Model Checkers in Education: 10^6 Users and Beyond

Frits Vaandrager

Radboud University Nijmegen

International Workshop in Honour of Gerard Holzmann
University of Twente, November 30, 2006

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Motivation

Despite enormous progress, model checking not yet push button technology:

- building good models is difficult
- finding tractable abstractions is difficult

Expertise (or expert advice) needed for use in practice.

Number of users of tools such as SPIN and UPPAAL appr $10^3/10^4$.

If we want model checkers to be widely $(> 10^6!)$ used and accepted, we need to

- further improve the technology,
- teach our students to use it.

Two Approaches

Type I:Emphasize theory behind model checkers

- Bachelor: Introduce model checkers as part of a logic course.
- Master: Explain ins and outs of model checkers: language, logics, algorithms, data structures,..

Type II:Emphasize application of model checkers

- Bachelor: Tool to explain/visualize/solve simple concurrency problems
- Master: Tool that can help in the modelling, design and analysis of complex systems

Approaches are complementary (and often combined in practice), but for todays students application should precede theory.

Uppaal

Recently, the timed automata model checker Uppaal has been extended with C-like functions, and the verification engine has become much more powerful.

Main advantages for use in teaching: graphical user interface and simulator.

Main disadvantage: no good support for liveness properties.

Model Checker as a Teaching Aid

Beginning students traditionally find concurrency difficult:

- It is hard to visualize the dynamic behavior of concurrent algorithm in a static book.
- Typically there are no formal correctness proofs in textbooks on operating systems (this would distract attention)
- No easy way to obtain insight in safety and liveness properties.

Model checker can help!

Message:*Just like calculator, a model checker does math for you.*

UPPAAL DEMO

Additional Benefits

- Once students have seen how useful model checkers are, they will much faster decide to use them later on in their studies/carreer.
- Even in introductory course state explosions occur now and then. Students become interested/motivated to study theory/math behind model checkers.
- Maybe semapores aren't as bad as some authors say they are.

Use in Advanced Modelling/Verification Course

- Give students *real* cases from industry.
- Let them work in teams.
- Discuss problems with students and help them to find solution.

Presentation Students at FM06 Workshop

Conclusions

- All CS students should be exposed to model checkers (for instance in introductory concurrency course) since it (1) is fundamental new technology, (2) helps students to understand fundamental CS concepts.
- Great opportunity to increase impact of FM research
- Visualization and a graphical used interface very important
- Uppaal effective but still lacks support for liveness properties
- Emphasize application of model checkers rather than underlying theory