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

Action number: CA20111

Applicant name: Melanie Taprogge

Details of the STSM

Title: Verification of Higher-Order Logic Automated Reasoning within the Dedukti Framework

Start and end date: 19.05.2025 to 30.05.2025 (12 days)

Detail of the cost in EUROS:

- Transport: 253,98
- Hotel/day: 70
- Food/day: 50

TOTAL: 1693,98

Goals of the STSM

Purpose and summary of the STSM.

The goal of this Short-Term Scientific Mission is to advance the ongoing project of enabling the open-source higher-order logic automated theorem prover Leo-III to produce proofs verifiable in the Dedukti framework. The visit will focus on two main aspects: first, discussing the details of Leo-III's implementation relevant to verification, particularly the over 30 inference rules. This discussion will provide insights into the steps necessary for proof verification and may reveal cases where the way rules were implemented in Leo-III introduces avoidable complications and adjustments should be considered. Second, we will discuss the implementation of the extension outputting Dedukti proofs to ensure it aligns with the existing architecture and maintains the tool's efficiency. Additionally, we will coordinate this project with other ongoing and planned extensions of Leo-III to ensure compatibility and consistency across developments.

Working Plan

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

[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.

The applicant is the primary developer of the extension enabling Leo-III to produce proofs compatible with the Dedukti framework. The host, Alexander Steen, is the developer of Leo-III and an expert in automated reasoning within higher-order logic. This collaboration will take place at the University of Greifswald.

The working plan for the two weeks is structured as follows:

- Day 1-2: Discussion of the current state of the project
- Day 3-6: Survey of the inference rules implemented in Leo-III and discussion of encoding challenges and possible adjustments of the Leo-III code
- Day 7-8: Discussion of further extensions of Leo-III and their effects on proof verification
- Day 9 - 12: Refinement of the implementation of the extension producing Dedukti output

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.

Working groups to which this mission contributes: WG1

Enabling Leo-III to output proofs verifiable in the Dedukti framework contributes to two Research Coordination Objectives: Objective 1 (Express new proof systems in the Dedukti logical framework) and Objective 2 (Promote the output of detailed, checkable proofs from automated theorem provers). This effort will introduce the first fully automated higher-order system into the framework. Moreover, Leo-III supports rank 1 polymorphism and a direct encoding of several non-classical logics, making it a highly versatile system. Verification within the framework will thus become possible for a broader range of logics and application areas. Leo-III will also be used to extend the tool GDV-LP, which verifies TSTP proof certificates using automated provers outputting Dedukti proofs, to higher-order logic, contributing to deliverable D9 (Software for translating proof formats used by automated theorem provers to Dedukti). Additionally, as the first fully automated higher-order system encoded in Dedukti, the encoding of Leo-III proofs presents new challenges both in the encoding of the logic and the rules, as well as in the development of strategies for verifying proofs. Encodings and approaches reusable by other systems will thus be developed during this extension process, contributing to deliverable D11 (Collection of verification challenges with summary of working recipes for verifying them).