Summary
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supporting Yoram Hirshfeld

A striking feature of concurrent systems is their behavioural complexity. The dynamics of even a small concurrent system formed from simple processes may be difficult to predict. The combination of relatively clean, simple specifications and complex behaviours makes for one of the more compelling applications of mathematical techniques to the problem of "program correctness," and a number of formalisms including, for example, Milner's CCS and Hoare's CSP, have been developed with a view to specifying and reasoning about concurrent systems.

A rigorous notion of behavioural equivalence of processes was proposed by Park. Two processes are said to be *bisimilar* or *bisimulation equivalent* if, roughly, they may evolve together in such a way that whenever the first process performs a certain action, the second process is able to respond by performing the same action, and vice versa. Bisimulation equivalence has been intensively studied in the past decade, and plays a crucial role in algebraic theories of concurrency, such as that based on CCS.

The study of decidability of bisimulation equivalence on fragments of these process algebras is a lively research area. The fragment "BPP", based on a commutative parallel composition operator, and "BPA", based on a non-commutative sequential composition operator, are both known to be decidable. One of the most interesting questions left open was whether bisimulation equivalence is decidable for processes constructed using *both* operators. (The common generalisation of BPP and BPA is simply referred to as "process algebra" or PA.) This question formed the main focus of the proposal.

The visiting fellow, Yoram Hirshfeld, had previously worked with researchers at Edinburgh on the decidability question for PA. We had come to expect that bisimulation equivalence would turn out to be decidable, at least for so-called "normed" PA. Our approach was to develop a "structure theory", exhaustively classifying the situations when a parallel composition of two processes could be equivalent to a sequential composition of two processes. We had made considerable progress in this direction but some gaps remained. As a result of the visit funded by this VRF, we have finally completed the structure theory, although it turned out to be more intricate (and more interesting!) that we had envisaged. As a consequence, we have exhibited the first decision procedure for bisimulation equivalence in normed PA [1].

[1] Yoram Hirshfeld and Mark Jerrum, Bisimulation equivalence is decidable for normed Process Algebra, *Internal Report ECS-LFCS-98-386*, Department of Computer Science, University of Edinburgh, May 1998. (The report may be downloaded from `http://www.dcs.ed.ac.uk/lfcsreps/`)

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