Models of Distributed Algorithms
Emulation of the distance-\(k\) model under central daemon into the asynchronous distance-1 model

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1 Model Translation in Distributed Computing

Theoretical researches on distributed computing mainly consist of the design, proof, and complexity analysis of distributed algorithms. In this context, modeling is a crucial issue. High-level models allow to simplify the proofs, but make the algorithmic design far from real deployment. Conversely, low-level models are closer to the reality, but design and proofs in those models are increasingly more complex. An interesting line of research is then the design of general translation methods from a high-level model to a lower one.

2 Self-Stabilization

Self-stabilization [Dij74] is a versatile technique to withstand transient faults in a distributed system. Indeed, a distributed algorithm is said to be self-stabilizing if, after any finite sequence of transient faults, it will eventually recover, without external (e.g., human) intervention, provided that those faults did not corrupt its code. In particular, a self-stabilizing algorithm, starting from an arbitrary configuration, eventually behaves correctly.

3 Locally Shared Memory Model

The locally shared memory model (with composite atomicity) is an abstraction of the message-passing model introduced by Dijkstra [Dij74] which is commonly used in self-stabilization. In this model, each process is able to directly read the states of all its neighbors, i.e., each process can read at distance 1.

Several methods preserving self-stabilization, e.g., [KP93, AKM+07, DDT06], have been proposed to translate algorithms written in this model into the message-passing model, which is the lowest level model.

Reading at distance 2. Now, even in the (high-level) locally shared memory model, proofs may be complex and subtle. Hence, some higher level models have been studied. For example, Gairing et al [GGH+04] proposed a stronger version of locally shared memory model, where (1) processes can read at distance two and (2) no two processes can change their state simultaneously. In particular, they designed a method (preserving self-stabilization) to translate an algorithm written in that distance-2 model into the (fully) asynchronous distance-1 model.
Reading at distance $k$. We propose here to generalize this latter result to the distance-$k$ model, with $k \geq 2$. Hence, the expected contribution is a method to translate self-stabilizing algorithms written in the sequential distance-$k$ model to algorithms that are self-stabilizing (for the same specification) into the (fully) asynchronous distance-1 model.

4 Work To Be Done

Precisely, several contributions are expected:

- The design of the translation technique,
- its proof of correctness,
- the evaluation of the overhead (both in space and time),
- and the application of the method to an interesting case-study (optional).

5 Working context.

The internship is part of ANR project ESTATE\(^1\). The student will be integrated in the lab Verimag\(^2\). Possible extension into a PhD thesis.

References


\(^1\)https://wp-systeme.lip6.fr/estate/
\(^2\)http://www-verimag.imag.fr/

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