Module Folder (CS 4271)

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Course Description

In this folder, I will present my teaching of

CS 4271 : Critical Systems and their Verification

The course is aimed to teach the students an initial idea about formal reasoning and verification. The aim is to study scalable reasoning techniques which can be used for formally validating safety critical systems. The course description (which was posted in the course web-page) is given below.

This course will introduce verification techniques for validating safety critical reactive systems with specific focus on embedded systems. Primarily we will cover an automated verification technique called Model Checking which is based on state space search and can check all possible behaviors of a system. The different parts of the course will touch upon: (a) modeling of reactive system behaviors (b) verification via Model Checking (c) state space reduction techniques to make model checking space/time efficient and (d) specific issues in validation of reactive embedded systems.

Learning Objectives

The learning objectives of CS 4271 were as follows:

(a) Focused approach: study one technique (widely used in industry) for formal verification
(b) Hands-on approach towards formal verification, with initiation to *verification tools*
(c) Appreciation and basic understanding of more theoretical topics like
    a. Property specification (via temporal logic)
    b. Use of logical formula manipulation to achieve the effect of search algorithms

Assessment Plan

The assessment plan was geared towards a healthy mix of continuous evaluation and examinations. Apart from *one* midterms and a final examination, the students did hands-on work. For the hands-on work, I experimented with different formats – different homeworks or one single project. The students seem to prefer the project more, since it gives them an opportunity for independent exploration. The exams contained long questions. All the examinations (final and midterm) were open-book. The assessment plan was to test the students on overall analytical ability (captured more by the long questions). The long questions were formulated to test the students' understanding of generic concepts, that is, they were not merely a collection of short questions. Rather they were aimed to test the understanding of the connection between concepts which arise in formal reasoning.
The rough breakdown is as follows.

Final Exam: 50%, Midterm: 25%, Project 25%

The projects were administered as follows
End of 1st month --- Students form group of 2-3 and submit a project proposal. Each project is a case study for system modeling and verification.
End of 2nd month --- Students finish their modeling, and submit a midterm report.
End of 3rd month --- Students finish verification and submit final report along with their implementation.

Student Profile

I have taught this course for 5 consecutive years and the enrolment varies from year to year. The average enrolment is around 45 students and the maximum is 55 students. Most of the students are from our Computer Engineering program, since CS4271 is offered as an elective in the Computer Engineering program.

Teaching Strategy and Innovative Practices

My strategy in this course was to adopt a more conceptual way of teaching. The primary innovation is to avoid burdening the students with syntax or terminology of different models of computation and property specification languages. Instead we focussed on one model, one property specification language and one verification technique and studied it in depth. This allowed us to define a few basic concepts early on in the course so that we could have more in-depth discussions towards the end. Pointers to other techniques and specification languages were given in class (and these topics were discussed briefly).

All through the course, IT was used as part of an attempt to reach out to students. In fact, I have regularly sent out e-mails to students in an attempt to clarify their doubts etc. This year, I have not used IVLE discussion forum because based on my past experience I have notice that in small classes, people do not post too many messages to the discussion forum, instead they contact the lecturer. So, many times when a student sent me a question, I have broadcast the answer to the whole class. I have found the IVLE Lesson Plan to be very useful in my teaching. It helps plan the lecture schedule and gives out useful information (such as supplementary reading) to the students in advance.

Things that could be done differently

I conducted a mid-term module feedback using IVLE. Based on the feedback, I made some changes to the course, including abolishing the official consultation hours. The students were more comfortable seeking e-mail appointments, or asking questions in the tutorials so I stayed with this arrangement. This allows the students to come in at times of their convenience.

Appendices in CS4271 module folder

1. Lesson Plan
2. Sample Lecture Notes --- on system modeling and real-life case studies. The lecture on real-life case study discusses the **integration of some of my research activities into undergraduate teaching.**
3. Sample Midterm Examination
4. Sample Final Examination
5. List of Project Ideas given out to students
6. Sample project report (each group of students submits the code for their modeling/verification as well as a project report)

Reflections on teaching the CS4271 module appears in the following paper --- *Introducing Model Checking to Undergraduates*, by Abhik Roychoudhury, In proceedings in Formal Methods in Education Workshop 2006, co-located with Formal Methods (FM) Symposium 2006. This article is included in my teaching portfolio under the item --- *Pedagogical Articles*.