Confluence Competition 2018

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Abstract

We report on the 2018 edition of the Confluence Competition, a competition of software tools that aim to (dis)prove confluence and related properties of rewrite systems automatically.

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1 Confluence Competition

The annual Confluence Competition (CoCo)[5] has driven the development of techniques for (dis)proving confluence and related properties of a variety of rewrite formalisms automatically. Starting in 2012 with 4 tools competing in 2 categories, CoCo has grown steadily to 11 categories with 11 tools in 2017, and several tools ran in multiple categories.

CoCo is executed on the dedicated high-end cross-community competition platform *StarExec* [3]. A speciality of CoCo is that the whole competition is conducted within one slot at a conference or workshop (IWC in 2012–2017 and FSCD in 2018). The progress of the live competition is shared with the audience visually through the *LiveView* tool which interacts with StarExec. A screenshot of the LiveView of CoCo 2017 is shown in Figure 1.

2 Categories

CoCo supports two kinds of categories, *competition* and *demonstration* categories. The latter are one-time events for demonstrating new rewrite formats or properties. These can be requested until 2 months before a competition. *Competition* categories run also in future editions of CoCo. These can be requested until 6 months prior to the competition, in order to allow the CoCo steering committee to make a well-informed decision on the format (precise syntax as well as semantics) of the new categories and to extend the Confluence Problems database (Cops) accordingly. In CoCo 2018, we have the following 11 competition categories:

TRS/CTRS/HRS These three categories are about confluence of three important formalisms of rewriting, namely, *first-order term rewriting* (TRS), *conditional term rewriting* (CTRS), and *higher-order rewriting* (HRS).

CPF-TRS/CPF-CTRS These two categories are for *certified* confluence proofs. Participating tools must generate certificates that are checked by an independent certifier.

GCR This category is about *ground* confluence of many-sorted term rewrite systems.

NFP/UNC/UNR These categories are about confluence-related properties of first-order term rewrite systems, namely, *the normal form property* (NFP), *unique normal forms with respect to conversion* (UNC), and *unique normal forms with respect to reduction* (UNR).

CPF This category is the combination of the CPF-TRS and CPF-CTRS categories, evaluating the overall power of tools that generate certified confluence (dis)proofs.

UN This category is the combination of the NFP, UNC, and UNR categories. Tools compete to prove the strongest property among these three.

As GCR and NFP/UNC/UNR are new categories introduced in the last competition, we provide some more details. The other categories are described in the CoCo 2015 report [1]. Applications based on initial algebra semantics often rely on confluence of well-sorted ground

[5] `http://coco.nue.ie.niigata-u.ac.jp/`

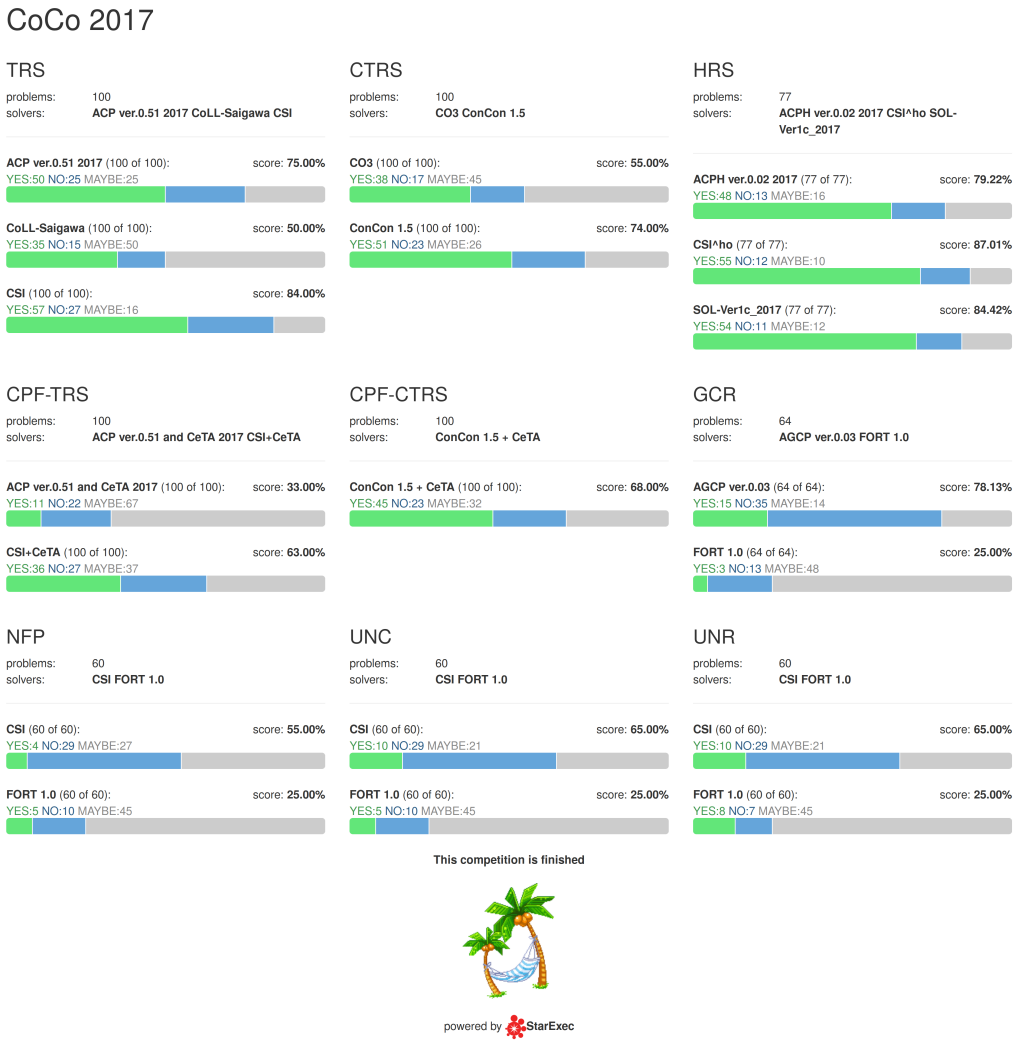

Figure 1 LiveView of CoCo 2017 upon completion.

terms, which is the reason why the GCR category deals with confluence of all well-sorted ground terms in a many-sorted term rewrite system. Uniqueness of normal forms also plays an important role in applications of rewriting. The notion is formalized in three different ways: A TRS satisfies NFP if $s \to^* t$ whenever $s \leftrightarrow^* t$ with t a normal form. A TRS satisfies UNC if $s = t$ whenever $s \leftrightarrow^* t$ with s and t normal forms. Finally, a TRS satisfies UNR if $s = t$ whenever $s \,{}^*\!\leftarrow \cdot \to^* t$ with s and t normal forms. The properties GCR, NFP, UNC, and UNR are all weaker than confluence and the implications "NFP $\Rightarrow$ UNC $\Rightarrow$ UNR" hold.

3 Problems

Problems selected for CoCo originate from Cops, an online database of confluence problems.[6] Via its web interface, everyone can retrieve and download confluence problems, and also submit new problems. Figure 2 shows the submission interface of Cops. Submitted problems

[6] `http://cops.uibk.ac.at/`

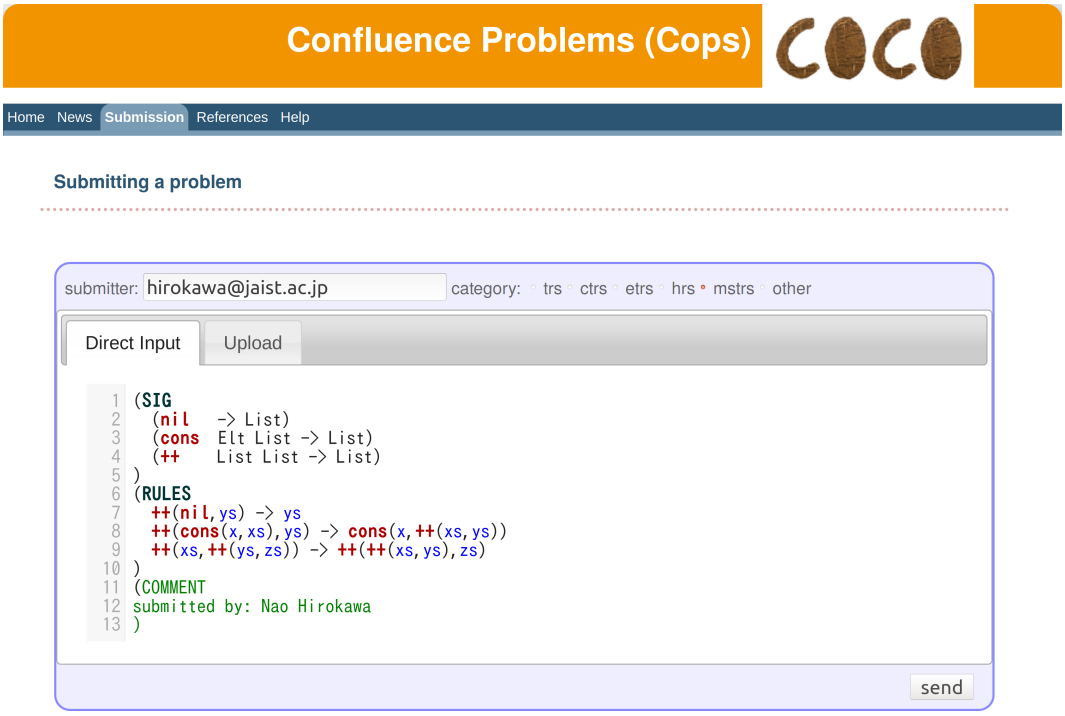

Figure 2 The submission interface of Cops.

are reviewed by the CoCo steering committee and then integrated into Cops. We refer to the website and [2] for detailed information about Cops. Problem selection for CoCo is subject to the following constraints:

- Only problems stemming from the literature are considered. This includes papers presented at informal workshops like the International Workshop on Confluence (IWC) and PhD theses. The reason for this restriction is to avoid bias towards one particular tool or technique.
- For the GCR, NFP, UNC and UNR categories, only non-confluent problems are considered.
- For the CTRS and CPF-CTRS categories, only *oriented* conditional term rewrite systems *of type 3* are considered.
- The restriction to *pattern* rewrite systems in the HRS category for CoCo 2015–2017 has been removed in CoCo 2018.

Further selection details are available from the CoCo website.

For the live competition, 100 suitable problems are randomly selected for each category. In the demonstration categories, participating tool authors are requested to provide the problems for the competition.

4 Evaluation

Given a problem, participating tools must—in the first line of their output—answer `YES` or `NO` within 60 seconds; any other answer indicates that the tool could not determine the status of the problem. The winner of each category is determined by the total number of `YES`/`NO` answers. The combined UN category is an exception to this rule. The winner in that category is determined by summing up the points earned according to Table 1. Here, the

Table 1 Scoring in the UN category.

	none	UNR	UNC	NFP
none	0	3	4	5
¬NFP	3	4	5	
¬UNC	4	5		
¬UNR	5			

column corresponds to the strongest property proved by the tool, and the row corresponds to the weakest property refuted by the tool. For example, a tool that proves UNR, disproves NFP, but does not decide UNC, would score 4 points (row: ¬NFP, column: UNR).

Shortly after each competition, detailed competition results are made available on the CoCo website and integrated into Cops as metadata to indicate the statuses of problems in past competitions. If a tool has given a non-plausible answer, it is disqualified as a winner of the categories in which those answers are involved. Moreover, the records are corrected if such an erroneous answer is spotted after the live competition.

Most participating tools are available at the CoCo website. Moreover, CoCoWeb[7] [2] provides a convenient web interface to execute tools without local installation.

5 Outlook

We expect CoCo to grow with new categories and tools in the years ahead. Natural candidates are commutation, rewriting modulo AC, and nominal rewriting. We are planning to enhance the functionality of the LiveView tool. In particular, we want to have it recognize `YES/NO` conflicts among participating tools in real time. It would also be nice if the scores of the UN and CPF categories are computed and viewed in real time. Based on the metadata of (completed) competitions imported into Cops, a website[8] admits to view details of past competitions, including the output of tools. Importing the metadata in real time would make all details of the live competition immediately accessible.

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[7] http://cocoweb.uibk.ac.at/
[8] http://cops.uibk.ac.at/results/