

Short-Term Scientific Mission Grant - APPLICATION FORM¹ -

Action number: CA20111

Applicant name: Thorsten Altenkirch

Details of the STSM

Title: Concurrency in cubical type theory

Start and end date: 01/09/2024 to 07/09/2024

Goals of the STSM

Purpose and summary of the STSM.

(max.200 word)

Cubical type theory and Cubical Agda have proven very useful for giving computational meaning to homotopy type theory and univalent foundations. This STSM focusses on using features of cubical agda and Homotopy Type Theory in general to reasoning about concurrency.

Concurrency is an important area where we want to apply formal verification since it is often impossible to effectively test proeprties and indeed many real world systems are concurrent and probabilistic. Existing formal approaches on concurrency are often focussed on labelled transition systems and various notions of bisimilarity. We want to see whether tools from Homotopy Type Theory like vanilla coinductive types, higher inductive types and proof relevant equality can be used to provide alternative and mathematically more modular approaches. We also will investigate whether novel concepts like Higher Coinductive Types could be relevant for this area.

Working Plan

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

Realistically within a one week STSM we can only hope to make first steps towards this goal. We will focus on recasting existing work on big step concurrency in the framework of cubical agda and sketch out further research goals: in particular investigate the design of concurrent specifications using big step semantics and coinductive techniques. We will investigate the following questions:

- How to formulate coinductive bigstep semantics in cubical agda
- Identify a number of key examples and verification problems
- How can we handle probabilistic systems
- What is the categorical perspective?

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.

- Are proof relevant equalities useful here?

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.

(max. 500 words)

This STSM will contribute to the objectives of WG6 (Type Theory). In particular we hope that we can identify practical relevant applications of Homotopy Type Theory and its cubical incarnation. We hope that this provides also a useful input for researchers working in more traditional systems by providing a high level semantics to follow in this sense it contributes to Objective 3 (Make techniques for program verification more effective and more accessible to all stakeholders).

Our work contributes towards the following Research Coordination Objectives: writing a library of examples, fixing current obstacles that arise when working with coinductive types, and making sure these are better supported, falls under Objective 3 (Make techniques for program verification more effective and more accessible to all stakeholders); work towards reducing the use of coinduction to a core principle falls under Objective 7 (Develop a modular theory of type theories).