TERMGRAPH 2002
Workshop Survey

Detlef Plump

Department of Computer Science
The University of York
York YO10 5DD, United Kingdom
det@cs.york.ac.uk

1 Background and Aims

The International Workshop on Term Graph Rewriting (TERMGRAPH 2002) will take place 7 October 2002 as a one-day satellite event of the International Conference on Graph Transformation (ICGT 2002). Term graph rewriting is concerned with the representation of functional expressions as graphs and the evaluation of these expressions by rule-based graph transformation. Using graphs rather than strings or trees allows to share common subexpressions, which improves the efficiency of computations in space and time. Sharing is ubiquitous in implementations of functional and logic programming languages, systems for automated reasoning, and symbolic computation systems.

Research in term graph rewriting ranges from theoretical questions to practical implementation issues. It includes such different lines as the modelling of (finite or infinitary) first-order term rewriting by (acyclic or cyclic) graph rewriting, rewrite rules on so-called sharing graphs for Levy-optimal reduction in the Lambda Calculus, rewrite calculi on cyclic higher-order term graphs for the semantics and analysis of functional programs, graph reduction implementations of functional programming languages, and automated reasoning and symbolic computation systems working on shared structures.

The aim of TERMGRAPH 2002 is to bring together researchers working in these different domains and to foster their interaction, to provide a forum for presenting new ideas and work in progress, and to enable newcomers to learn about current activities in term graph rewriting. The papers submitted to the workshop were refereed by the following program committee:

Zena M. Ariola	University of Oregon, Eugene (USA)
Richard Banach	University of Manchester (United Kingdom)
Rachid Echahed	IMAG, Grenoble (France)
Richard Kennaway	University of East Anglia, Norwich (United Kingdom)
Jan Willem Klop	Vrije Universiteit Amsterdam (The Netherlands)
Rinus Plasmeijer	Katholieke Universiteit Nijmegen (The Netherlands)
Detlef Plump	University of York (United Kingdom), chair

In addition, Adam Bakewell and Olaf Chitil (University of York) refereed papers.

2 Contributions

The contributions summarized below will appear in Volume 72 (Issue 1) of Elsevier's *Electronic Notes in Theoretical Computer Science.*

Conditional Term Graph Rewriting with Indirect Sharing

Enno Ohlebusch

This paper discusses the implementation of various forms of conditional term rewriting systems by term graph rewriting. Technically, term graphs are defined as terms with labels where subterms with equal labels are considered as shared. The main result is that for two classes of orthogonal, conditional term rewriting systems, term graph rewriting is *adequate* in the sense of Kennaway, Klop, Sleep and de Vries. This implies both, soundness in the form that every term graph rewrite sequence corresponds to a term rewrite sequence, and completeness in the form that a term graph can be reduced to an irreducible graph if its represented term can be reduced to an irreducible term.

Inequational Deduction as Term Graph Rewriting

Andrea Corradini, Fabio Gadducci, Wolfram Kahl and Barbara König

The authors consider multi-algebras which model nondeterminism in that operators are functions delivering sets of possible results rather than single results. Multi-rooted, acyclic term graphs are used to represent derived relations in multi-algebras. *Term graph specifications* are sets of inequations of term graphs which are interpreted as relation inclusion in multi-algebras. A deduction system for inequations is defined and shown to be sound. Then a translation from term graph specifications into sets of term graph rewrite rules is presented which is sound and complete for deduction: a graph F rewrites to a graph G if and only if the inequation $F \sqsubseteq G$ can be deduced.

A Duality in Proof Systems for Recursive Type Equality and for Bisimulation Equivalence on Cyclic Term Graphs

Clemens Grabmayer

This paper is concerned with dualities between proof systems for regular cyclic objects. First two proof systems for the equality of recursive types are compared, then the same is done for two proof systems for bisimulation equivalence of cyclic term graphs. In both cases, a duality is established between a coinductive system in the style of Brandt and Henglein, and a "syntactic matching" system in the style of Ariola and Klop. The dualities are given in form of mappings that translate proofs of the compared systems into each other.

Using Term Graph Rewriting Models to Analyse Relative Space Efficiency

Adam Bakewell

Summarizing the author's PhD thesis, an approach is presented to compare the space efficiency of different implementations of functional programming languages. Implementations are modelled as higher-order term term graph rewriting systems (with garbage collectors) and proof methods are described showing that for implementations A and B, every program's evaluation by A is as least as space-efficient as its evaluation by B. Moreover, a method is given for searching for a witness program that with B needs more space than with A, proving that B is "space-leakier" than A. These methods take into account translations, allowing A and B to be specified in different languages.

Lifting Infinite Normal Form Definitions from Term Rewriting to Term Graph Rewriting

Stefan Blom

To give non-terminating higher-order rewrite systems a semantics, the author considers infinite normal forms of terms and term graphs which generalize the Böhm trees of the Lambda Calculus. He defines infinite normal forms of higher-order term graphs by using the infinite normal forms of the underlying (possibly infinite) terms. Term graphs are represented as terms with the `letrec`-construct. A result is established ensuring the uniqueness of infinite normal forms by an infinitary soundness property rather than by confluence as in previous work. Moreover, a class of higher-order term graph rewrite systems is identified for which infinite normal form definitions can be lifted from terms to term graphs.

Packages Duplication in the Interaction Nets and Weak Head Reduction in the Lambda-calculus

Sylvain Lippi

The author presents a new implementation of the Lambda Calculus by Interaction Nets, aiming at reductions that are optimal in the sense of Lévy. This approach focuses on the duplication of a certain type of nets, so-called *packages*. The novelty—compared, for example, with the work of Abadi, Gonthier and Lévy—lies in the simplicity of the proposed system which does not need certain "house-keeping" constructs like *croissants* and *brackets*. Instead, the implementation gets along with four symbols. The price for this simplicity is that only weak head reductions are considered rather than full reductions.

A Higher-order Calculus for Graph Transformation

Maribel Fernández, Ian Mackie and Jorge Sousa Pinto

This paper proposes a formalism for defining higher-order term rewriting systems which model various forms of graph rewriting systems. The formalism is inspired by Klop's Combinatory Reduction Systems and uses a notation for graphs

that generalizes the equational presentation of graphs used by Ariola, Klop and Blom. The calculus is flexible enough to define first-order graph and term graph rewriting, interaction nets, interaction systems, and a process calculus, but also hierarchical graph rewriting, proof nets of linear logic and operational semantics of graph-based languages. The richness of the calculus gives rise to many potential applications. For example, the structuring of large graphs by abstracting subgraphs can be defined and studied in this framework.

3 Workshop Program

Monday, October 7, 2002

10.00 – 10.15: Opening

10.15 – 11.00: Conditional Term Graph Rewriting with Indirect Sharing
Enno Ohlebusch

11.00 – 11.45: Inequational Deduction as Term Graph Rewriting
Andrea Corradini, Fabio Gadducci, Wolfram Kahl and Barbara König

11.45 – 12.30: A Duality in Proof Systems for Recursive Type Equality and for Bisimulation Equivalence on Cyclic Term Graphs
Clemens Grabmayer

12.30 – 14.30: Lunch Break

14.30 – 15.15: Using Term Graph Rewriting Models to Analyse Relative Space Efficiency
Adam Bakewell

15.15 – 16.00: Lifting Infinite Normal Form Definitions from Term Rewriting to Term Graph Rewriting
Stefan Blom

16.00 – 16.30: Coffee Break

16.30 – 17.15: Packages Duplication in the Interaction Nets and Weak Head Reduction in the Lambda-calculus
Sylvain Lippi

17.15 – 18.00: A Higher-order Calculus for Graph Transformation
Maribel Fernández, Ian Mackie and Jorge Sousa Pinto

4 Authors' Affiliations

Adam Bakewell	University of York (United Kingdom)
Stefan Blom	CWI, Amsterdam (The Netherlands)
Andrea Corradini	Universitá de Pisa (Italy)
Maribel Fernández	École Normale Supérieure, Paris (France)
Fabio Gadducci	Universitá de Pisa (Italy)
Clemens Grabmayer	Vrije Universiteit Amsterdam (The Netherlands)
Wolfram Kahl	McMaster University, Hamilton (Canada)
Barbara König	Technische Universität München (Germany)
Sylvain Lippi	Institut de Mathématiques de Luminy, Marseille (France)
Ian Mackie	École Polytechnique, Palaiseau Cedex (France)
Enno Ohlebusch	Universität Bielefeld (Germany)
Jorge Sousa Pinto	Universidade do Minho, Braga (Portugal)