Unifying Theories of Concurrency

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A theory of concurrency provides a basis for reasoning about the behaviour of distributed interactive systems. Its goal is to give a conceptual framework for specifying systems, designing them, and implementing them correctly. Correctness is a relationship between two formulae expressed in the notations provided by the theory. Differing definitions have been adopted in a wide range of theories, for example, CCS, ACP, CSP, LOTOS and the pi-calculus; and each of these has many variations. Familiar examples of a correctness relation are: structural equivalence, reaction, algebraic reduction, bisimulation, refinement, and observational equivalence or inclusion; each of these has many variations. Each variation justly claims distinct advantages, for example, simple proof methods, mechanical model checking, guidance for practical implementation, support of operational intuition, high level of abstraction, or a clear notion of testability.

A unifying theory of concurrency is one which combines some or all of these advantages, by ensuring that the relevant definitions actually coincide in meaning. This series of lectures shows how to extend a theory of concurrency by additional transition rules, laws, axioms or theorems to achieve this effect. The technique is largely independent of the choice of a particular syntax or signature of the theory, and could be applied to many process calculi, past as well as future. The goal is that particular theories, useful for particular purposes, can be obtained by adding axioms or imposing constraints on a common unifying theory, so that all the theorems of the general theory will hold in all specific instances.

For the implementation and practical use of a theory, it is obviously beneficial to select one that combines known advantages, avoids unnecessary choices, and postpones the necessary ones until enough is known to make a sensible selection. These are the potential benefits of a unifying theory. However unification is definitely a bad idea if the objective of the research is actually to explore yet further variations of the theory, and discover further advantages, as yet unknown, that they may bring. Exploration of a wide range of diverse theories is in itself a valuable scientific goal, as well as being a prerequisite for any subsequent unification. Indeed, the main scientific purpose of unifying theories is to understand better their range of diversity, and the good reasons for each variation.

These lectures will give a self-contained introduction to Process Algebra in general, but please first look at one of the following: each of them provides excellent background, motivation, and illustrative examples.

References

1. Communicating Sequential Processes. CAR Hoare. First three chapters
   `http://216.239.57.104/search?q=cache:l76wE_UxMjMJ:www.usingcsp.com/+Communicating+Sequential+Processes+Hoare&hl=en&ie=UTF-8`
2. Communicating and Mobile Systems. Robin Milner. First three chapters. Cambridge University Press, 1999.