π-calculus, internal mobility and behavioural properties

M2 internship, Daniel Hirschkoff, Plume team, ENS de Lyon

Context

The π-calculus is a core calculus for concurrent and mobile computation based on the notion of channels. Various techniques have been studied to reason about π-calculus processes, notably behavioural equivalences, type systems and modal logics.

The π-calculus is very expressive: it is possible in particular to encode rich programming languages, including higher-order, concurrent or imperative features in the π-calculus..

Several variants of the π-calculus have been introduced in order to analyse this expressive power, and to provide useful techniques to reason about encodings of programming language features.

The internship

The internship will focus on $I\pi$, *the π-calculus with internal mobility* [5, 4], which is one such variant. $I\pi$ has been notably used to analyse encodings of the call-by-value λ-calculus in the π-calculus, and extensions thereof [1, 2]. These works, together with recent developments, suggest exploring further this rather well-established subcalculus of π, exploring in particular certain extensions of $I\pi$.

The student is expected to get familiar with relevant works in the field (see the bibliography below), and to define and analyse behavioural equivalences for an extended $I\pi$-calculus. Such equivalences will be based on the bisimulation proof technique, which makes it possible to define powerful proof techniques [3]. In some cases, the bisimulation approach can be enhanced using types, which we shall also consider in the internship. One expected outcome of this work is a better understanding of the central rôle played by $I\pi$ in the study of contextual equivalence for higher-order programming languages.

Keywords: π-calculus, λ-calculus, coinduction, bisimulation, type system.

This internship will take place in the Plume team of the LIP laboratory (ENS de Lyon). It will be jointly supervised by Daniel Hirschkoff (Plume) and Davide Sangiorgi (Università di Bologna and INRIA). Visits can be organised to discuss on the progress of the internship.

References

[1] Adrien Durier, Daniel Hirschkoff, and Davide Sangiorgi. Eager functions as processes (long version). *CoRR*, abs/2202.03187, 2022.

[2] Daniel Hirschkoff, Enguerrand Prebet, and Davide Sangiorgi. On sequentiality and well-bracketing in the π-calculus. In *36th Annual ACM/IEEE Symposium on Logic in Computer Science, LICS 2021, Rome, Italy, June 29 - July 2, 2021*, pages 1–13. IEEE, 2021.

[3] Damien Pous and Davide Sangiorgi. Enhancements of the bisimulation proof method. In Davide Sangiorgi and Jan J. M. M. Rutten, editors, *Advanced Topics in Bisimulation and Coinduction*, volume 52 of *Cambridge tracts in theoretical computer science*, pages 233–289. Cambridge University Press, 2012.

[4] Davide Sangiorgi. pi-Calculus, Internal Mobility, and Agent-Passing Calculi. *Theor. Comput. Sci.*, 167(1&2):235–274, 1996.

[5] Davide Sangiorgi and David Walker. *The Pi-Calculus - a theory of mobile processes*. Cambridge University Press, 2001.