

## Lista de Lucrări

Ionuț Țuțu este (co-)autor al unsprezece lucrări peer-reviewed. Șase dintre acestea (J1–J6) au fost publicate în jurnale bine-cunoscute în domeniu, iar cinci (C1–C5) au fost prezentate la conferințe.

- J6. I. Țuțu, J. L. Fiadeiro. *From Conventional to Institution-Independent Logic Programming*  
Journal of Logic and Computation, 27(6):1679–1716, Oxford University Press, 2017

We propose a logic-independent approach to logic programming through which the paradigm as we know it for Horn-clause logic can be explored for other formalisms. Our investigation is based on abstractions of notions such as logic program, clause, query, solution, and computed answer, which we develop over Goguen and Burstall’s theory of institutions. These give rise to a series of concepts that formalize the interplay between the denotational and the operational semantics of logic programming. We examine properties concerning the satisfaction of quantified sentences, discuss a variant of Herbrand’s theorem that is not limited in scope to any particular logical system or construction of logic programs, and describe a general resolution-based procedure for computing solutions to queries. We prove that this procedure is sound; moreover, under additional hypotheses that reflect faithfully properties of actual logic-programming languages, we show that it is also complete.

- C5. J. L. Fiadeiro, I. Țuțu, A. Lopes, D. Pavlovic. *Logics for Actor Networks: A case study in constrained hybridization*  
DaLi 2017: Dynamic Logic. New Trends and Applications, LNCS 10669:98–114, Springer, 2017

Actor Networks is a modelling framework for cyberphysical system protocols based on Latour’s actor-network theory that addresses the way we are now creating and exploiting the power of computational networks. We advance a logic for modelling and reasoning about such actor networks, which results from a two-stage constrained-hybridization process. The first stage sets the foundations of a formalism that captures the structure of actor networks and the way knowledge flows across such networks; the second addresses the dynamic aspects of actor networks, i.e. the way they can evolve as a result of the interactions that occur within them. For each of these stages, we develop a sound and complete proof system.

- C4. I. Țuțu, J. L. Fiadeiro. *Revisiting the Institutional Approach to Herbrand’s Theorem*  
Algebra and Coalgebra in Computer Science, LIPIcs 35:304–319, Schloss Dagstuhl, 2015

More than a decade has passed since Herbrand’s theorem was first generalized to arbitrary institutions, enabling in this way the development of the logic-programming paradigm over formalisms beyond the conventional framework of relational first-order logic. Despite the mild assumptions of the original theory, recent developments have shown that the institution-based approach cannot capture constructions that arise when service-oriented computing is presented as a form of logic programming, thus prompting the need for a new perspective on Herbrand’s theorem founded instead upon a concept of generalized substitution system. In this paper, we formalize the connection between the institution- and the substitution-system-based approach to logic

programming by investigating a number of features of institutions, like the existence of a quantification space or of representable substitutions, under which they give rise to suitable generalized substitution systems. Building on these results, we further show how the original institution-independent versions of Herbrand's theorem can be obtained as concrete instances of a more general result.

- C3. I. Vissani, C. G. Lopez Pombo, I. Țuțu, J. L. Fiadeiro. *A Full Operational Semantics for Asynchronous Relational Networks*  
Recent Trends in Algebraic Development Techniques, LNCS 9463:131–150, Springer, 2015

Service-oriented computing is a new paradigm where applications run over global computational networks and are formed by services discovered and bound at run-time through the intervention of a middleware. Asynchronous Relational Nets (ARNs) were presented by Fiadeiro and Lopes with the aim of formalising the elements of an interface theory for service-oriented software designs. The semantics of ARNs was originally given in terms of sequences of sets of actions corresponding to the behaviour of the service. Later, they were given an institution-based semantics where signatures are ARNs and models are morphisms into ground networks, that have no dependencies on external services. In this work, we propose a full operational semantics capable of reflecting the dynamic nature of service execution by making explicit the reconfigurations that take place at run-time as the result of the discovery and binding of required services. This provides us a refined view of the execution of ARNs based upon which a specialized variant of linear temporal logic can be used to express, and even to verify through standard model-checking techniques, properties concerning the behaviour of ARNs that are more complex than those considered before.

- J5. I. Țuțu, J. L. Fiadeiro. *Service-Oriented Logic Programming*  
Logical Methods in Computer Science, 11(3), 2015

We develop formal foundations for notions and mechanisms needed to support service-oriented computing. Our work builds on recent theoretical advancements in the algebraic structures that capture the way services are orchestrated and in the processes that formalize the discovery and binding of services to given client applications by means of logical representations of required and provided services. We show how the denotational and the operational semantics specific to conventional logic programming can be generalized using the theory of institutions to address both static and dynamic aspects of service-oriented computing. Our results rely upon a strong analogy between the discovery of a service that can be bound to an application and the search for a clause that can be used for computing an answer to a query; they explore the manner in which requests for external services can be described as service queries, and explain how the computation of their answers can be performed through service-oriented derivatives of unification and resolution, which characterize the binding of services and the reconfiguration of applications.

- J4. R. Diaconescu, I. Țuțu. *Foundations for Structuring Behavioural Specifications*  
Journal of Logical and Algebraic Methods in Programming, 83(3–4):319–338, Elsevier, 2014

We develop foundations for structuring behavioural specifications based on the logic tradition of hidden algebra. This includes an analysis of a number of important technical compositional properties for behavioural signatures, such as pushouts, inclusions and unions, as well as an investigation of algebraic rules for behavioural module composition. As a particularity of behavioural specifications, some of the constructions and results arise in a partial algebraic form. This partiality aspect is one of the distinguishing

features of our approach to behavioural specification modules. In addition, our study does not commit to any actual choice of structuring constructs, thus being applicable to a wide variety of structuring situations.

- J3. I. ȚuȚu. *Parameterisation for Abstract Structured Specifications*  
Theoretical Computer Science, 517(0):102–142, Elsevier, 2014

We investigate multiple-parameterised specifications and their instantiation within the institution-independent framework of abstract structured specifications. Our work identifies a set of distinctive features of specifications languages that have a fundamental role in defining and instantiating parameterised specifications. We consider both simultaneous and sequential instantiation of parameters, and allow not only sharing between the body of the parameterised specification and the instances of the parameters, but also between the parameters of a generic specification. The developments conclude with the examination of the relation between the results of simultaneous and sequential instantiation of parameters, which are shown to be isomorphic under a given set of sufficient abstract conditions.

- J2. I. ȚuȚu. *Comorphisms of Structured Institutions*  
Information Processing Letters, 113(22–24):894–900, Elsevier, 2013

In this paper we formalise the intuition of encoding an institution of structured specifications into another one by extending the concept of institution comorphism to the abstract framework of structured institutions. This allows us to define a category of comorphisms of structured institutions, and supports in this way the development of heterogeneous specification languages in which the actual structuring mechanisms may vary, in addition to the base logical systems. We consider a number of properties with practical relevance for the comorphisms between base institutions and discuss their implications in the structured setting.

- C2. I. ȚuȚu. *Logical Foundations of Services*  
Imperial College Computing Student Workshop, OASICS 35:111–118, Schloss Dagstuhl, 2013

In this paper we consider a logical system of networks of processes that interact in an asynchronous manner by exchanging messages through communication channels. This provides a foundational algebraic framework for service-oriented computing that constitutes a primary factor in defining logical specifications of services, the way models of these specifications capture service orchestrations, and how properties of interaction-points, i.e. points through which such networks connect to one another, can be expressed. We formalise the resulting logic as a parameterised institution, which promotes the development of both declarative and operational semantics of services in a heterogeneous setting by means of logic-programming concepts.

- C1. I. ȚuȚu, J. L. Fiadeiro. *A Logic-Programming Semantics of Services*  
Algebra and Coalgebra in Computer Science, LNCS 8089:299–313, Springer, 2013

We develop formal foundations for notions and mechanisms needed to support service-oriented computing. Our work provides semantics for the service overlay by abstracting concepts from logic programming. It draws a strong analogy between the discovery of a service that can be bound to a client application and the search for a clause that can be used for computing an answer to a query. In addition, it describes the process of binding services and the reconfiguration of applications as service-oriented derivatives of unification and resolution.

- J1. R. Diaconescu, I. Țuțu. *On the Algebra of Structured Specifications*  
Theoretical Computer Science, 412(28):3145–3174, Elsevier, 2011

We develop module algebra for structured specifications with model oriented denotations. Our work extends the existing theory with specification building operators for non-protecting importation modes and with new algebraic rules (most notably for initial semantics) and upgrades the pushout-style semantics of parameterized modules to capture the (possible) sharing between the body of the parameterized modules and the instances of the parameters. We specify a set of sufficient abstract conditions, smoothly satisfied in the actual situations, and prove the isomorphism between the parallel and the serial instantiation of multiple parameters. Our module algebra development is done at the level of abstract institutions, which means that our results are very general and directly applicable to a wide variety of specification and programming formalisms that are rigorously based upon some logical system.