

# CoCo 2024 Participant: CeTA 3.1

Dohan Kim<sup>1</sup>, Christina Kirk<sup>1</sup>, Teppei Saito<sup>2</sup>, and René Thiemann<sup>1</sup>

<sup>1</sup> University of Innsbruck, Austria

<sup>2</sup> Japan Advanced Institute of Science and Technology, Japan

The tool CeTA [1] is a certifier for, among other properties, (non-)confluence of term rewrite systems with and without conditions. Its soundness is proven as part of the formal proof library `IsaFoR`, the Isabelle Formalization of Rewriting. Below, we present the relevant changes from last year's version (2.45) to this year's version (3.1). For a complete reference of supported techniques we refer to the certification problem format (CPF) and the `IsaFoR/CeTA` website:

<http://cl-informatik.uibk.ac.at/isafor/>

In CeTA 3.1 several new term orderings have been added. These can be used in non-joinability proofs as discrimination pairs, or in infeasibility proofs as co-rewrite pairs. This includes CoWPO and WPO, also in combination with non-strongly normalizing orders such as polynomial interpretations with negative coefficients [2]. Moreover, the monotonic semantic path order and the generalized WPO have become available [3].

For non-joinability proofs [4] for terms  $s$  and  $t$  we further support the technique of showing that both  $s$  and  $t$  only reach a finite set of terms, and that these sets are disjoint.

One of the big differences is the switch to CPF 3, which has the following benefits:

- Joining sequences for various confluence and commutation criteria now have a uniform format. One of the possibilities is to provide just the intermediate terms, without having to explicitly specify the positions or the applied rules of each rewrite step. Moreover, whenever the join allows arbitrary many steps  $s \rightarrow^* t$ , then the intermediate terms can be connected by parallel rewrite steps.
- Rules and terms can be indexed, a technique to reduce the size of certificates. For instance in a modular decomposition it suffices to state that the system is split into rules (A), (B), (E) and rules (C), (D), without having to fully spell out these five rules again.
- Several redundant CPF 2 elements have been removed. For instance, the longish

```
<polynomial><sum>  
  <polynomial><variable>1</variable></polynomial>  
  <polynomial><coefficient><integer>2</integer></coefficient></polynomial>  
</sum></polynomial>
```

in CPF 2 is just `<sum><variable>1</variable><integer>2</integer></sum>` in CPF 3 in order to specify the polynomial  $x_1 + 2$ .

## References

- [1] René Thiemann and Christian Sternagel. Certification of Termination Proofs using CeTA. In *Proc. 22nd International Conference on Theorem Proving in Higher Order Logics*, volume 5674 of *Lecture Notes in Computer Science*, pages 452–468, 2009. doi: [10.1007/978-3-642-03359-9\\_31](https://doi.org/10.1007/978-3-642-03359-9_31).
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- [3] Teppei Saito and Nao Hirokawa. Weighted Path Orders Are Semantic Path Orders. In *Proc. 14th International Symposium on Frontiers of Combining Systems, Frocos 2023*, volume 14279 of *Lecture Notes in Computer Science*, pages 63–80, 2023. doi: [10.1007/978-3-031-43369-6\\_4](https://doi.org/10.1007/978-3-031-43369-6_4).
- [4] Takahito Aoto. Disproving Confluence of Term Rewriting Systems by Interpretation and Ordering. In *Proc. 9th International Symposium on Frontiers of Combining Systems, Frocos 2013*, volume 8152 of *Lecture Notes in Computer Science*, pages 311–326, 2013. doi: [10.1007/978-3-642-40885-4\\_22](https://doi.org/10.1007/978-3-642-40885-4_22).