Research internship (Master M2)

Title Verification of Distributed Systems with Parameterized Network Topology

Description

We consider distributed systems that can be run on arbitrary network topologies from a given class of architectures (e.g., on all pipelines, all grids, or all ring topologies). Typically, such a program is given by a single sequential process, and a copy of that process can be run on any node in the given network topology. See [4] for a recent overview.

Parameterized systems are hard to analyze, and their verification problems quickly turn undecidable. There have been several orthogonal approaches to regain decidability: (i) restricting the amount of information that can be exchanged (e.g., unary tokens instead of binary ones), (ii) relaxing point-to-point communication towards broadcasting or nondeterministic choice, or (iii) imposing a bound on the number of *contexts* that a process traverses [1, 2]; a context may, e.g., restrict communication to one fixed neighbor, or to one type of communication such as "send".

In the internship, we propose to investigate some extensions of (iii) among the following:

- Relax the notion of *context* by introducing a suitable notion of split-width [3] (the latter has been used to verify concurrent systems with fixed architecture).
- Extend the approach to topology classes of unbounded degree such as star architectures.
- Enrich the model so that messages can contain process identifiers. This would allow one to model and verify leader-election protocols.
- Add recursion in terms of pushdown stacks to the model (cf. [3] for fixed architectures).
- The papers [1, 2] assume rendez-vous communication. It would be interesting to extend this to (bounded) buffers.
- The model-checking problem was tackled in [2] wrt. MSO logic, which implies a high complexity. Are there temporal logics that allow for more efficient verification procedures?

Prerequisites are basic knowledge in automata theory, logic, verification, and computability & complexity theory.

References

[1] B. Bollig, P. Gastin and J. Schubert. Parameterized Verification of Communicating Automata under Context Bounds. In *RP'14*, *LNCS* 8762. Springer, 2014.
`http://www.lsv.ens-cachan.fr/~bollig/Papers/rp2014.pdf`

[2] B. Bollig, P. Gastin and A. Kumar. Parameterized Communicating Automata: Complementation and Model Checking. In *FSTTCS'14*, *LIPIcs*, 2014. To appear.
`http://hal.archives-ouvertes.fr/hal-01030765`

[3] A. Cyriac. Verification of Communicating Recursive Programs via Split-width. *Thèse de doctorat*, Laboratoire Spécification et Vérification, ENS Cachan, France, January 2014.
`http://www.lsv.ens-cachan.fr/Publis/PAPERS/PDF/cyriac-phd14.pdf`

[4] J. Esparza. Keeping a crowd safe: On the complexity of parameterized verification. In *STACS'14*, volume 25 of LIPIcs, pages 1–10, 2014.
`http://drops.dagstuhl.de/opus/volltexte/2014/4498/`

Encadrants

Benedikt Bollig
`http://www.lsv.ens-cachan.fr/~bollig/`
Tél: 01 47 40 75 38
`bollig@lsv.ens-cachan.fr`

Paul Gastin
`http://www.lsv.ens-cachan.fr/~gastin/`
Tél: 01 47 40 75 60
`gastin@lsv.ens-cachan.fr`