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Playing Games and Proving Properties of Concurrent Systems

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Concurrency theory is concerned with formal notations and techniques for modeling and reasoning about concurrent systems such as protocols and safety critical control systems. In the talk we gave a very brief introduction to how concurrent systems can be modelled within process calculi, as terms of an algebraic language. Their behaviours are described using transitions. Reasoning has centred on two kinds of questions. One is relationships between descriptions of concurrent systems. For instance, when are two descriptions equivalent? The second is appropriate logics for describing crucial properties of concurrent systems. Temporal logics have been found to be very useful. We described how bisimulation equivalence, due to Park and Milner, is essentially game theoretic and we built on this view. Bisimulation equivalence can also be characterized in terms of modal logic (Hennessy-Milner logic). However as a logic it is not very expressive. So we also described modal mu-calculus, modal logic with fixed points, and showed that it is a very expressive temporal logic for describing properties of processes. However it is also very important to be able to verify that processes have temporal properties. We showed that property checking can be understood in terms of game playing. In the finite state case, games under pin efficient model checking algorithms. Second the games are definable independently of property checking as graph games which can be reduced to other combinatorial games (and in particular to simple stochastic games). An important open question is whether finite state property checking of modal mu-calculus properties can be done in polynomial time.

References

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