

*Commenced Publication in 1973*

Founding and Former Series Editors:

Gerhard Goos, Juris Hartmanis, and Jan van Leeuwen

Editorial Board

David Hutchison

*Lancaster University, UK*

Takeo Kanade

*Carnegie Mellon University, Pittsburgh, PA, USA*

Josef Kittler

*University of Surrey, Guildford, UK*

Jon M. Kleinberg

*Cornell University, Ithaca, NY, USA*

Friedemann Mattern

*ETH Zurich, Switzerland*

John C. Mitchell

*Stanford University, CA, USA*

Moni Naor

*Weizmann Institute of Science, Rehovot, Israel*

Oscar Nierstrasz

*University of Bern, Switzerland*

C. Pandu Rangan

*Indian Institute of Technology, Madras, India*

Bernhard Steffen

*University of Dortmund, Germany*

Madhu Sudan

*Massachusetts Institute of Technology, MA, USA*

Demetri Terzopoulos

*University of California, Los Angeles, CA, USA*

Doug Tygar

*University of California, Berkeley, CA, USA*

Moshe Y. Vardi

*Rice University, Houston, TX, USA*

Gerhard Weikum

*Max-Planck Institute of Computer Science, Saarbruecken, Germany*

Andrea Corradini Hartmut Ehrig  
Ugo Montanari Leila Ribeiro  
Grzegorz Rozenberg (Eds.)

# Graph Transformations

Third International Conference, ICGT 2006  
Natal, Rio Grande do Norte, Brazil  
September 17-23, 2006  
Proceedings

## Volume Editors

Andrea Corradini  
Ugo Montanari

University of Pisa  
Department of Computer Science  
56127 Pisa, Italy  
E-mail: {andrea,ugo}@di.unipi.it

Hartmut Ehrig  
Technical University of Berlin  
Department for Software Technology and Theoretical Informatics  
10587 Berlin, Germany  
E-mail: ehrig@cs.tu-berlin.de

Leila Ribeiro  
Universidade Federal do Rio Grande do Sul  
Instituto de Informática  
91501-970 Porto Alegre, Brazil  
E-mail: leila@inf.ufrgs.br

Grzegorz Rozenberg  
Leiden University  
Leiden Institute of Advanced Computer Science (LIACS)  
2333 CA Leiden, The Netherlands  
E-mail: rozenber@liacs.nl

Library of Congress Control Number: 2006931633

CR Subject Classification (1998): E.1, G.2.2, D.2.4, F.1, F.2.2, F.3, F.4.2-3

LNCS Sublibrary: SL 1 – Theoretical Computer Science and General Issues

ISSN           0302-9743  
ISBN-10       3-540-38870-2 Springer Berlin Heidelberg New York  
ISBN-13       978-3-540-38870-8 Springer Berlin Heidelberg New York

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, re-use of illustrations, recitation, broadcasting, reproduction on microfilms or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

Springer is a part of Springer Science+Business Media  
springer.com

© Springer-Verlag Berlin Heidelberg 2006  
Printed in Germany

Typesetting: Camera-ready by author, data conversion by Scientific Publishing Services, Chennai, India  
Printed on acid-free paper   SPIN: 11841883   06/3142   5 4 3 2 1 0

# Preface

ICGT 2006 was the 3rd International Conference on Graph Transformation, following the previous two in Barcelona (2002) and Rome (2004), and a series of six international workshops between 1978 and 1998. ICGT 2006 was held in Natal (Rio Grande do Norte, Brazil) on September 17-23, 2006, co-located with the Brazilian Symposium on Formal Methods (SBMF 2006), under the auspices of the Brazilian Computer Society (SBC), the European Association of Software Science and Technology (EASST), the European Association for Theoretical Computer Science (EATCS) and the IFIP WG 1.3 on Foundations of Systems Specification. The conference obtained partial support from Formal Methods Europe and IFIP TC 1 on Foundations of Computer Science.

The scope of the conference concerned graphical structures of various kinds (like graphs, diagrams and visual sentences) that are useful when describing complex structures and systems in a direct and intuitive way. These structures are often enriched with formalisms that model their evolution via suitable kinds of transformations. The field of the conference was concerned with the theory, applications, and implementation issues of such formalisms. Particular emphasis was put on metamodels which can accommodate a variety of graphical structures within the same abstract theory.

The theory is strongly related to areas such as graph theory and graph algorithms, formal language and parsing theory, the theory of concurrent and distributed systems, formal specification and verification, logics, and semantics. The application areas include all those fields of computer science, information processing, engineering, biology and the natural sciences where static and dynamic modelling using graphical structures and graph transformations, respectively, play important roles. In many of these areas tools based on graph transformation technology have been implemented and used.

The proceedings of ICGT 2006 consist of two parts. The first part contains the contributions of the invited speakers followed by 28 accepted papers that were selected out of 62 carefully reviewed submissions. The topics of the papers range over a wide spectrum, including graph theory and graph algorithms, theoretic and semantic aspects, modelling, contributions to software engineering and global computing, applications to biology, and tool issues. The second part contains a short description of a tutorial on foundations and applications of graph transformations, and short presentations of the satellite events of ICGT 2006.

We would like to thank the members of the program committee and the secondary reviewers for their enormous help in the selection process. Moreover, we would like to express our gratitude to the local organizers who did a great job, in particular to the Organizing Committee chair Anamaria Martins Moreira.

July 2006      Andrea Corradini, Hartmut Ehrig, Ugo Montanari (PC co-chair)  
Leila Ribeiro (PC co-chair), Grzegorz Rozenberg

# Organization

## Program Committee

Paolo Baldan	Venice (Italy)
Paolo Bottoni	Rome (Italy)
Bruno Courcelle	Bordeaux (France)
Andrea Corradini	Pisa (Italy)
Hartmut Ehrig	Berlin (Germany)
Gregor Engels	Paderborn (Germany)
Reiko Heckel	Leicester (UK)
Dirk Janssens	Antwerp (Belgium)
Gabor Karsai	Nashville (Tennessee, USA)
Hans-Jörg Kreowski	Bremen (Germany)
Barbara König	Duisburg-Essen (Germany)
Mercè Llabrés	Mallorca (Spain)
Anamaria Martins Moreira	Natal (Brazil)
Ugo Montanari (co-chair)	Pisa (Italy)
Manfred Nagl	Aachen (Germany)
Fernando Orejas	Barcelona (Spain)
Francesco Parisi-Presicce	Rome (Italy) and Fairfax (Virginia, USA)
Mauro Pezzè	Milan (Italy)
John Pfaltz	Charlottesville (Virginia, USA)
Rinus Plasmeijer	Nijmegen (The Netherlands)
Detlef Plump	York (UK)
Leila Ribeiro (co-chair)	Porto Alegre (RS, Brazil)
Grzegorz Rozenberg	Leiden (The Netherlands)
Andy Schürr	Darmstadt (Germany)
Gabriele Taentzer	Berlin (Germany)
Dániel Varró	Budapest (Hungary)
Daniel Yankelevich	Buenos Aires (Argentina)

## Secondary Referees

András Balogh	Søren Christensen	Claudia Ermel
Benjamin Braatz	Giovanni Cignoni	Maribel Fernandez
Victor Braberman	Juan de Lara	Esteban Feuerstein
Chiara Braghin	Anne Dicky	Irene Finocchi
Clara Bertolissi	Dino Distefano	Fabio Gadducci
Laura Bocchi	Mike Dodds	Giorgio Ghelli
Roberto Bruni	Juan Echague	Luís Gomes
Alexey Cherkhago	Karsten Ehrig	Annegret Habel

Tobias Heindel	Marc Lohmann	Guilherme Rangel
Frank Hermann	Ivan Lanese	Christophe Ringeissen
Dan Hirsch	Greg Manning	Francesc Rosselló
Kathrin Hoffmann	Leonardo Mariani	Domenico Saccà
Nicolas Kicillof	Tony Modica	Hans Schippers
Markus Klein	Olaf Muliawan	Gabriel Valiente
Manuel Koch	Nikos Mylonakis	Niels Van Eetvelde
Radu Kopetz	Julia Padberg	Pieter Van Gorp
Maciej Koutny	Jean-Guy Penaud	Gergely Varró
Georgios Lajios	Ulrike Prange	Jessica Winkelmann
Leen Lambers	Paola Quaglia	

## Sponsoring Institutions

Brazilian Computer Society (SBC)

European Association for Theoretical Computer Science (EATCS)

European Association of Software Science and Technology (EASST)

Formal Methods Europe (FME)

International Federation for Information Processing (IFIP) WG 1.3

# Table of Contents

## Invited Papers

Nested Quantification in Graph Transformation Rules . . . . .	1
<i>Arend Rensink</i>	
Idioms of Logical Modelling . . . . .	14
<i>Daniel Jackson</i>	
New Algorithms and Applications of Cyclic Reference Counting . . . . .	15
<i>Rafael Dueire Lins</i>	

## New Graph Transformation Models

Sesqui-Pushout Rewriting . . . . .	30
<i>Andrea Corradini, Tobias Heindel, Frank Hermann, Barbara König</i>	
Automata on Directed Graphs: Edge Versus Vertex Marking . . . . .	46
<i>Dietmar Berwanger, David Janin</i>	
Conflict Detection for Graph Transformation with Negative Application Conditions . . . . .	61
<i>Leen Lambers, Hartmut Ehrig, Fernando Orejas</i>	
Adaptive Star Grammars . . . . .	77
<i>Frank Drewes, Berthold Hoffmann, Dirk Janssens, Mark Minas, Niels Van Eetvelde</i>	

## Structure Manipulation

Narrowing Data-Structures with Pointers . . . . .	92
<i>Rachid Echahed, Nicolas Peltier</i>	
Molecular Analysis of Metabolic Pathway with Graph Transformation . . . . .	107
<i>Karsten Ehrig, Reiko Heckel, Georgios Lajios</i>	
Matrix Approach to Graph Transformation: Matching and Sequences . . . .	122
<i>Pedro Pablo Pérez Velasco, Juan de Lara</i>	

String Generating Hypergraph Grammars with Word Order  
Restrictions ..... 138  
*Martin Riedl, Sebastian Seifert, Ingrid Fischer*

**Borrowed Contexts and Adhesive Categories**

Composition and Decomposition of DPO Transformations  
with Borrowed Context ..... 153  
*Paolo Baldan, Hartmut Ehrig, Barbara König*

Process Bisimulation *Via* a Graphical Encoding ..... 168  
*Filippo Bonchi, Fabio Gadducci, Barbara König*

Toposes Are Adhesive ..... 184  
*Stephen Lack, Paweł Sobociński*

**Extensions for Distributed and Global Computing**

Graph Transactions as Processes ..... 199  
*Paolo Baldan, Andrea Corradini, Luciana Foss, Fabio Gadducci*

Categorical Foundations of Distributed Graph Transformation ..... 215  
*Hartmut Ehrig, Fernando Orejas, Ulrike Prange*

Dynamic Graph Transformation Systems ..... 230  
*Roberto Bruni, Hernán Melgratti*

Autonomous Units and Their Semantics — The Sequential Case ..... 245  
*Karsten Hölscher, Hans-Jörg Kreowski, Sabine Kuske*

**Software Engineering Methods and Tools**

Termination Analysis of Model Transformations by Petri Nets ..... 260  
*Dániel Varró, Szilvia Varró-Gyapay, Hartmut Ehrig, Ulrike Prange,  
Gabriele Taentzer*

Non-functional Analysis of Distributed Systems in Unreliable  
Environments Using Stochastic Object Based Graph Grammars ..... 275  
*Odorico Machado Mendizabal, Fernando Luis Dotti*

Temporal Graph Queries to Support Software Evolution ..... 291  
*Tobias Röttschke, Andy Schürr*

On the Use of Alloy to Analyze Graph Transformation Systems ..... 306  
*Luciano Baresi, Paola Spoletini*



## Model-Driven Development

Non-materialized Model View Specification with Triple Graph Grammars .....	321
<i>Johannes Jakob, Alexander Königs, Andy Schürr</i>	
Model-Driven Monitoring: An Application of Graph Transformation for Design by Contract .....	336
<i>Gregor Engels, Marc Lohmann, Stefan Sauer, Reiko Heckel</i>	
Model View Management with Triple Graph Transformation Systems .....	351
<i>Esther Guerra, Juan de Lara</i>	

## Efficient Implementation

Graph Transformation in Constant Time .....	367
<i>Mike Dodds, Detlef Plump</i>	
GrGen: A Fast SPO-Based Graph Rewriting Tool .....	383
<i>Rubino Geiß, Gernot Veit Bätz, Daniel Grund, Sebastian Hack, Adam Szalkowski</i>	
Realizing Graph Transformations by Pre- and Postconditions and Command Sequences .....	398
<i>Fabian Büttner, Martin Gogolla</i>	
Heuristic Search for the Analysis of Graph Transition Systems .....	414
<i>Stefan Edelkamp, Shahid Jabbar, Alberto Lluch Lafuente</i>	

## Logics

Satisfiability of High-Level Conditions .....	430
<i>Annegret Habel, Karl-Heinz Pennemann</i>	
Weakest Preconditions for High-Level Programs .....	445
<i>Annegret Habel, Karl-Heinz Pennemann, Arend Rensink</i>	

## Tutorial and Workshops

Introductory Tutorial on Foundations and Applications of Graph Transformation .....	461
<i>Reiko Heckel</i>	

Workshop on Graph Computation Models . . . . .	463
<i>Yves Métivier, Mohamed Mosbah</i>	
Workshop on Graph-Based Tools . . . . .	465
<i>Albert Zündorf, Dániel Varró</i>	
Workshop on Petri Nets and Graph Transformations . . . . .	467
<i>Paolo Baldan, Hartmut Ehrig, Julia Padberg, Grzegorz Rozenberg</i>	
3rd International Workshop on Software Evolution Through Transformations: Embracing Change . . . . .	470
<i>Jean-Marie Favré, Reiko Heckel, Tom Mens</i>	
<b>Author Index . . . . .</b>	<b>473</b>