

Internship subject (Master 2 or Master 1)

# Open Automata meet Session Types

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## Context

In the previous years, we have studied theoretical foundations for open systems and we defined open automata [5, 2, 4] that can be seen as labelled transition systems (LTSs) with parameters and holes. The transitions of open automata are much more complex than transitions of an LTS: they include guards expressing the relations between the parameters of the automaton with the actions of the holes, and assignments encoding their effects. We proved that our models have good properties, namely that composition preserves some properties like bisimulation.

The composition of open automata refers to filling holes, it requires to check the compatibility of their sorts. Nowadays, we simply verify the compatibility of two automata to be composed based on action labels and arity. But, we are interested in enriching holes with description of behaviours to give them enough power and enable us to check equivalences for these open systems. The description will characterise all the interactions and the series of inputs and outputs of data exchanged between the automata and its surroundings. Precisely, the theory of session types and behavioural types [3] are intended to describe dynamic aspects of the behaviour of processes.

To tackle this issue, we ask: *Can we synthesise a global type from a collection of automata in order to ensure the composability of an open automaton with a compatible surrounding automaton?*

## Objectives

The main objective of the internship is to deal with the characterization of interactions of open automaton with its environment. These interactions can be characterised as behavioural types. More specifically, the internship would follow the following steps:

- Familiarization with technical material: the semantics of open automata and the notion behavioural types [1] that allows to describe the dynamic aspects of processes. In particular the notion of session types that focus on process interactions should be studied.
- Design of an adequate characterisation of compatibility condition suitable for the composition open automata, and study the guarantees brought by this condition.
- Application to the proof of absence of deadlock upon composition.

- We additionally have defined a notion of refinement between open automata that would benefit from such behavioural types. One additional objective of the internship could be to improve the definition of refinement based on the notion of behavioural types that has been defined in the previous steps.
- Design of examples demonstrating the benefit of this work.

## References

- [1] Hans Hüttel, Ivan Lanese, Vasco T. Vasconcelos, Luís Caires, Marco Carbone, Pierre-Malo Deniérou, Dimitris Mostros, Luca Padovani, António Ravara, Emilio Tuosto, Hugo Torres Vieira, Gianluigi Zavattaro: Foundations of Session Types and Behavioural Contracts. *ACM Comput. Surv.* 49(1): 3:1-3:36 (2016)
- [2] Henrio, L., Madelaine, E., Zhang, M.: A Theory for the Composition of Concurrent Processes. In Albert, E., Lanese, I., eds.: 36th International Conference on Formal Techniques for Distributed Objects, Components, and Systems (FORTE). Volume LNCS-9688 of Formal Techniques for Distributed Objects, Components, and Systems., Heraklion, Greece (June 2016) 175–194. <https://hal.inria.fr/hal-01299562>
- [3] Alessandro Fantechi, Elie Najm, Jean-Bernard Stefani: From Behavioural Contracts to Session Types. *Models, Languages, and Tools for Concurrent and Distributed Programming 2019*: 278-297
- [4] Hou, Z., Madelaine, E.: Symbolic Bisimulation for Open and Parameterized Systems. In: PEPM 2020 - ACM SIGPLAN Workshop on Partial Evaluation and Program Manipulation, New-Orleans, United States (January 2020). <https://hal.inria.fr/hal-02406098>
- [5] Rabéa Ameer-Boulifa and Ludovic Henrio and Eric Madelaine: Compositional equivalences based on Open pNets. arXiv 2007.10770 (2020). <https://arxiv.org/abs/2007.10770>