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Model checking of component connectors

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A Abstract

In this thesis, we present a framework for automata theoretic model checking of coordination systems specified in Reo. Reo is a coordination language that is based on a calculus of channel composition. Using Reo specifications, complex connectors can be built compositionally, organized as a network of channels to interconnect and orchestrate or choreograph the interactions among a set of concurrent components and/or distributed services.

We introduce Büchi automata of records (BAR) and their augmented version (ABAR) as an operational modeling formalism that covers several intended forms of behavior of Reo connectors, such as fairness, I/O synchronization, and context dependency. To specify the properties to be verified, we introduce an action based linear temporal logic, called ρ-LTL, interpreted over the executions of augmented Büchi automata of records, and show how the formulas can be translated into ABARs. This translation can be done either inductively, or by using an on-the-fly method. To deal with the large state spaces, we show that ABARs can be implemented using ordered binary decision diagrams (OBDD). For this purpose, we also introduce the necessary modifications over the basic model checking algorithm that can be applied directly over OBDD structures. Our implementation and a number of case studies that we carried out show the applicability of our method over large state spaces.

We also show that the state explosion problem can be tackled by compositional minimization methods using some suitable equivalence relations. In fact, we show two equivalences that are congruences with respect to the connector composition operators and such that they both preserves linear time temporal logic properties. Again, we demonstrate our method by means of few practical case studies.