

Volume 1  
FOUNDATIONS

# HANDBOOK of GRAPH GRAMMARS and COMPUTING by GRAPH TRANSFORMATION



Edited by  
**Grzegorz Rozenberg**

World Scientific

# Handbook Of Graph Grammars And Computing By Graph Transformation Vol 1

**Thomas Griffiths**



## **Handbook Of Graph Grammars And Computing By Graph Transformation Vol 1:**

### **Handbook Of Graph Grammars And Computing By Graph Transformation, Vol 1: Foundations** Grzegorz

Rozenberg,1997-02-27 Graph grammars originated in the late 60s motivated by considerations about pattern recognition and compiler construction Since then the list of areas which have interacted with the development of graph grammars has grown quite impressively Besides the aforementioned areas it includes software specification and development VLSI layout schemes database design modeling of concurrent systems massively parallel computer architectures logic programming computer animation developmental biology music composition visual languages and many others The area of graph grammars and graph transformations generalizes formal language theory based on strings and the theory of term rewriting based on trees As a matter of fact within the area of graph grammars graph transformation is considered a fundamental programming paradigm where computation includes specification programming and implementation Over the last 25 odd years graph grammars have developed at a steady pace into a theoretically attractive and well motivated research field In particular they are now based on very solid foundations which are presented in this volume Volume 1 of the indispensable Handbook of Graph Grammars and Computing by Graph Transformations includes a state of the art presentation of the foundations of all the basic approaches to rule based graph specification and transformation algebraic approach logic approach node based rewriting hyper edge based rewriting programmed graph rewriting and 2 structures The book has been written in a tutorial survey style to enhance its usefulness

### **Handbook of Graph Grammars and Computing by Graph Transformation**

Hartmut Ehrig,Grzegorz Rozenberg,Hans-Jörg Kreowski,1997 Graph grammars originated in the late 60s motivated by considerations about pattern recognition and compiler construction Since then the list of areas which have interacted with the development of graph grammars has grown quite impressively Besides the aforementioned areas it includes software specification and development VLSI layout schemes database design modeling of concurrent systems massively parallel computer architectures logic programming computer animation developmental biology music composition visual languages and many others The area of graph grammars and graph transformations generalizes formal language theory based on strings and the theory of term rewriting based on trees As a matter of fact within the area of graph grammars graph transformation is considered a fundamental computation paradigm where computation includes specification programming and implementation Over the last three decades graph grammars have developed at a steady pace into a theoretically attractive and important for applications research field Volume 3 of the indispensable Handbook of Graph Grammars and Computing by Graph Transformations presents the research on concurrency parallelism and distribution important paradigms of modern science The topics considered include semantics for concurrent systems modeling of concurrency mobile and coordinated systems algebraic specifications Petri nets visual design of distributed systems and distributed algorithms The contributions have been written in a tutorial survey style by the top experts

*Handbook Of Graph*

*Grammars And Computing By Graph Transformations, Vol 3: Concurrency, Parallelism, And Distribution* Grzegorz Rozenberg, Hartmut Ehrig, Hans-jorg Kreowski, Ugo Montanari, 1999-08-30 Graph grammars originated in the late 60s motivated by considerations about pattern recognition and compiler construction Since then the list of areas which have interacted with the development of graph grammars has grown quite impressively Besides the aforementioned areas it includes software specification and development VLSI layout schemes database design modeling of concurrent systems massively parallel computer architectures logic programming computer animation developmental biology music composition visual languages and many others The area of graph grammars and graph transformations generalizes formal language theory based on strings and the theory of term rewriting based on trees As a matter of fact within the area of graph grammars graph transformation is considered as a fundamental computation paradigm where computation includes specification programming and implementation Over the last three decades graph grammars have developed at a steady pace into a theoretically attractive and important for applications research field Volume 3 of the indispensable Handbook of Graph Grammars and Computing by Graph Transformations presents the research on concurrency parallelism and distribution important paradigms of modern computer science The topics considered include semantics for concurrent systems modeling of concurrency mobile and coordinated systems algebraic specifications Petri nets visual design of distributed systems and distributed algorithms The contributions have been written in a tutorial survey style by the top experts *Handbook Of Graph Grammars And Computing By Graph Transformations, Vol 2: Applications, Languages And Tools* Grzegorz Rozenberg, 1999-10-20 Graph grammars originated in the late 60s motivated by considerations about pattern recognition and compiler construction Since then the list of areas which have interacted with the development of graph grammars has grown quite impressively Besides the aforementioned areas it includes software specification and development VLSI layout schemes database design modeling of concurrent systems massively parallel computer architectures logic programming computer animation developmental biology music composition visual languages and many others The area of graph grammars and graph transformations generalizes formal language theory based on strings and the theory of term rewriting based on trees As a matter of fact within the area of graph grammars graph transformation is considered as a fundamental computation paradigm where computation includes specification programming and implementation Over the last three decades graph grammars have developed at a steady pace into a theoretically attractive and important for applications research field Volume 2 of the indispensable Handbook of Graph Grammars and Computing by Graph Transformations considers applications to functional languages visual and object oriented languages software engineering mechanical engineering chemical process engineering and images It also presents implemented specification languages and tools and structuring and modularization concepts for specification languages The contributions have been written in a tutorial survey style by the top experts in the corresponding areas This volume is accompanied by a CD Rom containing implementations of specification

environments based on graph transformation systems and tools whose implementation is based on the use of graph transformation systems Handbook of Graph Grammars and Computing by Graph Transformation Grzegorz Rozenberg,1997-01-01 Graph grammars originated in the late 60s motivated by considerations about pattern recognition and compiler construction Since then the list of areas which have interacted with the development of graph grammars has grown quite impressively Besides the aforementioned areas it includes software specification and development VLSI layout schemes database design modeling of concurrent systems massively parallel computer architectures logic programming computer animation developmental biology music composition visual languages and many others The area of graph grammars and graph transformations generalizes formal language theory based on strings and the theory of term rewriting based on trees As a matter of fact within the area of graph grammars graph transformation is considered a fundamental programming paradigm where computation includes specification programming and implementation **Foundation of Software**

**Science and Computation Structures** Jerzy Tiuryn,2000-03-15

ETAPS2000wasthethirdinstanceoftheEuropeanJointConferencesonTheory and Practice of Software ETAPS is an annual federated conference that was established in 1998 by combining a number of existing and new conferences This year it comprised the conferences FOSSACS FASE ESOP CC TACAS and satellite workshops CBS CMCS CoFI GRATRA INT seven invited lectures a panel discussion and ten tutorials The events that comprise ETAPS address various aspects of the system development process including specification design implementation analysis and improvement The languages methodologies and tools which support these activities are all well within its scope Different blends of theory and practice are represented with an inclination towards theory with a practical motivation on one hand and soundly based practice on the other Many of the issues involved in software design apply to systems in general including hardware systems and the emphasis on software is not intended to be exclusive ETAPS is a loose confederation in which each event retains its own identity with a separate program committee and independent proceedings Its format is open ended allowing it to grow and evolve as time goes by Contributed talks and system demonstrations are in synchronized parallel sessions with invited lectures in plenary sessions Two of the invited lectures are reserved for unifying talks on topics of interest to the whole range of ETAPS attendees

*Graph Transformation* Andrea Corradini,Hartmut Ehrig,Hans-Jörg Kreowski,Grzegorz Rozenberg,2003-06-30 ICGT 2002 was the first International Conference on Graph Transformation following a series of six international workshops on graph grammars with applications in computer science held in Bad Honnef 1978 Osnabrück 1982 Warrenton 1986 Bremen 1990 Williamsburg 1994 and Paderborn 1998 ICGT 2002 was held in Barcelona Spain October 7-12 2002 under the auspices of the European Association of Theoretical Computer Science EATCS the European Association of Software Science and Technology EASST and the IFIP Working Group 1.3 Foundations of Systems Specification The scope of the conference concerned graphical structures of various kinds like graphs diagrams visual sentences and others that are useful to describe complex

structures and systems in a direct and intuitive way These structures are often augmented by formalisms which add to the static description a further dimension allowing for the modeling of the evolution of systems via all kinds of transformations of such graphical structures The field of Graph Transformation is concerned with the theory applications and implementation issues of such formalisms 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 logic and semantics

**Processes, Terms and Cycles: Steps on the Road to Infinity** Aart Middeldorp, 2005-12-13 This Festschrift is dedicated to Jan Willem Klop on the occasion of his 60th birthday The volume comprises a total of 23 scientific papers by close friends and colleagues written specifically for this book The papers are different in nature some report on new research others have the character of a survey and again others are mainly expository Every contribution has been thoroughly refereed at least twice In many cases the first round of referee reports led to significant revision of the original paper which was again reviewed The articles especially focus upon the lambda calculus term rewriting and process algebra the fields to which Jan Willem Klop has made fundamental contributions

**Uncertain Automata and Uncertain Graph Grammar** Takaaki Fujita, Florentin Smarandache, 2025-01-01 Graph theory has been widely studied resulting in numerous applications across various fields Among its many topics Automata and Graph Grammar have emerged as significant areas of research This paper delves into these concepts emphasizing their adaptation to uncertain frameworks like Fuzzy Neutrosophic Vague Turiyam Neutrosophic and Plithogenic systems By integrating uncertainty into traditional graph theoretical models the paper aims to address ongoing research challenges and expand the scope of these models

Graph-Based Representations in Pattern Recognition Luc Brun, Mario Vento, 2005-03-10 Many vision problems have to deal with different entities regions lines line junctions etc and their relationships These entities together with their relationships may be encoded using graphs or hypergraphs The structural information encoded by graphs allows computer vision algorithms to address both the features of the different entities and the structural or topological relationships between them Moreover turning a computer vision problem into a graph problem allows one to access the full arsenal of graph algorithms developed in computer science The Technical Committee TC15 <http://www.iapr.org/tcs.html> of the IAPR International Association for Pattern Recognition has been funded in order to federate and to encourage research work in these fields Among its activities TC15 encourages the organization of special graph sessions at many computer vision conferences and organizes the biennial workshop GbR While being designed within a specific framework the graph algorithms developed for computer vision and pattern recognition tasks often share constraints and goals with those developed in other research fields such as data mining robotics and discrete geometry The TC15 community is thus not closed in its research fields but on the contrary is open to interchanges with other groups communities

**Graph Transformations** Hartmut Ehrig, Arend Rensink, Grzegorz Rozenberg, Andy Schürr, 2010-09-27 This book constitutes the proceedings of the 5th International Conference on Graph Transformations ICGT 2010 held in Twente

The Netherlands in September October 2010 The 22 papers presented were carefully reviewed and selected from 48 submissions These papers mirror the wide ranged ongoing research activities in the theory and application of graph transformation They are concerned with different kinds of graph transformation approaches their algebraic foundations composition and analysis the relation to logic as well as various applications mainly to model transformation and distributed systems

**Graph Transformations and Model-Driven Engineering** Gregor Engels, Claus Lewerentz, Wilhelm Schäfer, Andy Schürr, Bernhard Westfechtel, 2010-11-08 This festschrift volume published in honor of Manfred Nagl on the occasion of his 65th birthday contains 30 refereed contributions that cover graph transformations software architectures and reengineering embedded systems engineering and more

**Formal and Natural Computing** Wilfried Brauer, Hartmut Ehrig, Juhani Karhumäki, Arto K. Salomaa, 2003-08-01 This book presents state of the art research in theoretical computer science and related elds In particular the following areas are discussed automata theory formal languages and combinatorics of words graph transformations Petri nets concurrency as well as natural and molecular computing The articles are written by leading researchers in these areas The writers were originally invited to contribute to this book but then the normal refereeing procedure was applied as well All of the articles deal with some issue that has been under vigorous study during recent years Still the topics range from very classical ones to issues raised only two or three years ago Both survey articles and papers attacking specific research problems are included The book highlights some key issues of theoretical computer science as they seem to us now at the beginning of the new millennium Being a comprehensive overview of some of the most active current research in theoretical computer science it should be of definite interest for all researchers in the areas covered The topics range from basic decidability and the notion of information to graph grammars and graph transformations and from trees and traces to aqueous algorithms DNA encoding and self assembly Special effort has been given to lucid presentation Therefore the book should be of interest also for advanced students

**Current Trends in Theoretical Computer Science** Gheorghe Păun, 2004 This book is based on columns and tutorials published in the Bulletin of the European Association for Theoretical Computer Science EATCS during the period 2000-2003 It presents many of the most active current research lines in theoretical computer science The material appears in two volumes OC Algorithms and ComplexityOCO and OC Formal Models and SemanticsOCO reflecting the traditional division of the field The list of contributors includes many of the well known researchers in theoretical computer science Most of the articles are reader friendly and do not presuppose much knowledge of the area in question Therefore the book constitutes very suitable supplementary reading material for various courses and seminars in computer science Contents Vol 1 Algorithms Computational Complexity Distributed Computing Natural Computing Vol 2 Formal Specification Logic in Computer Science Concurrency Formal Language Theory Readership Upper level undergraduates graduate students and researchers in theoretical computer science and biocomputing

**Transactions on Computational Collective Intelligence VI**

Ngoc-Thanh Nguyen,2012-06-01 The LNCS journal Transactions on Computational Collective Intelligence TCCI focuses on all facets of computational collective intelligence CCI and their applications in a wide range of fields such as the Semantic Web social networks and multi agent systems TCCI strives to cover new methodological theoretical and practical aspects of CCI understood as the form of intelligence that emerges from the collaboration and competition of many individuals artificial and or natural The application of multiple computational intelligence technologies such as fuzzy systems evolutionary computation neural systems consensus theory etc aims to support human and other collective intelligence and to create new forms of CCI in natural and or artificial systems This the sixth issue of Transactions on Computational Collective Intelligence contains 10 selected papers focusing on the topics of classification agent cooperation paraconsistent reasoning and agent distributed mobile interaction      *Rewriting Logic and Its Applications* Santiago Escobar,Narciso Martí-Oliet,2020-12-10 This book constitutes selected papers from the 12th International Workshop on Rewriting Logic and Its Applications WRLA 2020 held in Dublin Ireland in April 2020 Due to the COVID 19 pandemic the workshop took place virtually The 11 full papers presented in this volume were carefully reviewed and selected from 16 submissions Rewriting logic is a natural model of computation and an expressive semantic framework for concurrency parallelism communication and interaction It can be used for specifying a wide range of systems and languages in various application fields      **Model Driven Architecture - Foundations and Applications** Alan Hartman,David Kreische,2005-11-04 This book constitutes the refereed proceedings of the First European Conference Workshops on Model Driven Architecture Foundations and Applications ECMDA FA 2005 held in Nuremberg Germany in November 2005 The 24 revised full papers presented 9 papers from the applications track and 15 from the foundations track were carefully reviewed and selected from 82 submissions The latest and most relevant information on model driven software engineering in the industrial and academic spheres is provided The papers are organized in topical sections on MDA development processes MDA for embedded and real time systems MDA and component based software engineering metamodeling model transformation and model synchronization and consistency      *Mathematical Foundations of Computer Science 2011* Filip Murlak,Piotr Sankowski,2011-08-09 This volume constitutes the refereed proceedings of the 36th International Symposium on Mathematical Foundations of Computer Science MFCS 2011 held in Warsaw Poland in August 2011 The 48 revised full papers presented together with 6 invited talks were carefully reviewed and selected from 129 submissions Topics covered include algorithmic game theory algorithmic learning theory algorithms and data structures automata grammars and formal languages bioinformatics complexity computational geometry computer assisted reasoning concurrency theory cryptography and security databases and knowledge based systems formal specifications and program development foundations of computing logic in computer science mobile computing models of computation networks parallel and distributed computing quantum computing semantics and verification of programs and theoretical issues in artificial intelligence      Trustworthy Global Computing Martin Wirsing,Martin Hofmann,Axel



Rauschmayer, 2010-09-15 Global computing refers to computation over global computers i.e. computational infrastructures available globally and able to provide uniform services with variable guarantees for communication cooperation and mobility resource usage security policies and mechanisms etc with particular regard to exploiting their universal scale and the programmability of their services As the scope and computational power of such global infrastructures continue to grow it comes more and more important to develop methods theories and techniques for trustworthy systems running on global computers This book constitutes the thoroughly refereed proceedings of the fifth edition of the International Symposium on Trustworthy Global Computing TGC 2010 that was held in Munich Germany February 24-26 2010 The Symposium on Trustworthy Global Computing is an international annual venue dedicated to safe and reliable computation in global computers It focuses on providing frameworks tools and protocols for constructing well behaved applications and on reasoning rigorously about their behavior and properties The related models of computation incorporate code and data mobility over distributed networks with highly dynamic topologies and heterogeneous devices

*Foundations of Software Science and Computation Structures* Igor Walukiewicz, 2004-03-04 ETAPS 2004 was the seventh instance of the European Joint Conferences on Theory and Practice of Software ETAPS is an annual federated conference that was established in 1998 by combining a number of existing and new conferences This year it comprised five conferences FOSSACS FASE ESOP CC TACAS 23 satellite workshops 1 tutorial and 7 invited lectures not including those that are specific to the satellite events The events that comprise ETAPS address various aspects of the system development process including specification design implementation analysis and improvement The languages methodologies and tools that support these activities are all well within its scope Different blends of theory and practice are represented with an inclination towards theory with a practical motivation on the one hand and soundly based practice on the other Many of the issues involved in software design apply to systems in general including hardware systems and the emphasis on software is not intended to be exclusive

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