CoCo 2017 Participant: CSI^ho 0.3*

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Higher-order rewriting combines first-order rewriting with notions and concepts from λ-calculus, resulting in rewrite systems with higher-order functions and bound variables. CSI^ho is a tool for automatically proving confluence of such higher-order systems, specifically pattern rewrite systems (PRSs) as introduced by Nipkow [3, 6]. The restriction to pattern left-hand sides is essential for obtaining decidability of unification and thus makes it possible to compute critical pairs. To this end CSI^ho implements a version of Nipkow's algorithm for higher-order pattern unification [7]. CSI^ho is an extension of CSI, a powerful confluence prover for first-order term rewrite systems. The tool and a web interface are available from

http://cl-informatik.uibk.ac.at/software/csi/ho

Below we briefly describe the criteria implemented by CSI^ho, a more detailed description (also of CSI) can be found in [5].

The first criterion is based on a higher-order version of the critical pair lemma, that is, for terminating PRSs we decide confluence by checking joinability of critical pairs [6]. For showing termination CSI^ho implements a basic higher-order recursive path ordering and static dependency pairs with dependency graph decomposition and the subterm criterion. Alternatively, one can also use an external termination tool like WANDA [2] as an oracle. For potentially non-terminating systems CSI^ho supports two more classical criteria based on critical pairs, namely weak orthogonality [9] and van Oostrom's result on development closed critical pairs [8]. As a divide-and-conquer technique CSI^ho implements modularity, i.e., decomposing a PRS into parts with disjoint signatures, for left-linear PRSs—note that confluence of PRSs is not modular in general [1]. Finally CSI^ho uses the simple technique of adding and removing redundant rules [4], adapted for PRSs, e.g. for finding non-joinable peaks via forward closures.

References

[1] C. Appel, V. van Oostrom, and J. G. Simonsen. Higher-order (non-)modularity. In *Proc. 21st RTA*, volume 6 of *LIPIcs*, pages 17–32, 2010.

[2] Cynthia Kop. *Higher Order Termination.* PhD thesis, Vrije Universiteit, Amsterdam, 2012.

[3] R. Mayr and T. Nipkow. Higher-order rewrite systems and their confluence. *TCS*, 192(1):3–29, 1998.

[4] J. Nagele, B. Felgenhauer, and A. Middeldorp. Improving automatic confluence analysis of rewrite systems by redundant rules. In *Proc. 26th RTA*, volume 36 of *LIPIcs*, pages 257–268, 2015.

[5] J. Nagele, B. Felgenhauer, and A. Middeldorp. CSI: New evidence – a progress report. In *Proc. 26th CADE*, volume 10395 of *LNCS (LNAI)*, pages 385–397, 2017.

[6] T. Nipkow. Higher-order critical pairs. In *Proc. 6th LICS*, pages 342–349, 1991.

[7] Tobias Nipkow. Functional unification of higher-order patterns. In *Proc. 8th LICS*, pages 64–74, 1993.

[8] V. van Oostrom. Developing developments. *TCS*, 175(1):159–181, 1997.

[9] V. van Oostrom and F. van Raamsdonk. Weak orthogonality implies confluence: The higher order case. In *Proc. 3rd LFCS*, volume 813 of *LNCS*, pages 379–392, 1994.

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