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

Action number:

Applicant name:

Details of the STSM

Title: **Sabanci** University Coq Workshop and Research Visit

Start and end date: 01/09/2022 to 10/09/2022

Goals of the STSM

Emilio J. Gallego Arias, the visiting researcher, is an Inria researcher at Paris, whose main expertise domain is interactive theorem proving; he is a core member of the Coq development team.

Suha Mutluergil, the host, is an lecturer at Sabanci University, whose main expertise domain is software verification and validation, concurrency theory, and linearizability.

Suha and Emilio meet at the Institute of Fundamental Research in Computer Science in Paris (IRIF) when Suha was employed there; and had discussed this plan before but COVID did interrupt it.

We hope to resume our discussion, and thus we propose this short-term visit with two goals in mind:

a) to explore possibilities of interaction between the verification and theorem proving community, for example, in the form of verification tools producing certificates, or formally verifying particular complex analysis;

b) to teach an introductory course on interactive theorem proving targeted to mathematicians and computer scientists in Istanbul / Turkey, targeted to people with no previous expertise levels, and also open to students.

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.

Work Plan

The visit will last for 10 days, from September 1st 2022 to September 10th 2022. The work plan is also structured in two parts, following the goals:

- **Sep. 1st to 3rd: Research discussion:**
  We will discuss how verification techniques can profit from theorem proving and vice-versa. We hope to structure the discussion along 3 axes:
  - identifying areas of the verification toolchain that could benefit from formal verification / mechanization,
  - understanding feasibility of encoding the certificates produced by verification tools into standard proof calculus such as lambda-pi or the Calculus of Inductive Constructions,
  - understanding what are the possibilities that the greater expressiveness of proof calculus can open for verification tools, in the sense of richer certificates, or semi-automatic checkable ones.
- **Sep. 5th to 8rd: Course "Introduction to Interactive Verification with the Coq Proof Assistant"**

  The core week of the visit will be devoted to an introductory course on interactive verification using the Coq Proof Assistant as a core tool. The course targets people with general knowledge of CS, but no previous knowledge of Coq.

  The course will be hosted using the jsCoq tool, which allows for literate-style interactive slides and books, and only requires a browser, thus lowering the participation barrier greatly. We will use an extended version suited for courses, already in beta testing with core Coq teaching material such as Software Foundations.

  A preliminary syllabus of the course is:
  - day 1: introduction to type theory and foundations
  - day 2: functional programming in Gallina
  - day 3: basic tactics and proof strategies for software: lists, inductives, numbers
  - day 4: basic tactics and proof strategies for mathematics: groups, matrices, sets
  - day 5: 1 hour "perspectives" seminar

  Each day will have interactive slides and exercises, that students can complete. We will provide a forum for exercise discussion.
- **Sep. 9th: Wrap up.**

  We will reserve the last day of the visit to gather course feedback and questions, and to lay out a plan for potential future collaborations related to goal a).
- **Sep. 10th: Return to Paris**

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

We expect to contribute progress to the objectives of the COST action at several levels, in particular to the capacity building objectives:

- We expect to significantly contribute to point 4 "Ease access to formal verification techniques in education and other areas of science." In particular, we hope this course serves as a blueprint for future similar courses. We will record the classes and publish the material, which can be reused and adapted by other researchers.

  We also hope to improve the tooling significantly with occasion of this course. Moreover, our tooling is not specific to Coq, but should be usable (and it is our hope) by other proof systems that are implemented in OCaml.

- We also hope to contribute to point 3 "Create an excellent and inclusive network of researchers in Europe with lasting collaboration beyond the lifetime of the Action." , as many researchers that will participate in the course have long expressed a great interest in getting acquitted with interactive theorem proving.

- It seems to us that point 5 "Actively support young researchers, the under-represented gender, and teams from regions with less capacity." is relevant to our visit too; it seems that while Turkey has very strong researchers in CS, it lacks specialists in the ITP sub-field. Moreover, VISA and money change issues makes hard for Turkish students to attend schools organized in some European countries.

In terms of research coordination, we hope the visit contributes to the start of work on point 2 "Promote the output of detailed, checkable proofs from automated theorem provers" between the visiting researcher and the host.