Recent Developments in the Theory of Graph Transformation, 2010

Preface

The area of Graph Transformation, also called Graph Grammars or Graph Rewriting, started in 1970 as a generalisation of string and term rewriting. It has since then grown out to an independent branch of formal methods, finding connections with diverse fields such as biology, architecture, computer graphics and (especially) software engineering. One of the main developments on the theoretical front, involving an abstract algebraic setting in which many of the concepts and techniques of Graph Transformation can be applied far beyond graphs themselves, has also resulted in feedback and synergy with related fields such as Process Algebra.

In fact, the research area has organised its own specialistic meeting already since 1978; from 2002 on this has taken the form of the biannual International Conference on Graph Transformation (ICGT), which is a forum for presenting both theoretical advances and practical applications. This special issue contains selected papers from the fifth edition of ICGT, which took place from 29 September to 1 October 2010 at the University of Twente in Enschede, The Netherlands.

From the 22 papers presented at the conference, the best theoretically oriented ones were invited to submit an extended version for this special issue, while another special journal issue (of Software and Systems Modelling) has been organised around the more practially oriented papers. The contributions that were eventually submitted underwent the usual two-stage reviewing procedure, resulting in the six papers now collected in the volume in front of you. They constitute the most recent advances in the algebraic theory of Graph Transformation, as well as some very interesting intersections with other domains, namely assertional reasoning and temporal logics.

- The paper on *Adhesivity with Partial Maps instead of Spans* by Tobias Heindel challenges one of the basic tenets of the algebraic formalisation of graph theory, namely that rules are essentially spans of morphisms in a category satisfying some version of the adhesiveness property. The paper shows that an elegant and relevant generalisation can be obtained by interpreting rules as *partial maps* instead, and replacing the criterion of adhesivity by *partial map adhesivity*. This paper won the EATCS Best Theory Paper Award of ICGT 2010.

- The paper on *M-Adhesive Transformation Systems with Nested Application Conditions* by Hartmut Ehrig, Ulrike Golas, Annegret Habel, Leen Lambers and Fernando Orejas studies in a general setting the concept of *nested application conditions*, which are expressively equivalent to first order logic. Two important properties of graph transformation systems, namely *embedding* (meaning that the effect of a transformation on a large graph is captured by its effect on any large enough subgraph) and *local confluence* (meaning that the order of certain rule applications can be interchanged) are extended to rules with nested conditions.

- The paper on *Lazy Graph Transformation* by Fernando Orejas and Leen Lambers provides an alternative way to deal with attributes in graphs: rather than insisting that attributes always have concrete values, it essentially regards them as variables, the value of which is (partially) determined by a set of constraints alongside each rule. This has the advantage of allowing rules that do not uniquely specify the values of all attributes, or specify them in a non-algorithmic manner. The evaluation of such rules is augmented by a constraint solver that narrows the possible solutions at every rule application. The approach is called *lazy* because the constraint solving may as well be delayed some steps without affecting the semantics of the transformation.

- The paper on *Transformation of Typed Composite Graphs with Inheritance and Containment Structures* by Stefan Jurack and Gabriele Taentzer combines within one (algebraic) framework a number of concepts that are vital to the use of graph-like structures as models in software engineering: typing, node type inheritance, containment relations, and (graph) composition. Theoretical foundations for each of these concepts have been studied before to one degree or another; the contribution of this paper is to combine them. In doing so, the paper solves a number of issues that arise only in the combination, such as the interaction of inheritance and containment with the decomposition of type graphs.

- The paper on *Hoare-Style Verification of Graph Programs* by Christopher Poskitt and Detlef Plump provides a cross-connection between the fields of graph transformation and assertional reasoning. For a given graph programming language (GP) developed earlier by the authors, they define an approach for verifying partial correctness based on Hoare-style rules for nested graph conditions. This nicely complements earlier work by Pennemann et al. on weakest precondition semantics. A special feature of GP is that it features nodes with data-type labels; the approach therefore allows reasoning with data as well as structural graph properties.

- Finally, the paper on *Counterpart Semantics for a Second-Order μ-Calculus* by Fabio Gadducci, Alberto Lluch Lafuente and Andrea Vandin studies a very expressive temporal specification logic, which extends the propositional modal μ-calculus (a generalisation of CTL*, which in turn generalises CTL and LTL) with first-order quantification. For this logic they propose a new semantic model, inspired by the algebraic framework for graph transformation, in which the states are algebras (which can be seen as a generalisation of graphs) and the transitions are so-called *counterpart relations* (which generalise graph rule applications). With respect to existing work, the new semantics has the advantage of enforcing fewer restrictions and allowing reasoning about deletion, creation and merging of model elements.

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