Tree decomposition of graphs for efficient model-checking

L. Jezequel, D. Lime

**Keywords:** graph theory, message-passing algorithms, automata, model-checking.

**Subject:** Message-passing algorithms are a class of algorithms which can be used to estimate the local behaviour of compound systems living on trees – that is, such that the interaction between the components (forming what is called the interaction graph of the system) occurs along the edges of a tree. These algorithms are called message-passing because they proceed by repeated exchanges of messages along the edges of the interaction graph. In previous works we have used message-passing algorithms to modularly compute summaries: representations of all the possible behaviours of a component embedded in a modular system [1]. This allowed to derive efficient algorithms for both planning [2] and model-checking [3] in distributed systems.

The requirement that systems live on trees is however quite strong: it is an important limitation to the practical use of message-passing algorithms. Indeed, many real-life problems have interaction graphs with cycles (most networks or distributed systems, for example, have interaction cycles). Several solutions can be considered to deal with such problems, ranging from approximate methods strongly using the structure of the interaction graph [4] to exact methods not using this structure at all [5].

The aim of this doctorate work will be to develop exact methods allowing the use of message passing algorithms on larger classes of interaction graphs than just trees. This will be achieved by studying the structure of the interaction between the components of various real (and possibly, as well, randomly generated) model checking problems, in order to see to which extent graph decomposition techniques (see for example [6] among many others) can be applied (and extended) to deal with such interaction graphs. Currently, such decompositions are able to transform any interaction graph with cycles into a tree by merging some components, but are not designed for the particular case of message-passing algorithms (i.e. the tree they produce is in general not optimal for applying the message-passing).

**Requested profile:** Master in computer science or mathematics with interest in verification, good knowledge on graph theory, automata theory, and/or model checking. Strong programming skills will be deeply appreciated.

**References**


