

# Second International Workshop on Rewriting Techniques for Program Transformations and Evaluation

WPTE'15, July 2, 2015, Warsaw, Poland

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## ■ Preface

This volume contains the papers presented at the *Second International Workshop on Rewriting Techniques for Program Transformations and Evaluation (WPTE 2015)* which was held on July 2, 2015 in Warsaw, Poland, and affiliated with the *eighth edition of the International Conference on Rewriting, Deduction, and Programming (RDP 2015)*.

### Scope of WPTE

Verification and validation of properties of programs, optimizing and compiling programs, and generating programs can benefit from the application of rewriting techniques. Source-level program transformations are used in compilation to simplify and optimize programs, in code refactoring to improve the design of programs; and in software verification and code validation, program transformations are used to translate and/or simplify programs into the forms suitable for specific verification purposes or tests. Those program transformations can be translations from one language into another one, transformations inside a single language, or the change of the evaluation strategy within the same language.

Since rewriting techniques are of great help for studying correctness of program transformations, translations and evaluation, the aim of WPTE is to bring together the researchers working on program transformations, evaluation, and operationally-based programming language semantics, using rewriting methods, in order to share the techniques and recent developments and to exchange ideas to encourage further activation of research in this area. The first WPTE was held in Vienna 2014 during the *Vienna Summer of Logic 2014 (VSL 2014)* as a workshop of the *sixth Federated Logic Conference (FLoC 2014)*.

Topics in the scope of WPTE include the correctness of program transformations, optimizations and translations; program transformations for proving termination, confluence and other properties; correctness of evaluation strategies; operational semantics of programs, operationally-based program equivalences such as contextual equivalences and bisimulations; cost-models for reasoning about the optimizing power of transformations and the costs of evaluation; program transformations for verification and theorem proving purposes; translation, simulation, equivalence of programs with different formalisms, and evaluation strategies; program transformations for applying rewriting techniques to programs in specific programming languages; program transformations for program inversions and program synthesis; program transformation and evaluation for Haskell and Rewriting.

“Program transformation and evaluation for Haskell and Rewriting” is a new topic of this workshop including equational reasoning and other rewriting techniques for program verification and analysis; lambda calculi and type systems for functional programs and higher-order rewrite systems; rewriting of type expressions in the type checker; rewriting of programs by refactoring tools, optimizers, code generators; execution of programs as a form of graph rewriting (terms with sharing); Template Haskell, generally introducing a rewriting-like macro language into the compilation process; rewriting modulo commonly occurring axioms such as associativity, commutativity, and identity element.

### WPTE 2015

For WPTE 2015 four regular research papers were accepted out of the submissions. Additionally the program of WPTE contained the following talks which the program committee recommended for presentation:

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- Guillaume Madelaine, Cédric Lhoussaine, and Joachim Niehren: *Structural simplification of chemical reaction networks preserving deterministic semantics*
- Naosuke Matsuda: *A simple extension of the Curry-Howard correspondence with intuitionistic lambda rho calculus*
- Koichi Sato, Kentaro Kikuchi, Takahito Aoto, and Yoshihito Toyama: *Context-Moving Transformation for Term Rewriting Systems*

Each submission was reviewed by at least three members of the Program Committee, with the help of three external reviewers. Paper submission, reviewing, and the electronic meeting of the program committee used the great EasyChair system of Andrei Voronkov, which was also indispensable for preparing the WPTE program and collecting the papers for these proceedings.

In addition to the contributed papers, the WPTE program contained an invited talk by Brigitte Pientka with title “*Mechanizing Meta-Theory in Beluga*”.

### Acknowledgment

We thank our publisher Schloss Dagstuhl–Leibniz-Zentrum für Informatik for publishing our proceedings in the OpenAccess Series in Informatics (OASICs). In particular we would like to thank Mark Herbstritt and Michael Wagner for their very helpful and always prompt support during production of the OASICs proceedings.

We thank the organizers of RDP 2015 for hosting our workshop, and for the financial support for our proceedings published via OASICs. We are particularly indebted to Aleksy Schubert (chair of RDP 2015) and Jacek Chrząszcz for their help in preparing our workshop.

Finally we thank the members of the program committee for their careful reviewing of all submissions and we thank the participants for their valuable contributions.

July 2015

Yuki Chiba  
Santiago Escobar  
Naoki Nishida  
David Sabel  
Manfred Schmidt-Schauß

## ■ The Collection of all Abstracts of the Talks at WPTE 2015

The aim of this chapter is to document all talks of the “Second International Workshop on Rewriting Techniques for Program Transformations and Evaluation” (WPTE 2015). Hence, this collection contains all abstracts of talks held at WPTE 2015. The abstracts are ordered alphabetically by author names. Further information and e.g. extended abstracts on the talks on work in progress, can also be found in USB flash drives distributed to all participants of RDP 2015.

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### Head reduction and normalization in a call-by-value lambda-calculus

**Author:** Giulio Guerrieri

**Abstract:** Recently, a standardization theorem has been proven for a variant of Plotkin’s call-by-value lambda-calculus extended by means of two commutation rules (sigma-reductions): this result was based on a partitioning between head and internal reductions. We study the head normalization for this call-by-value calculus with sigma-reductions and we relate it to the weak evaluation of original Plotkin’s call-by-value lambda-calculus. We give also a (non-deterministic) normalization strategy for the call-by-value lambda-calculus with sigma-reductions.

### Structural simplification of chemical reaction networks preserving deterministic semantics

**Authors:** Guillaume Madelaine, Cédric Lhoussaine, and Joachim Niehren

**Abstract:** We study the structural simplification of chemical reaction networks preserving the deterministic kinetics. We aim at finding simplification rules that can eliminate intermediate molecules while preserving the dynamics of all others. The rules should be valid even though the network is plugged into a bigger context. An example is Michaelis-Menten’s simplification rule for enzymatic reactions. In this paper, we present structural simplification rules for reaction networks that can eliminate intermediate molecules at equilibrium, without assuming that all molecules are at equilibrium, i.e. in a steady state. Our simplification rules preserve the deterministic semantics of reaction networks, in all contexts compatible with the equilibrium of the eliminated molecules. We illustrate the simplification on a biological example network from systems biology.

### A simple extension of the Curry-Howard correspondence with intuitionistic lambda rho calculus

**Author:** Naosuke Matsuda

**Abstract:** In (Fujita et.al., to appear), a natural deduction style proof system called “intuitionistic  $\lambda\rho$ -calculus” for implicational intuitionistic logic and some reduction rules for the proof system were given. In this paper, we show that the system is easy to treat but has sufficient expressive power to provide a powerful model of computation.

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## Towards Modelling Actor-Based Concurrency in Term Rewriting

**Authors:** Adrián Palacios and Germán Vidal

**Abstract:** In this work, we introduce a scheme for modelling actor systems within sequential term rewriting. In our proposal, a TRS consists of the union of three components: the functional part (which is specific of a system), a set of rules for reducing concurrent actions, and a set of rules for defining a particular scheduling policy. A key ingredient of our approach is that concurrent systems are modelled by terms in which concurrent actions can never occur inside user-defined function calls. This assumption greatly simplifies the definition of the semantics for concurrent actions, since no term traversal will be needed. We prove that these systems are well defined in the sense that concurrent actions can always be reduced.

Our approach can be used as a basis for modelling actor-based concurrent programs, which can then be analyzed using existing techniques for term rewrite systems.

## Mechanizing Meta-Theory in Beluga

**Author:** Brigitte Pientka

**Abstract:** Mechanizing formal systems, given via axioms and inference rules, together with proofs about them plays an important role in establishing trust in formal developments. In this talk, I will survey the proof environment Beluga. To specify formal systems and represent derivations within them, Beluga provides a sophisticated infrastructure based on the logical framework LF; in particular, its infrastructure not only supports modelling binders via binders in LF, but extends and generalizes LF with first-class contexts to abstract over a set of assumptions, contextual objects to model derivations that depend on assumptions, and first-class simultaneous substitutions to relate contexts. These extensions allow us to directly support key and common concepts that frequently arise when describing formal systems and derivations within them.

To reason about formal systems, Beluga provides a dependently typed functional language for implementing inductive proofs about derivations as recursive functions on contextual objects following the Curry-Howard isomorphism. Recently, the Beluga system has also been extended with a totality checker which guarantees that recursive programs are well-founded and correspond to inductive proofs and an interactive program development environment to support incremental proof / program construction. Taken together these extensions enable direct and compact mechanizations. To demonstrate Beluga's strength, we develop a weak normalization proof using logical relations. The Beluga system together with examples is available from <http://complogic.cs.mcgill.ca/beluga/>.

## Observing Success in the Pi-Calculus

**Authors:** David Sabel and Manfred Schmidt-Schauß

**Abstract:** A contextual semantics – defined in terms of successful termination and may- and should-convergence – is analyzed in the synchronous pi-calculus with replication and a constant Stop to denote success. The contextual ordering is analyzed, some nontrivial process equivalences are proved, and proof tools for showing contextual equivalences are provided. Among them are a context lemma and new notions of sound applicative similarities for may- and should-convergence. A further result is that contextual equivalence in the pi-calculus with Stop conservatively extends barbed testing equivalence in the (Stop-free) pi-calculus and thus results on contextual equivalence can be transferred to the (Stop-free) pi-calculus with barbed testing equivalence.

## Context-Moving Transformation for Term Rewriting Systems

**Authors:** Koichi Sato, Kentaro Kikuchi, Takahito Aoto, and Yoshihito Toyama

**Abstract:** Proofs by induction are often incompatible with tail-recursive definitions as the accumulator changes in the course of unfolding the definitions. Context-moving (Giesl, 2000) for functional programs transforms tail-recursive programs into non tail-recursive ones which are more suitable for verification. In this work, we formulate a context-moving transformation for term rewriting systems, and prove the correctness with respect to both eager evaluation semantics and initial algebra semantics under some conditions on the programs to be transformed.

## Formalizing Bialgebraic Semantics in PVS 6.0

**Authors:** Sjaak Smetsers, Ken Madlener, and Marko van Eekelen

**Abstract:** Both operational and denotational semantics are prominent approaches for reasoning about properties of programs and programming languages. In the categorical framework developed by Turi and Plotkin both styles of semantics are unified using a single, syntax independent format, known as GSOS, in which the operational rules of a language are specified. From this format, the operational and denotational semantics are derived. The approach of Turi and Plotkin is based on the categorical notion of bialgebras. In this paper we specify this work in the theorem prover *PVS*, and prove the adequacy theorem of this formalization. One of our goals is to investigate whether *PVS* is adequately suited for formalizing metatheory. Indeed, our experiments show that the original categorical framework can be formalized conveniently. Additionally, we present a GSOS specification for the simple imperative programming language *While*, and execute the derived semantics for a small example program.



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