CRC: A Church-Rosser Checker Tool for Conditional Order-Sorted Equational Maude Specifications

Francisco Durán

Universidad de Málaga, Spain

The (ground) Church-Rosser and termination properties are essential for an equational specification to have good executability conditions, and also for having a complete agreement between the specification's initial algebra, mathematical semantics, and its operational semantics by rewriting. For order-sorted specifications, being Church-Rosser and terminating means not only confluence, but also a *descent* property ensuring that the normal form will have the least possible sort among those of all other equivalent terms.

The Maude Church-Rosser Checker tool (CRC) checks whether a (possibly conditional) order-sorted equational specification modulo equational axioms satisfies the Church-Rosser property. CRC is particularly well-suited for checking Maude specifications [1] with an initial algebra semantics to be ground-Church-Rosser, although it can be used to check the Church-Rosser property of conditional order-sorted specifications that do not have an initial algebra semantics. If the specification cannot be shown to be Church-Rosser by the tool, proof obligations are generated and are given back to the user, which can be used as a guide in the attempt to establish the ground-Church-Rosser property. Specifically, the tool gives as output a set of critical pairs and a set of membership assertions that must be shown, respectively, ground-joinable, and ground-rewritable to a term with the required sort.

The CRC tool and the Maude Termination Tool [3] are both integrated in the Maude Formal Environment [5], and can effectively deal with Maude equational specifications that are order-sorted, conditional, possibly with extra variables in their conditions, and whose equations can be applied modulo any combination of associativity, commutativity and identity axioms. Besides its generality, the main features of the tool are: (i) the capacity to discharge unjoinable critical pairs by proving them to be either unfeasible or context-joinable; and (ii) the capacity to deal with any combination of associativity and/or commutativity and/or identity axioms. CRC can be used on any Maude module, including structured modules, parameterized modules, etc.

CRC is available at http://maude.lcc.uma.es/CRChC. Its foundations, design and methodological guidelines can be found in [4]. The check of specifications with any combination of associativity/commutativity/identity axioms has not been available until the release of Maude 2.7.1, which includes built-in support for unification modulo these combinations of theories [2].

References

[1] M. Clavel, F. Durán, S. Eker, P. Lincoln, N. Martí-Oliet, J. Meseguer, and C. Talcott. *All About Maude - A High-Performance Logical Framework*, LNCS 4350. Springer, 2007.

[2] M. Clavel, F. Durán, S. Eker, P. Lincoln, N. Martí-Oliet, J. Meseguer, and C. Talcott. Maude 2.7.1 Manual. Available in http://maude.cs.uiuc.edu, July 2016.

[3] F. Durán, S. Lucas, C. Marché, J. Meseguer, and X. Urbain. Proving operational termination of membership equational programs. *Higher-Order and Symbolic Computation*, 21(1-2):59–88, 2008.

[4] F. Durán and J. Meseguer. On the church-rosser and coherence properties of conditional order-sorted rewrite theories. *J. Log. Algebr. Program.*, 81(7-8):816–850, 2012.

[5] F. Durán, C. Rocha, and J. M. Álvarez. Tool interoperability in the Maude Formal Environment. In A. Corradini, B. Klin, and C. Cîrstea, ed., *CALCO 2011.* LNCS 6859: 400–406. Springer, 2011.