

**First Interaction and Concurrency Experience:
Synchronous and Asynchronous Interactions
in Concurrent Distributed Systems
(ICE08)**

Final Report

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1 Interaction and Concurrency Experiences

Interaction and Concurrency Experiences (ICEs) is intended as a series of international scientific meetings focusing on interactions and synchronization mechanisms of concurrent or distributed systems. The workshop intends to attract researchers in theoretical and applied computer science interested in models, verification, tools, and programming primitives concerning such complex interactions. The first experience (ICE08) has been held in Reykjavik on the 6th of July 2008 as an ICALP'08 affiliated event and has been centered around synchrony and asynchrony in concurrent/distributed systems.

ICE combines a few interesting peculiarities with respect to traditional scientific meetings; here, we highlight two of them: *(i)* the workshop specific topics vary each year focusing on specific facets of interactive systems and *(ii)* ICE features a novel review and discussion procedures to support the selection of papers whereby interactive discussions among authors and reviewers take place on a web forum.

Both these features require some efforts but are rather rewarding. Variability of topics brings in the possibility of tailoring the workshop on some of the most interesting and cutting-edge research on modern interactive systems. The novel selection procedure serves a twofold purpose: on the one hand it allows reviewers to quickly clarify possible blur aspects of papers by directly asking authors for elucidations; on the other hand, it allows authors to better understand and address reviewers comments and improve their work.

ICE08 has received 12 submissions by both young and outstanding computer scientists. Each paper has been reviewed by at least three PC members and then, it has been widely discussed by the authors and the whole programme committee. At the end of the discussion, 8 papers have been selected for the presentation at the meeting in Reykjavik. The accepted papers have been modified by the authors along the lines suggested by the PC members during the discussion and they will be published on the online journal Electronic Notes in Theoretical Computer Science.

The authors of the accepted papers and two invited speakers (namely, Catuscia Palamidessi and Joseph Sifakis) have presented their works during the meeting. Besides the speakers and the organizers, some PC members and some other interested people have joined the meeting.

The program committee of ICE08 consisted of researchers from Asia, Europe, North and South America : Simon Bliudze (VERIMAG), Michele Boreale (University of Florence), Marco Carbone (Queen Mary), Vincent Danos (Paris VII - CNRS), Azadeh Farzan (Carnegie Mellon University), Fabio Gadducci (University of Pisa), Blaise Genest (CNRS, Rennes), Ichiro Hasuo (University of Kyoto), Thomas Hildebrandt (ITU-Copenhagen), Barbara Koenig (University of Duisburg-Essen), Jean Krivine (École Polytechnique), Ruggero Lanotte (University of Insubria), Francesco Logozzo (Microsoft Research), Gavin Lowe (Oxford), Hernan Melgratti (UBA, Buenos Aires), Mohamad Reza Mousavi (Eindhoven University), Julian Rathke (University of Southampton), Frank Valencia (École Polytechnique), Daniele Varacca (Paris VII) and Herbert Wiklicky (Imperial College).

2 Scientific Contents

In this section we briefly reports the contents of the accepted works and the discussions during the meeting. For the sake of presentation, we classify the contributions in four different classes. However, many relations and links can be drawn even amongst papers under in different subsection. For instance, behavioural equivalences appeared in most of the talks. They came out when analyzing expressiveness, when proving the correctness of an encoding, when characterizing a class of models satisfying a certain property. In spite of a lot of studies concerning abstract semantics, it is still quite unclear which is the sound semantics for a precise purpose. This requires for a systematic studies of behavioural equivalences and, more generally, for a systematic way for defining interactive semantics for those formalisms modelling concurrent-distributed systems.

2.1 Invited Speakers

The first invited speaker, **Catuscia Palamidessi** (École Polytechnique), has addressed the problem of implementing mixed choice of *synchronous* π -calculus in a distributed environment. In order to tackle this issue, the speaker introduces a probabilistic extension of *asynchronous* π -calculus and an encoding of the former language into the latter. Such an encoding is sound and complete with respect to *testing semantics*, but not with other well-known equivalence such as strong and weak bisimilarity. This result establishes the basis for a distributed and symmetric implementation of mixed choice which, unlike previous proposals, does not rely on assumptions on the relative speed of processes.

The second invited speaker, the Turing Award winner **Joseph Sifakis**, has shown his current work at VERIMAG: a platform for the implementation and the formal analysis of real-time distributed systems. The framework is based on the BIP (*Behavior, Interaction, Priority*) semantic model, characterized by a layered representation of *components*. Systems are obtained by gluing atomic components with *connectors* tuned by dynamic priorities. Connectors describe structured interactions between atomic components, in terms of two basic protocols: *rendezvous* and *broadcast*. Dynamic priorities are used to select amongst possible interactions, in particular, to express scheduling policies. BIP supports a methodology for incremental construction within a three-dimensional space: Behavior-Interaction-Priority. The separation between behavior and architectural constraints expressed by interactions and priorities, eases compositional verification of systems through a separate analysis of their atomic components and their architectural constraints.

The discussion made evident that the BIP model is very close to the well-known GSOS format. Also, BIP's expressiveness results higher than e.g., CCS and CSP expressiveness if only coordination operators are considered.

2.2 Petri Nets

Jens-Wolfhard Schicke (joint work with **Ursula Goltz** and **Rob van Glabbeek**) has illustrated how to relax the inherent synchrony of Petri nets that require tokens to be removed instantaneously when transitions are fired; this may

be problematic. This issue can be tackled by assuming that removal of tokens from places is no longer instantaneous. This can be formally defined by inserting silent (unobservable) transitions between transitions and their pre-places.

This work considers three different patterns of asynchronous interaction (i.e., *full asynchrony*, *symmetric asynchrony* and *asymmetric asynchrony*) and determines for which classes of Petri nets the asynchronous model is failure equivalent to the original ones.

The discussion mainly focused on clarifying if automata-like models instead of Petri nets could be adopted. Moreover, the participants discussed about the use of failure equivalence with respect to other behavioural equivalences.

Luca Fossati (joint work with **Daniele Varacca**) has presented a Petri nets model for a *handshake protocol* widely used in distributed systems. Since, previous work has shown the inadequacy of simple language-theoretical models, Fossati introduces *handshake Petri nets* and proves that these precisely capture the protocol behavior. Moreover, handshake Petri nets can be composed, and this composition mimics the behaviour of two interacting system executing an handshake protocol.

Several people of the audience were interested in understanding the relationship with another kind of recently introduced Petri nets that are called *Open nets* that can interact by exchanging tokens on a set of *open places*, and can be composed by gluing over this places.

2.3 Automata-based approaches

Ruggero Lanotte (joint work with **Danicèle Beauquier** and **Joëlle Cohen**) presented a characterisation of a class of security policies that can be enforced at run-time. This work proves that such class of properties are a sub-class of ∞ -regular ones (those memory bounded) and provide an effective algorithm to check in $O(n^2)$ if a property in such a class can be enforced by an edit automata with n states. Finally, the authors show how the controller of an enforceable property can be algorithmically synthesized.

The discussion was mainly centered on the dependency in the proof of the characterisation theorem from the algorithm chosen to synthesize the controlled. It was determined that this is not the case.

Fahima Cheikh presented a joint work with **Philippe Balbiani** and **Guillaume Feuillade**. The authors study the algorithmic complexity of web service compositions. Services are abstracted as finite input/output automata upon which a product operation is defined. Such operation is then used to define the decision problem of the existence of a controller that composed with a number of services is bisimilar to a give behaviour (expressed as an input/output automaton). Finally the authors study the asymptotic complexity of the proposed algorithm and show that it is EXPTIME-hard. The proof is constructive and yields a controller when one exists.

The discussion suggested an interesting research direction, namely to determine whether or not the synthesized controlled is the most general one and provide its peculiarities with respect to other possible controllers. Also, a few possible connections between the presented work and other work and work in the literature was

highlighted.

2.4 Behavioral Equivalences

The problem of defining good behavioural equivalences for reduction-based formalisms has captured the attention of many scientist, especially after the introduction of the *theory of reactive systems* by Leifer and Milner. In order to obtain a labeled transition system (expressing the interactions of a systems with its environment) from a reduction system (expressing the evolution of the system in isolation), the theory of Leifer and Milner proposes to take as labels, the minimal contexts allowing a reduction. **Pawel Sobociński** (joint work with **Julian Rathke**) argued that bisimilarities induced by minimal context are typically too strict. This becomes evident in *asynchronous* models, where the input interaction is not observable. In order to make the unobservable unobservable, this work proposes to systematically add the so called *Honda-Tokoro rules* that yield unobservable interactions to *all* processes. As a results, bisimilarity over the derived labeled transition system is sound and complete with respect to *reduction congruence*. Sobociński has illustrated the theory by means of three interaction mechanisms, namely, *full asynchrony*, *asynchrony* and *synchrony*.

From the discussion emerges that the resulting semantics coincides with *saturated bisimilarity* by Bonchi and Montanari. The semantics proposed by Sobociński relies on the standard notion of bisimulation (over a larger labeled transition system), while the latter relies on an asymmetric definition of bisimulation (over a smaller labeled transition system).

Andrea Bracciali (joint work with **Roberto Bruni** and **Alberto LLuch-Lafuente**) has shown a systematic approach to the study of *open systems* with *symbolic transition system* (STS).

Open systems feature interactions in a partially specified environment. The specification and the analysis of open systems is more complex than those of traditional closed interactive systems. Hence, STS transitions are labeled with (classical) interactions *and modal formulas* describing the structure/behaviour that unspecified components should provide. Two different notions of bisimilarity have been considered (*strict* and *loose weak bisimilarity*) and applied to a *web crawler* motivating example.

The discussion highlights several links with the work of Sobociński. Strict weak bisimilarity is too strict because it allows to observe what should be unobservable. Thus adding Honda-Tokoro rules to the symbolic transition system could allow to retrieve a coarser behavioural equivalence, probably the loose weak bisimilarity. Indeed, the definition of the latter is very close *semi-saturated bisimilarity* by Bonchi and Montanari.

2.5 Non-functional aspects

Matthew Hennessy (joint work with **Manish Gaur**) has shown a variant of the asynchronous π -calculus featuring a *cost environment* used to associate costs to channels so that processes must “pay” for their usage. The cost environment resembles environments usually adopted in typed versions of the π -calculus, but it

is rather used to establish the minimal requirements necessary to model and reason about behaviour of *costed processes* (as the authors call them). Hennessy has also demonstrated how the proposed requirements can be instantiated to a concrete model of costs.

With respect to previous work, this approach proposes to combine typical behaviour equivalences as bisimulation together with partial orders so that processes exhibiting a same behaviour can be ordered according to the costs required to use computational resources.

The discussion tried to establish the extend to which the requirements proposed by this work can be applied to other frameworks and to clarify the differences with other approaches.

Tobias Heindel has shown how to model secrecy within a weakly adhesive categorical framework. This work aims to provide a better understanding of the concept of public/confidential information by putting it in the context of open/bound names as defined in many process algebraic frameworks. The paper relies on a technical result that shows how a categorical construction where objects are monomorphisms and arrows are pullback squares preserves weak adhesivity. Intuitively, this corresponds to annotating part of the system state as confidential and to verify that the state-transformer operations preserve the “labelling”.

The discussion tried to figure out if the approach could be applied to other security properties (like the fundamental *authentication* and *integrity*, or to less primitive properties like *non-repudiation*). Though in principle this looks feasible, it required some adjustment to the underlying categorical construction.

3 Conclusions and Future ICEs

Besides the interesting scientific contributes, we consider ICE08 an encouraging empirical experiment for the innovative selection procedure that it has proposed. Indeed, since the initial phase of the experience, we have received a lot of attentions and positive comments from many people of the scientific community. Both all the Programme Committee and the authors of submitted papers declare themselves very glad of the possibility to discuss in the web forum, as it is witnessed by the many messages that have been exchanged during the selection procedure.

The number of submissions has not been very high. We argue that this is due to two main factors: *(i)* ICE08 is the very first edition of the series and *(ii)* the very expensive venue, though hosting the prestigious ICALP, may have discouraged submissions and participation. It is also to be remarked that other ICALP-affiliated workshops did not receive many submissions (and some of them have been even canceled).

Despite the low number of submissions, the quality of accepted paper is rather high; we contend that this is due to the selection procedure and to the effort of all PC members. It is noteworthy indeed, that all the PC members have directly reviewed the papers assigned to them without delegating the job to other people. Particularly interesting is the fact that some PC members choose to discuss in the forum without anonymity and that the whole discussion has been very polite.

For the next year, we think to have the meeting in a less expensive location; we already have been offered to co-locate the workshop with CONCUR and with COORDINATION. We are currently considering both options and will soon make a choice.

The topic for the next edition is also to be determined; at the moment, we have several options and some of them have been already considered in a few discussions with authors and PC members attending the workshop. We would like to encourage PC members to propose other topics and discuss them in an on-line forum.

4 Programme

- 09:00 Opening
- 09:00-10:00 Invited Talk: A randomized implementation of synchronous communication in presence of mixed choice.
Catuscia Palamidessi
- 10:00-10:30 Symmetric and Asymmetric Asynchronous Interaction.
Rob van Glabbeek, Ursula Goltz and Jens-Wolfhard Schicke
- 10:30-11:00 Coffe Break
- 11:00-11:30 Counting the cost in the π -calculus.
Matthew Hennessy and Manish Gaur
- 11:30-12:00 Making the unobservable unobservable.
Julian Rathke and Pawel Sobocinski
- 12:00-12:30 Security policies enforcement using finite edit automata.
Danile Beauquier, Joelle Cohen and Ruggero Lanotte
- 12:30-14:00 Lunch break
- 14:00-15:00 Invited Talk: Component-based Construction of Heterogeneous Real-time Systems in BIP.
Joseph Sifakis
- 15:00-15:30 A Petri Net Model of Handshake Protocols.
Luca Fossati and Daniele Varacca
- 15:30-16:00 Coffee break
- 16:00-16:30 On Symbolic Semantics for Name-decorated Contexts.
Andrea Bracciali, Roberto Bruni and Alberto Lluch Lafuente
- 16:30-17:00 Composition of Web services: algorithms and complexity.
Philippe Balbiani, Fahima Cheikh and Guillaume Feuillade
- 17:00-17:30 Secrecy for rewriting in adhesive categories.
Tobias Heindel
- 17:30-18:00 Discussion

5 List of Participants

Convenors

- (i) Dr. Filippo Bonchi, Pisa, (IT)
- (ii) Dr. Davide Grohmann, Udine, (IT)
- (iii) Dr. Paola Spoletini, Milano, (IT)
- (iv) Dr. Angelo Troina, Torino, (IT)
- (v) Dr. Emilio Tuosto, Leicester, (UK)

Speakers

- (i) Dr. Andrea Bracciali, Pisa, (IT)
- (ii) Ms. Fahima Cheikh, Toulouse Cedex 4, (FR)
- (iii) Mr. Luca Fossati, Torino, (IT)
- (iv) Mr. Tobias Heindel, Duisburg, (DE)
- (v) Professor Matthew Hennessy, Dublin, (IE)
- (vi) Mr. Schicke Jens-Wolfhar, Braunschweig, (DE)
- (vii) Dr. Ruggero Lanotte, Como, (IT)
- (viii) Professor Catuscia Palamidessi, Palaiseau, (FR)
- (ix) Professor Joseph Sifakis, Gieres, (FR)
- (x) Dr. Pawel Sobocinśki, Southampton, (UK)

Participants

- (i) Professor Roberto Amadio, Paris Cedex 13, (FR)
- (ii) Dr. Simon Bliudze, Gieres, (FR)
- (iii) Professor Vincent Danos, Edinburgh, (UK)
- (iv) Professor Ursula Goltz, Braunschweig, (DE)
- (v) Dr. Bartek Klin, Warsaw, (PL)
- (vi) Professor Dale Miller, PALAISEAU Cedex, (FR)
- (vii) Dr. Balbiani Philippe, Toulouse Cedex 4, (FR)
- (viii) Professor Jan Strejcek, Brno, (CZ)
- (ix) Professor Rob Van Glabbeek, Sydney, (AU)
- (x) Professor Bjrn Victor, Uppsala, (SE)
- (xi) Dr. Marcelo Zanconi Gieres, (FR)