

Executive Summary:

Dagstuhl Seminar 10111 on Practical Software Testing: Tool Automation and Human Factors

March 14-19, 2010

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Seminar Goal and Structure

The main goal of the seminar “Practical Software Testing: Tool Automation and Human Factors” was to bring together academics working on algorithms, methods, and techniques for practical software testing, with practitioners, interested in developing more soundly-based and well-understood testing processes and practices. The seminar’s purpose was to make researchers aware of industry’s problems, and practitioners aware of research approaches. The seminar focused in particular on testing automation and human factors:

Tool automation. Automation of testing is a crucial concern in industry. It is only with automation that testing becomes practical and scalable to the size of a typical system with which the industry has to deal. Test automation or tool support spans the spectrum from test planning, generation, minimization, execution, oracle checking, to management. Test automation can exploit not only knowledge from the code under test but also from available models or specifications.

Human factors. Human factors play important roles in software testing. Given the code under test, tools can try to automate the generation of test inputs as much as possible, but test oracles still need to come from testers, who specify them in the form of specifications, properties, or test assertions, or directly inspect the actual test outputs for correctness. In addition, tools are not always perfect to deal with software complexity; testers need to cooperate with tools to effectively carry out testing tasks, by giving guidance to tools and interpreting results produced by tools. Thus testers need to be well trained.

In the week of March 14-19, 2010, 40 researchers from 11 countries (Canada, France, Germany, Italy, Luxembourg, the Netherlands, Sweden, Switzerland,

South Africa, United Kingdom, United States) discussed their recent work, and recent and future trends in software testing. The seminar consisted of five main types of presentations or activities: *topic-oriented presentations*, *research-oriented presentations*, *short self-introduction presentations*, *tool demos*, and *working group meetings and presentations*.

The **topic-oriented presentations** were organized so as to present the state-of-the art, challenges, automation, and future perspective on selected topics. For each topic, the seminar organizers selected a pair of speakers (one from academia and one from industry for most topics) and three to four panelists. Immediately after the invited talk for a research topic, a small panel led further discussion on the topic among the participants. For these invited talks and panels, five research topics were chosen by the seminar organizers to cover important topics in software testing. The topic-oriented presentations and panels (with each topic about 1 hour 45 minutes) occurred during the first two days of the seminar. Below are the list of invited speakers and panelists for each topic (invited speakers for a topic also served on the panel):

- **Human Factors in Software Development Tools.** Invited speakers: Andrew J. Ko and Eileen Kraemer. Panelists: Laura Dillon, Stephen Oney, and John Penix.
- **Testing in Academia and in Industry.** Invited speakers: Thomas Ball and Willem Visser. Panelists: Mark Grechanik and Michal Young.
- **Code-based Test Data Generation.** Invited speakers: Patrice Godefroid and Mauro Pezzè. Panelists: Darko Marinov, Nikolai Tillmann, and Paolo Tonella.
- **Model-based Testing.** Invited speakers: Bruno Legeard and Jan Tretmans. Panelists: Wolfgang Grieskamp, Robert M. Hierons, and Amit Paradkar.
- **Regression Testing.** Invited speakers: Mary Jean Harrold and Brian P. Robinson. Panelists: Adam Porter, David Rosenblum, Per Runeson, and Shin Yoo.

The **research-oriented presentations** had the goal of presenting current research on a certain topic (i.e., reporting on some recent research results by participants). The research-oriented presentations (15 minutes each) occurred during the morning of the third and fourth days of the seminar. There were five different research-oriented presentations on concurrency testing, database application testing, model-based testing, and requirement-based testing:

- “Preemption Sealing for Efficient Concurrency Testing” by Thomas Ball.
- “Preserving Test Coverage While Achieving Anonymity for Database-Centric Applications” by Mark Grechanik.
- “Eco Testing for Components” by Jan Tretmans.
- “Holistic Requirements based Analysis and Testing” by Amit Paradkar.
- “Coverage Metrics and Requirements-Based Testing” by Michael Whalen.

The **short self-introduction presentations** had the goal of presenting each participant’s brief background and short overview of the research work.

The short self-introduction presentations occurred in the beginning of the first and second days.

The **tool demos** had the goal of presenting live demonstrations of research or industrial tools. The tool demos occurred during the second day's evening after dinner. There were ten tools being demonstrated, including JPF by Willem Visser, CHESS by Thomas Ball, Spec Explorer by Wolfgang Grieskamp, Test Designer by Bruno Legeard, Milu by Yue Jia, Text 2 Test by Amit Paradkar, Pex by Nikolai Tillmann, Whyline by Andrew J. Ko, ReAssert by Darko Marinov, and Pex Custom Arithmetic Solver by Kiran Lakhotia.

The **working group meetings and presentations** had the goal of identifying open problems, promising directions, and collaboration opportunities on certain topics. In the end of the second day of the seminar, the participants broke into six working groups, each dedicated to a specific topic. The participants from each working group were instructed to carry out the following steps: (0) choose a group coordinator, (1) identify three open problems, (2) identify at least one promising direction, (3) identify at least one new way in which members of the group could collaborate, (4) suggest at least one possible title for a new paper that members of the group could potentially write, (5) suggest one possible title for a funding proposal that some member(s) of the group could potentially submit, (6) write a paper on the identified topic, (7) read other groups' papers, and (8) present the main insights of their group's paper. A prize was presented to the best group, voted by the seminar participants based on the presentation of the coordinator of each working group.

Working group meetings occurred during the late morning of the third day, and the late morning and afternoon of the fourth day. There were working groups' report presentations and discussions to all the seminar participants at the last meeting sessions of the third and fourth days. During the fifth day's morning, each working group presented their resulting working group paper or paper outline.

Below are the six working groups, each one working on a topic selected by the participants:

- **Code-based Test Generation.** Coordinator: Paolo Tonella. Members: Nadia Alshahwan, Gordon Fraser, Yue Jia, Kiran Lakhotia, David Shuler, Paolo Tonella. Working group paper title: "AUTOMOCK: Automated Synthesis of a Mock Environment for Test Case Generation".
- **Test Oracles.** Coordinator: Andrew J. Ko. Members: Jamie Andrews, Mark Grechanik, Andrew J. Ko, Brian P. Robinson, and Michal Young. Working group paper title: "Computing and Diagnosing Changes in Unit Test Energy Consumption".
- **Integration of Testing/Analysis Techniques.** Coordinator: Michael W. Whalen. Members: Patrice Godefroid, Leonardo Mariani, Andrea Polini, Nikolai Tillmann, Willem Visser, and Michael W. Whalen. Working group paper title: "FITE: Future Integrated Testing Environment".
- **Regression Testing.** Coordinator: Per Runeson. Members: Mary Jean Harold, Darko Marinov, Stephen Oney, Mauro Pezzè, Adam Porter, John Penix,

Per Runeson, and Shin Yoo. Working group paper title: “Introducing Continuous Selective Testing of Evolving Software”.

- **Model-based Testing.** Coordinator: Wolfgang Grieskamp. Members: Antonia Bertolino, Wolfgang Grieskamp, Robert M. Hierons, Yves Le Traon, Bruno Legeard, Henry Muccini, Amit Paradkar, David Rosenblum, and Jan Tretmans. Working group paper title: “Model-Based Testing for the Cloud”.
- **Concurrency Testing.** Coordinator: Thomas Ball. Members: Thomas Ball, Eileen Kraemer, and Laura K. Dillon. Working group paper title: “Groundwork for the Development of Testing Plans for Concurrent Software”.

Based on the voting, the winners of the presentations were the “Integration of Testing/Analysis Techniques” and the “Model-based Testing” working groups.

The seminar arranged outing time as the afternoon of the third day. Many participants joined the organized journey to the World Cultural Heritage Site at the Volklingen Ironworks, and had great time there.

In summary, the seminar accomplished all the expected goals, generating a great deal of forward momentum. The discussion and working groups allowed participants to form better understanding of open challenges and future directions in software testing. During the seminar, academic researchers and industrial researchers fully exchanged ideas for attempting to bridge the gap between research and practice. A number of participants exploited the substantial interactions at the seminar to foster future collaborations. After the seminar, the seminar organizers and participants compiled a bibliography by collecting a list of papers discussed or mentioned during the seminar. Several of the groups indicated that they intended to continue the discussion process after the seminar. We hope that the ideas and collaborations initiated at this Dagstuhl seminar in March 2010 will find fruition in papers, funded research projects, and technical innovations in the years to come.

List of Participants

Nadia Alshahwan, King’s College - London; Jamie Andrews, University of Western Ontario; Thomas Ball, Microsoft Research - Redmond; Antonia Bertolino, CNR - Pisa; Laura Dillon, Michigan State University; Gordon Fraser, Universität des Saarlandes; Patrice Godefroid, Microsoft Research - Redmond; Mark Grechanik, Accenture Labs - Chicago; Wolfgang Grieskamp, Microsoft Corp. - Redmond; Mark Harman, King’s College - London; Mary Jean Harrold, Georgia Institute of Technology; Robert Hierons, Brunel University; Yue Jia, King’s College - London; Andrew J. Ko, University of Washington; Eileen Kraemer, University of Georgia; Kiran Lakhotia, King’s College - London; Yves Le Traon, University of Luxembourg; Bruno Legeard, Smartesting - Besancon; Leonardo Mariani, University of Milano-Bicocca; Darko Marinov, University of Illinois - Urbana; Henry Muccini, Univ. degli Studi di L’Aquila; Stephen Oney, Carnegie Mellon University - Pittsburgh; Amit Paradkar, IBM TJ Watson Research Center - Hawthorne; John Penix, Google Inc. - Mountain View; Mauro Pezzè, University

of Lugano; Andrea Polini, Università di Camerino; Adam Porter, University of Maryland - College Park; Brian P. Robinson, ABB - Raleigh; David Rosenblum, University College London; Per Runeson, Lund University; David Schuler, Universität des Saarlandes; Wolfram Schulte, Microsoft Research - Redmond; Nikolai Tillmann, Microsoft Research - Redmond; Paolo Tonella, Fondazione Bruno Kessler - Trento; Jan Tretmans, Embedded Systems Institute - Eindhoven; Willem Visser, Stellenbosch University - Matieland; Michael W. Whalen, University of Minnesota; Tao Xie, North Carolina State University; Shin Yoo, King's College - London; Michal Young, University of Oregon.

Links

Dagstuhl web page: <http://www.dagstuhl.de/10111>

Seminar Schedule: <http://www.dagstuhl.de/schedules/10111.pdf>

Participants and shared documents: <http://www.dagstuhl.de/Materials/index.en.phtml?10111>

Wiki: <http://www.dagstuhl.de/10111/Wiki> (password required).