

Short-Term Scientific Mission Grant - APPLICATION FORM¹ -

Action number: CA20111

Applicant name: Thomas Traversié

Details of the STSM

Title: Translation templates for Dedukti

Start and end date: 02/02/2025 to 14/02/2025

Detail of the cost in EUROS:

- Transport: 470€

- Hotel/day: 130€

- Food/day: 40€

TOTAL: 2550€

Goals of the STSM

Purpose and summary of the STSM.

(max.200 word)

The lambdaPi-calculus modulo rewriting is a logical framework which extends the Edinburgh Logical framework (LF) with rewrite rules. Many different theories can be encoded in the lambdaPi-calculus modulo rewriting, which makes it and its associated proof language Dedukti good candidates for a formal middleware for exchanging proofs between different proof systems. Here it is critical that the middleware can verify key invariants about the translation such as type/proof preservation and conservativity.

Several ways have been studied for formalizing such translations in LF, including theory morphisms [HST94], logical relations [RS13], and lax morphisms [Rab15]. All of these explore different trade-offs between very simple translation frameworks (which are too limited to capture translations between real-life logical systems) and Turing-complete ones (which make verification of the invariants very difficult). However, all of these developments were done in the absence of rewriting.

The goal of this STSM is to extend the existing translations (theory morphisms, logical relations) between LF theories to theories of the lambdaPi-calculus modulo rewriting, to explore how rewriting can be leveraged to improve the translation capabilities, and to leverage that to generalize the approach of the individual translations. Moreover, we will formalize some translations as case studies.

[HST94] Robert Harper, Donald Sannella, and Andrzej Tarlecki. Structured theory presentations and logic representations. *Annals of Pure and Applied Logic*, 67(1):113–160, 1994.

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.

[Rab15] Florian Rabe. Lax theory morphisms. ACM Transactions on Computational Logic, 17(1), October 2015.

[RS13] Florian Rabe and Kristina Sojakova. Logical relations for a logical framework. ACM Transactions on Computational Logic, 14(4), November 2013.

Working Plan

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

(max.500 word)

The host (Florian Rabe) has extensive experience on the subject, in particular working previously in the Logosphere project and carrying out the LATIN and OAF projects, all of which pursued goals similar to EuroProofNet WG 1, and has implemented several translation mechanisms in Twelf and MMT.

The applicant (Thomas Traversié) has encoded individual interpretations [Tra24] for the lambdaPi-calculus modulo rewriting, that are morphism-like and that are relativized by a predicate, but without a general framework for studying such translations.

They have started a loose collaboration on this subject in summer 2024. They have made preliminary steps towards the goals mentioned above, including the development of a novel notion of logical of invariant-guaranteeing translation for lambdaPi-calculus modulo rewriting, and have started a joint paper on it. The applicant has implemented these preliminary ideas in Dedukti (<https://github.com/Deducteam/TranslationTemplates>). This visit will support, intensify, and scale up the collaboration.

The concrete work plan is the following:

- collect benchmark examples of formal translations;
- study the limits of the various translation mechanisms;
- generalize the mechanisms as needed;
- implement them in Dedukti;
- cross-fertilize recent development in Dedukti and MMT.

[Tra24] Thomas Traversié. Proofs for Free in the $\lambda\Pi$ -Calculus Modulo Theory. In Florian Rabe and Claudio Sacerdoti Coen, editors, Proceedings Workshop on Logical Frameworks and Meta-Languages: Theory and Practice, Tallinn, Estonia, 8th July 2024, volume 404 of Electronic Proceedings in Theoretical Computer Science, pages 49–63. Open Publishing Association, 2024.

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:

(max.500 words)

The objectives of this STSM are at the core of the EuroProofNet objectives of boosting interoperability between proof systems, and fall under Research Coordination Objective 1 (Express new proof systems in the Dedukti logical framework). This mission mainly contributes to WG1 (Tools on Proof Systems Interoperability) with a connection to WG4 (Libraries of Formal Proofs).

The main contribution is to strengthen the exchange of proofs within Dedukti, thus improving the interoperability between proof systems and strengthening Dedukti's position as a proof exchange

arbiter.

The specific outputs of this STSM are:

- the specification of translation templates for the lambdaPi-calculus modulo rewriting;
- an improved implementation of these in Dedukti;
- the formalization of some specific translations;
- a journal or conference paper about the above.