog.wmich.edu> under Academic Policies, Student Rights and Responsibilities.] If there is reason to believe you have been involved in academic dishonesty, you will be referred to the Office of Student Conduct. You will be given the opportunity to review the charge(s). If you believe you are not responsible, you will have the opportunity for a hearing. You should consult with your instructor if you are uncertain about an issue of academic honesty prior to the submission of an assignment or test.

Submission of another person's work in part or whole is not permitted. Learning can certainly occur with discussion of class material and assignments with other students, and we will be doing considerable collaborative activity, but at all times take care that you don't represent the work of another as your own.

Easy availability of information, material, source codes, lecture notes etc on the Internet may make it possible to find solutions to your assignments on the Internet or elsewhere. It is okay to refer to those, understand them and use them to enhance your solutions, generate your own ideas etc. However, you must give proper and full credit to original

authors of the work, if you include their ideas and/or solutions. Failing to do so is part of academic and professional dishonesty. It will not be tolerated in this class. Do not give in to temptations.

If you are found responsible for violation of academic honesty in the course, you will receive a penalty up to and including an E grade in the class.