Journal of Computer and System Sciences 81 (2015) 797–798

Contents lists available at ScienceDirect

Journal of Computer and System Sciences

www.elsevier.com/locate/jcss

Foreword

From the Editors

State-based systems are traditionally modelled as having crisp relational transitions but are increasingly coming to be viewed in terms of more complex transition structures, e.g. weighted, probabilistic, or game-based. The arising multitude of semantic structures multiplies the need for the development of meta-theory, logics, algorithms, and tools. Universal coalgebra has emerged as a unifying framework for state-based modelling that allows treating a broad variety of system types as instances of the general concept of coalgebra for a functor. Coalgebra has been successful both in establishing generic results that work for wide ranges of system types (*abstract coalgebra*) and in gaining new insights for specific system types using the coalgebraic perspective on systems (*concrete coalgebra*).

The current special issue presents selected papers from the 11th International Workshop on Coalgebraic Methods in Computer Science, CMCS 2012, held on March 31–April 1, 2012 in Tallinn, Estonia, as a satellite event of the European Joint Conferences on Theory and Practice of Software, ETAPS 2012. Postproceedings containing ten contributed and three invited papers presented at the workshop have appeared as vol. 7399 of Lecture Notes in Computer Science. Out of these papers, the following appear, in substantially extended form, in the special issue.

One of the core topics of coalgebra is modal reasoning in many forms. Abramsky and Zvesper give an account of the Brandenburg–Keisler paradox in epistemic game theory, which can be seen as involving modalities *believes* and *assumes*. They lift the paradox to a fixpoint result valid over regular categories, and give a coalgebraic construction of so-called assumption-complete models.

The basic idea of coalgebra is to encapsulate types of transition systems as endofunctors on a given base category; it is thus of particular importance to understand syntactic descriptions of such functors. Adámek et al. prove that finitary endofunctors on locally presentable categories have equational presentations, i.e. can be defined in terms of generating operations and equations. The class of locally presentable categories includes many categories that are central for semantics, such as complete partial orders and metric spaces; examples studied by the authors include the Hausdorff functor (compact subsets) and the Kantorovich functor (tight measures) on complete metric spaces.

A classical example of a powerful abstraction is the notion of distributive laws among functors and monads, which syntactically translates into a definition format for the semantics of expression languages and process calculi. Under suitable conditions, these definitions take the shape of rules adhering to a suitable form, such as GSOS. Bacci and Miculan present an abstract GSOS-like format MGSOS for defining the semantics of stochastic processes with continuous state spaces in terms of coalgebras over measurable spaces.

In the semantics of concurrent systems, one of the core issues is the distinction between branching-time and linear-time semantics, which in fact are just two extremes on a whole spectrum of semantics. While branching time fits in naturally with coalgebraic notions of bisimulation, linear time, i.e. trace semantics, requires more effort. One approach to coalgebraic trace semantics is to split the functor into one part determining the branching structure, typically a monad, and one part representing the trace structure, and then move the trace functor to another base category induced by the branching monad, such as its Kleisli or Eilenberg–Moore category. Jacobs et al. study the relationship between the latter two approaches, and show that they are equivalent when both are applicable.

The above-mentioned close relation between state-based systems and modal logics has led to the development of coalgebraic logic, based on various types of generic modalities induced by the coalgebraic type functor. Modal logics typically behave well w.r.t. behavioural equivalence of states, and hence w.r.t. generic notions of bisimilarity provided that the functor supports these. Marti and Venema discuss a notion of bisimilarity induced by particular form of relation liftings called lax extensions, and develop a coalgebraic logic based on a cover modality induced by a lax extension. Notably, this framework applies also to functors that fail to preserve weak pullbacks, such as the monotone neighbourhood functor.

The core theme of (bi-)simulation is also taken up by Sobociński, who provides a treatment of weak simulation in the setting of relational presheaves, with a focus on algebraic structures on labels. He shows that Milner's weak closure of a labelled transition system is a left adjoint to a change-of-base functor between categories of relational presheaves, thus paving the ground for an abstract theory of weak simulation.

http://dx.doi.org/10.1016/j.jcss.2015.02.004

As an example of work in concrete coalgebra, Winter et al. develop a coalgebraic treatment of context-free languages. The coalgebraic view suggests the use of typical tools from coalgebra, such as coinduction, final coalgebras, and behavioural differential equations, and thereby leads to more concise and perspicacious proofs of known results as well as new results, e.g. concerning closure properties of the class of context-free languages and a characterisation of automatic sequences.

The special issue thus provides a snapshot of coalgebra as a research area with wide applications and lively research activity. The recurrent central topics of coinduction, corecursion, and modal logic have received substantial further development in the contributions collected here; we are looking forward to future advances of the field.

Dirk Pattinson
Australian National University, Canberra, Australia

Lutz Schröder
Friedrich-Alexander-Universität Erlangen–Nürnberg, Germany