Preface

The 19th International Symposium on Implementation and Application of Functional Languages (IFL 2007) is held at Freiburg, Germany, on the 27th to the 29th September 2007. Local organiser is the Programming Languages Group of the Department of Computer Science of the University of Freiburg.

IFL brings together researchers active in the area of functional programming, with an emphasis on the implementation and application of the same. IFL provides an annual open forum for researchers who wish to present and discuss new ideas and concepts, work in progress, preliminary results, etc. IFL has been held throughout Europe in the Netherlands, United Kingdom, Germany, Sweden, Spain, Ireland and Hungary. This year for the first time IFL is co-located with the International Conference on Functional Programming (ICFP). A record number of 44 papers have been submitted for these draft proceedings. By the time of printing 73 researchers had registered for attendance at the symposium.

Following tradition, two proceedings are to be published: the draft proceedings used at the symposium (this document), released as a technical report of the Computing Laboratory of the University of Kent, and the post-symposium proceedings based on revised papers. The draft proceedings are un-refereed and provide a useful reference to the delegates at the symposium. All participants who give talks at the symposium are invited to submit revised papers for review after the symposium, to normal conference standards. The post-symposium proceedings of selected revised papers will be published by Springer-Verlag in its Lecture Notes in Computer Science (LNCS) series.

Olaf Chitil
Programme Chair
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September 2007

Local Organisers

Markus Degen
Peter Thiemann
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# Table of Contents

Termination and Complexity Bounds for SAFE programs .......................... 8  
*Salvador Lucas, Ricardo Peña*

Graph Parser Combinators ......................................................... 24  
*Steffen Mazanek, Mark Minas*

Encoding Iterators in Interaction Nets ........................................ 40  
*José Almeida, Ian Mackie, Jorge Sousa Pinto, Miguel Vilaça*

Testing Erlang Refactorings with QuickCheck ................................. 55  
*Huqing Li, Simon Thompson*

Call Graphs, Dominator Trees, and Lambda Lifting ............................. 71  
*Marco T. Morazan, Ulrik Schultz*

To Be or Not to Be ... Lazy .................................................. 89  
*Mercedes Hidalgo-Herrero, Yolanda Ortega-Mallén*

The Structure of the Essential Haskell Compiler, or Coping with Compiler Complexity .......................................................... 107  
*Atze Dijkstra, Jeroen Fokker, Doaitse Swierstra*

XHaskell — Adding Regular Expression Types to Haskell ...................... 123  
*Martin Sulzmann, Kenny Zhuo Ming Lu*

Evaluating and Using a Grid-Enabled Parallel Haskell .......................... 139  
*Phil Trinder, Abyd Al Zain, Kevin Hammond*

Partial Parsing: Combining Choice with Commitment ........................... 140  
*Malcolm Wallace*

Functional Master-Worker Skeletons ............................................. 152  
*Jost Berthold, Mischa Dieterle, Rita Loogen, Steffen Priebe*

Towards an Implementation of a Computer Algebra System in a Functional Programming Language .................................................. 168  
*Oleg Lobachev*

Lazy Contract Checking for Immutable Data Structures ........................ 179  
*Robert Bruce Findler, Shu-yu Guo, Anne Rogers*

Haskell – Join – Rules .......................................................... 195  
*Martin Sulzmann, Edmund Lam*

Splitting and Merging Program Refactorings .................................... 211  
*Christopher Brown, Simon Thompson*

An Interpretation of Temporal Properties in Functional Programs ............ 224  
*Máté Tejfel, Tamás Kozsik, Zoltán Horváth*
Approaches to Subtyping in Functional Languages ........................................ 229
Glenn Strong

On the Validation of Specifications used in Model-Based Testing .................. 230
Pieter Koopman, Peter Achten, Rinus Plasmeijer

Car Damage Subrogation Workflow — an iTask exercise ............................... 232
Erik Zuurbier, Rinus Plasmeijer

Towards Open Type Functions for Haskell ................................................. 233
Tom Schrijvers, Martin Sulzmann, Simon Peyton Jones, Manuel Chakravarty

Transparent Ajax and Client-Site Evaluation of iTasks .................................. 252
Rinus Plasmeijer, Jan Martin Jansen, Pieter Koopman, Peter Achten

Static Inference of Non-Monotonic Polynomial Sized Types .......................... 254
Marko van Eckelen, Olha Shkaravska

Efficient, Modular Tries ................................................................. 258
Frank Huch, Sebastian Fischer

FunSETL — Functional Reporting for ERP Systems ..................................... 268
Michael Nissen, Ken Friis Larsen

The Reduceron: Widening the von Neumann Bottleneck for Graph Reduction using an FPGA ................................................................. 290
Matthew Naylor, Colin Runciman

Incremental Extension of a Domain Specific Language Interpreter ............... 301
Olivier Michel, Jean-Louis Giavitto

Generic Programming Combinators ......................................................... 318
Sebastian Fischer, Frank Huch

Supero: Making Haskell Faster ............................................................. 334
Neil Mitchell, Colin Runciman

Checking Dependent Types Efficiently ..................................................... 350
Dirk Kleeblatt

HW-Hume in Isabelle ............................................................................. 366
Chunxu Liu, Greg Michaelson

Static Contract Checking for Haskell ....................................................... 382
Dana Na Xu, Simon Peyton Jones, Koen Claessen

Debugging Lazy Functional Programs by Asking the Oracle ....................... 400
Bernd Braßel, Holger Siegel

Uniqueness Typing Simplified .................................................................... 416
Edsko de Vries, Rinus Plasmeijer, David Abrahamson

Tabular Expressions and Total Functional Programming ........................... 431
Baltasar Trancón y Widemann, David L. Parnas
Positive Supercompilation for a Higher Order Call-By-Value Language

Peter Jonsson, Johan Nordlander

The Simple Category of Modules

Mikolaj Konarski

Polytopes & Polytypes: Generic Isosurfacing & Functional Programming

Colin Runciman, David Duke, Rita Borgo, Malcolm Wallace

Meta(Fun) — Towards a Functional-Style Interface for C++ Template Metaprograms

Ádám Sipos, Zoltán Porkoláb, Norbert Pataki, Viktória Zsók

Speculative Inlining of Predefined Procedures in an R5RS Scheme to C Compiler

Marc Feeley

Circuit Parallelism in Haskell Programs

Andreas Koltes, John O’Donnell

On Implementing S-Net

Clemens Grelck, Frank Penczek

From Contracts Towards Dependent Types: Proofs by Partial Evaluation

Stephan Herhut, Sven-Bodo Scholz, Robert Bernecky, Clemens Grelck, Kai Trojahner

A Rational Simplifier for GHC

Laszlo Nemeth

Amortizing the Cost of Commuting Conversions when Beta-Reducing Monadic Normal Forms and A-Normal Forms

Olivier Danvy
## Index

Abrahamson, David, 416  
Achten, Peter, 230, 252  
Al Zain, Abyd, 139  
Almeida, Jose, 40  

Bernecky, Robert, 534  
Berthold, Jost, 152  
Borgo, Rita, 474  
Brassel, Bernd, 400  
Brown, Christopher, 211  

Chakravarty, Manuel, 233  
Claessen, Koen, 382  

Danvy, Olivier, 552  
de Vries, Edske, 416  
Dieterle, Mischa, 152  
Dijkstra, Atze, 107  
Duke, David, 474  

Feeley, Marc, 503  
Findler, Robert Bruce, 179  
Fischer, Sebastian, 258, 318  
Fokker, Jeroen, 107  

Giavitto, Jean-Louis, 301  
Grelck, Clemens, 531, 534  
Guo, Shu-yu, 179  

Hammond, Kevin, 139  
Herhut, Stephan, 534  
Hidalgo-Herrero, Mercedes, 89  
Horvath, Zoltan, 224  
Huch, Frank, 258, 318  

Jansen, Jan Martin, 252  
Jonsson, Peter, 441  

Kleeblatt, Dirk, 350  
Koltes, Andreas, 519  
Konarski, Mikolaj, 457  
Koopman, Pieter, 230, 252  
Kozsik, Tamás, 224  

Lam, Edmund, 195  
Larsen, Ken Friis, 268  
Li, Huiqing, 55  
Liu, Chunxu, 366  
Lobachev, Oleg, 168  
Loogen, Rita, 152  
Lu, Kenny Zhuo Ming, 123  
Lucas, Salvador, 8  

Mackie, Ian, 40  
Mazamek, Steffen, 24  
Michaelsen, Greg, 366  
Michel, Olivier, 301  
Minas, Mark, 24  
Mitchell, Neil, 334  
Morazan, Marco T., 71  

Naylor, Matthew, 290  
Nemeth, Lazlo, 551  
Nissen, Michael, 268  
Nordlander, Johan, 441  

O’Donnell, John, 519  
Ortega-Mallen, Yolanda, 89  

Parnas, David L., 431  
Pataki, Norbert, 489  
Pena, Ricardo, 8  
Penczek, Frank, 531  
Peyton Jones, Simon, 233, 382  
Pinto, Jorge Sousa, 40  
Plasmeijer, Rinus, 230, 232, 252, 416  
Porkolab, Zoltan, 489  
Priebe, Steffen, 152  

Rogers, Anne, 179  
Runciman, Colin, 290, 334, 474  

Scholz, Sven-Bodo, 534  
Schrijvers, Tom, 233  
Schultz, Ulrik, 71  
Shkaravska, Olha, 254
Siegel, Holger, 400
Sipos, Adam, 489
Strong, Glenn, 229
Sulzmann, Martin, 123, 195, 233
Swierstra, Doaitse, 107

Tejfel, Máté, 224
Thompson, Simon, 55, 211
Trancón y Widemann, Baltasar, 431
Trinder, Phil, 139
Trojahner, Kai, 534

van Eekelen, Marko, 254
Vilaca, Miguel, 40

Wallace, Malcolm, 140, 474
Xu, Dana Na, 382
Zsok, Viktoria, 489
Zuurbier, Erik, 232
On the Validation of Specifications used in Model-Based Testing

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Abstract. In model-based testing the behavior of a system under test, \( s_{ut} \), is compared automatically with the behavior of the specification. A significant fraction of issues found in testing appear to be caused by problems with the specification. In order to ensure that the specification prescribes the desired behavior, it has to be validated by a human. In this work we introduce a tool to support this validation. In addition to an interactive simulator of the specification, the tool is able to generate transition tables and diagrams of the observed behavior. In order to make simulation and the displaying of the observed behavior finite, we introduce equivalence of states, inputs and outputs.

Extended Abstract

In model-based testing the behavior of a system under test, \( s_{ut} \), is compared automatically with the behavior of the specification. The specification is a state transition system that can be nondeterministic. Usually the number of states, inputs and outputs possible is infinite. The \( s_{ut} \) is also assumed to be a state transition system, but its state is hidden. One can only apply input to the system and observe the corresponding output. We have used model-based testing successfully to improve controllers, protocols, javacard applets and more.

For this comparison of behavior, the test system takes a specification and executes a user defined number of traces. For each trace the \( s_{ut} \) and the specification starts in their initial states. The test system selects an input that is covered by the specification, applies this input to the \( s_{ut} \), and computes the allowed states of the specification. If no states are possible for the specification the \( s_{ut} \) has shown behavior that is not covered by the specification. The testers say that an issue is found.

Ideally, each issue indicates an error in the \( s_{ut} \). However, in practice a significant fraction of issues appear to be caused by problems with the specification: the specification does not correctly capture the intentions of the users and the \( s_{ut} \) does something different. Although the fraction of issues caused by the specification differs with the kind of system and the amount of effort put in the correctness of the specification, we estimate that on average in about 25% of the issues found in model-based testing one has to blame the specification.
Incorrect specifications are a problem for several reasons. First, if an issue is found it is not clear whether we have to blame the specification or the sut. Finding and correcting errors in the specification takes time during the test phase of the project. This is not the right moment to create a correct specification. In many projects there is a significant time pressure during the testing phase of a system. Second, only behavior that is implemented differently by the sut can cause issues. All other errors in the specification are not found at all during model-based testing. Third, any change in the specification during the testing phase can cause significant implementation changes to the sut. Finally, any change in the specification invalidates in principle all previous test results (just like any change in the sut). This implies that errors in the specification can be very expensive and it is worthwhile to invest effort to ensure the quality of the specification.

In our model-based test system $G\forall st$ we use the functional language Clean as specification language. Due to the high abstraction level of this language it is possible to write concise specifications which contributes to their quality. The Clean compiler will check quality aspects like type correctness and consistent definition of identifiers used. We have shown that quality aspects such as the reachability of states, determinism and completeness of the specification, and the preservation of constraints can be checked by systematic testing.

However, this does not rule out the possibility that the specification prescribes the wrong behavior in a consistent way. In order to ensure that the specification prescribes the desired behavior, it has to be validated by a human. In this work we introduce tools to support this validation. First, a simulator enables the user to execute the specification. Such an interactive execution can be much more illustrative than looking at the code of the specification. Second, it is possible to record the traces of the specification executed in the simulator. The states visited and their transitions can be visualized in a table or a state transition diagram. Since the number of states, inputs and outputs can be infinite and different in each and every specification, this is not straightforward. The key to the solution is an operator to define equivalence of states, inputs and outputs. For instance, values that are handled by the same symbolic transition in the specification (function alternative in the specifying function) are usually considered to be equivalent. All states that are considered equivalent can be mapped to the same entry of the table or the same place in the transition diagram. Since the equivalence of values is problem dependent, some human input is required to define equivalence.