

Two Decades of Probabilistic Verification — Reflections and Perspectives

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Model checking is emerging as a practical tool for automated debugging of complex reactive systems such as embedded controllers and network protocols. In model checking, specifications about the system are expressed as (temporal) logic formulas, and efficient symbolic algorithms are used to traverse the model defined by the system and check if the specification holds or not. Whereas traditional model checking focuses on the absolute correctness of systems, in practice such rigid notions are hard, or even impossible, to guarantee. Instead, systems are subject to various phenomena of stochastic nature, such as message loss or garbling, unpredictable environments, faults, and delays. Accordingly, stochastic model checking aims to establish, for instance, whether “the chance of shutdown occurring is at most 0.01%”. Stochastic model checking is based on conventional model checking, but also entails the calculation of the actual likelihoods through appropriate numerical methods. The goal of the workshop was to survey state-of-the-art techniques for the modeling and verification of random aspects of computer systems, and to identify the main research challenges for the next decade. The workshop was organized by VOSS2, a research collaboration between the Netherlands and Germany within the NWO-DFG bilateral cooperation program. The workshop brought together 50 researchers, including 28 from the VOSS2 project.

There were 6 invited presentations in which experts gave an overview of what has been accomplished but also outlined future research directions. The remaining activities concentrated on four (related) themes, selected with the explicit purpose to stimulate/encourage active collaboration between the participants:

(a) The first day was devoted to the presentation and comparison of tools, tool-chaining, and tool-related design issues. Altogether 13 probabilistic verification tools were presented by their designers/specialists: PRISM, MRMC, MOTOR, MOEBIUS, SMART, CADP, PReMo, APEX, PIPE, CASPA, CORAL, PASS, Liquor/PROBMELA. The presentations were followed by lively discussions about possible connections between tools, and ways to further improve them.

(b) Already before the start of the workshop, participants were asked to tackle a challenging case study on gossiping protocols that was defined by the organizers. During the second day, following a tutorial on gossip algorithms by Maarten van Steen, participants

presented their solutions. As was to be expected, analysis of gossip algorithms is beyond the capabilities of current probabilistic model checkers, which can only handle networks with about 5 nodes, whereas practical networks contain more than 10.000 nodes. Several ideas for solutions were discussed, with as bottom line that we need to get away from enumerating things, moving to fluid-flow like models.

(c) Participants were asked to propose one or more specific technical problems. The seven most interesting problems were selected, and about one day was devoted to discuss these problems in subgroups.

(d) During one session, all participating PhD students/postdocs got 10-15 minutes to present their ongoing research, followed by in depth discussions in subgroups.

The workshop saw the birth of many new collaborations on probabilistic verification. We intend to prepare a special issue of *ACM SIGMETRICS Performance Evaluation Review*, which should appear by the end of 2008, devoted to the results of the case study verification. We also aim at a few theory related publications, possibly in a special issue of the *Information & Computation* journal. A start was made with a follow-up of the VOSS2 project, possibly also involving other European countries.

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