Short-Term Scientific Mission Grant
- APPLICATION FORM[1] -

Action number:

Applicant name: Julie Cailler

Details of the STSM

Title: Expansion of the Goéland Theorem Prover and Interoperability with the LISA Proof Assistant

Start and end date: 19/02/2024 to 01/03/2024

Goals of the STSM

Purpose and summary of the STSM.

The objective of this project is threefold: the development of a generic tool to translate proofs from a generic sequent-calculus format to multiple proof assistants, the enhancement of the collaboration between the Goéland automated theorem prover [4] and the LISA proof assistant [6], and the expansion of the capabilities of Goéland.

Build on prior work (including another STSM proposal, for Simon Guilloud to visit University of Regensburg), the fist aspect aims to create a tool able to translate proofs in sequent calculus TSTP format designed for tableaux (SCT-TSTP, which is one of the deliverables of the EuroProofNet STSM proposal Interoperability of Tableaux and Sequent Calculus Proof Systems) to various proof assistant formats (LISA, Dedukti [1], Coq [2]).

The second aspect aims to integrate Goéland as a tactic in LISA and enable it to produce proofs compatible with LISA.

The last aspect involves strengthening Goéland through the incorporation of two additional reasoning modules: one based on Set theory and the other on orthologic. The latter will also provide an opportunity to investigate the application and impact of orthologic-based reasoning in Tableaux-style automated theorem provers.

Working Plan

Description of the work to be carried out by the applicant.

The first step is the implementation of a standalone and executable artifact that translates proofs written in SCT-TSTP to Dedukti. Exporting arbitrary proofs written in TSTP into other tools is difficult because of the large variety of ontologies and proofs steps different systems use. By restricting our focus on sequent calculus systems for FOL, which encompass many proof systems, we believe we can

[1] This form is part of the application for a grant to visit a host organisation located in a different country than the country of affiliation. It is submitted to the COST Action MC via e-COST. The Grant Awarding Coordinator coordinates the evaluation on behalf of the Action MC and informs the Grant Holder of the result of the evaluation for issuing the Grant Letter.

avoid those problems. This should in particular achieve, in combination with the deliverables of STSM proposal ``Interoperability of Tableaux and Sequent Calculus Proof Systems'', the export of proofs from LISA and Princess to Dedukti.

In addition to that, and thanks to prior work with the export of proofs to different proof assistants, such as Zenon and Goéland theorems provers toward Deduckti and Coq proof assistants [3], we want to design a general program able to take any SCT-TSTP proof and translate it to a dedicated proof assistants (Coq, Dedukti and LISA to start with).

We will then make the Goéland theorem prover export proofs in this TSTP standard, facilitating the use of Goéland by other tools and systems. In particular, we want to reinforce the interoperability between Goéland and LISA by integrating Goéland as a proof-producing tactic in the LISA.

We will study extensions of Tableaux proving methods with orthologic, as described in [5,7], which encounter some theoretical challenges, such as the production of proofs, the backtracking, and the detection of unnecessary steps in the proof. In practice, we will evaluate the impact of orthologic in tableaux-style ATP by measuring the improvements it brings in time efficiency and proving capabilities.

Finally, if time permits, we will extend Goéland with dedicated reasoning tools for statements in set theory. Set theoretic properties and symbols have a good interaction with Tableaux-style theorem proving, as multiple of them can be expressed as a combination of α, β, δ and γ rules.

Expected outputs and contribution to the Action MoU objectives and deliverables.

Main expected results and their contribution to the progress towards the Action objectives (either research coordination and/or capacity building objectives) and deliverables.

We will mostly contribute to the objectives of WG1 ``Tools for proof systems interoperability'' and WG2 ``Automated theorem provers''. More precisely, our deliverables are the following:

- The first deliverable is a program transforming proof files in SCT-TSTP to Dedukti, suitable to import proofs into Dedukti from ATPs producing sequent calculus-style and tableaux-style proofs. This would achieve indirect transfer of proofs from LISA and Princess [8] to Dedukti. Thus, we contribute to MoU ``Express new proof systems in the Dedukti logical framework.''
- The second deliverable is the addition into Goéland of a module to export proofs into SCT-TSTP. Thus, we contribute to MoU ``Promote the output of detailed, checkable proofs from automated theorem provers.''
- The third deliverable the integration of Goéland as a proof-producing tactic in LISA. Thus, we contribute to MoU ``Promote the output of detailed, checkable proofs from automated theorem provers.''
- The fourth deliverable is an extension of Goéland with set-theoretic capabilities. Thus, we contribute to MoU ``Make techniques for program verification more effective and more accessible to all stakeholders.''
- The last deliverable is a case study of orthologic in Tableaux proving methods, in particular regarding proof production and increase in speed/proving power in practice. Thus, we contribute to MoU ``Make techniques for program verification more effective and more accessible to all stakeholders.''

In the professional and social domain, the applicant and their coworker expect that this STSM will help them build a professional network, establishing productive collaborations and learning from each other's (and their respective supervisors') area of expertize. Moreover, both are junior researchers, respectively PhD student and recently graduated postdoctoral researcher. Hence, this STSM proposal is in accordance with the MoU ``Bring together members of the different communities working on proofs in Europe.", ``Create an excellent and inclusive network of researchers in Europe with lasting collaboration beyond the lifetime of the Action." and ``Actively support young researchers, the under-represented gender, and teams from regions with less capacity."

References

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