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

Action number: CA20111

Applicant name: Pierre Boutry

Details of the STSM

Title: Formal verification of rule-based geometry

Start and end date: 08/06/2025 to 13/06/2025

Detail of the cost in EUROS:

- Transport (upload screen capture): 169 euros of plane tickets but there should be some additional cost to reach the airport in Frankfurt (there is no direct flight from Strasbourg and the dates for flights from Basel, Karlsruhe or Stuttgart are not suitable) and to go from Belgrade's airport to the hotel

- Hotel/day (upload screen capture): 360 euros

- Food/day: 40 euros per day

TOTAL: 749 without the extra transport cost

Goals of the STSM

Purpose and summary of the STSM.

(max.200 word)

The purpose of this research visit is to work towards the formalization of common geometric lemmas used as axioms within rule-based geometric theorem provers (like GCProver [1]) and geometric construction solvers (like ArgoTriCS [2]). This is extremely important since an inconsistent set of rules can lead to unexpected behaviour of a system.

Proving the correctness is to be carried within Coq, by proving each of lemmas from the Tarski's axioms for Euclidean geometry.

This is a follow-up of the work initiated during meeting "Rule based automated provers for geometry", organized within EuroProofNet action.

[1] Marinković, V., Šukilović, T., Novaković, V, Marić F. Readable automated proofs of ruler and compass constructions. *Annals of Mathematics and Artificial Intelligence* (2025)

[2] Marinković, V.: ArgoTriCS - automated triangle construction solver. *Journal of Experimental & Theoretical Artificial Intelligence* 29(2), 247–271 (2017)

Working Plan

COST Association AISBL
Avenue du Boulevard – Bolwerklaan 21 | 1210 Brussels, Belgium
T +32 (0)2 533 3800 | office@cost.eu | www.cost.eu

Funded by the European Union

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

(max.500 word)

We will work on formally proving of the set of geometric lemmas using GeoCoq. This way we will obtain correctness proofs in Coq and would have guarantees that proofs and constructions that rely on this geometric knowledge are correct.

We plan to experiment with different set of rules, used by different geometry tools: one used by ArgoTriCS and another one used within Deductive Database method. Depending on the results we could start working extending these tools to produce a trace allowing to construct a Coq proof.

If there is time left, we plan to start working on manual port to IsaGeoCoq. Having an example of a development completed in two proof assistants by the same person will allow to get a better understanding of how to automate a translation from Coq to Isabelle.

This research visit will allow me to collaborate directly with the members of Automated Reasoning group (https://argo.matf.bg.ac.rs/) based at the University of Belgrade, which is directly engaged into automation and formalization of geometry knowledge. I will also use this opportunity to communicate and exchange research ideas with them and to present my current work at their seminar.

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)

Obtaining constructions and proving their correctness is currently based on the set of common geometry lemmas, considered as axioms and their correctness is taken for granted. This visit would enable a signification contribution to the ArgoTriCS and GCProver solvers by enabling them to export verifiable solutions. This would directly contribute to the objective 2 and deliverable D11 of the Action.

If the first steps towards manual port of GeoCoq to IsaGeoCoq were conducted, it would contribute to the general objective of this COST action which is to improve interoperability between proof assistants.