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

Action number: CA20111

Applicant name: Rishikesh Vaishnav

Details of the STSM

Title: Adding Extensionality to Lean

Start and end date: 17/02/2025 to 02/03/2025

Detail of the cost in EUROS:

- Transport (upload screen capture): Train, 126 Euros
- Hotel/day (upload screen capture): 110 Euros / Day
- Food/day: 20 Euros / Day (breakfast provided by hotel)

TOTAL: 1946 Euros

Goals of the STSM

Purpose and summary of the STSM.

(max.200 word)

The goal of this STSM is to collaborate with my host Sebastian Ullrich (working remotely in Germany for the Lean FRO) on extending Lean with a form of (simulated) extensional typechecking. While Lean's kernel itself has no extensional features (and should probably not be extended with any for soundness concerns), it may be possible to translate extensional terms to intensional ones before passing them to the kernel, as a part of Lean's elaboration routine. The translation itself could be effected by extending a translation I have already implemented called "Lean4Less", a modification of Mario Carneiro's "Lean4Lean" (a port of the Lean C++ kernel typechecker to Lean) that translates terms to eliminate definitional proof irrelevance (replacing it with an axiom) as a special case of the extensional to intensional translation. This implementation is part of my PhD work in translating from Lean to Dedukti (and eventually to other proof assistants), where features like proof irrelevance would otherwise complicate the translation. Enabling extensional reasoning in Lean is an important task in particular to help bring Lean up to par with other proof assistants (e.g., F*) in its ability to reason about program correctness.

[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.

Working Plan

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

(max.500 word)

Lean4Less's translation framework should be consistent with a general ETT-to-ITT translation described by Winterhalter et al., and could be integrated with Lean's frontend to perform this translation in real-time (perhaps as a tactic or elaboration option). I will introduce Sebastian to my work on Lean4Less, and we will discuss possible ways to extend it to recognize user-defined definitional equalities, and the means by which the user will specify these equalities to Lean. We also try to design an algorithm to possibly derive new definitional equalities from existing ones, by both general principles (e.g. transitivity and congruence) and possibly also domain-specific equality derivation rules that can also be specified by users. We will then begin the Implementation of our plan, at first possibly implementing some kind of "extensionality tactic" that causes a user-specified definitional equality to take effect within the scope of a tactic block. We will also consider how to make such equalities operate on a more global scale (e.g. with namespace scope, and within term mode proofs). Another important topic we will likely have to discuss is efficiency, namely how to make sure that the mechanism for checking for the existence of a user-defined definitional equality between two terms does not have too much additional runtime cost in the common cases of elaboration. While implementing this tooling, we will also construct test cases to cover the various ways in which we may want to use extensionality.

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

Main expected results and their contribution to the progress towards the Action objectives (https://europroofnet.github.io/objectives/) and deliverables (https://europroofnet.github.io/deliverables/).

Working groups to which this mission contributes:

(max.500 words)

Expected output: An integration of Lean4Less with the Lean elaborator that enables user-extensible extensional reasoning in Lean.

Research Coordination Objectives:

This STSM is in support of WG1: Tools on Proof Systems Interoperability (translating Lean to Dedukti), WG4: Libraries of Formal Proofs (exporting Lean’s mathlib to other proof assistants), and WG6: Type Theory (implementing a practical ETT to ITT translation)

1. Express new proof systems in the Dedukti logical framework.

3. Make techniques for program verification more effective and more accessible to all stakeholders.

Capacity Building Objectives:

1. Bring together members of the different communities working on proofs in Europe.

3. Create an excellent and inclusive network of researchers in Europe with lasting collaboration beyond the lifetime of the Action

Deliverables:

D13. Extension of the database and associated tools to other systems like Agda, Minlog, PVS, Lean, Mizar, Atelier B, TLAPS