

Report on the outcomes of a Short-Term Scientific Mission¹

Action number: CA20111 - European Research Network on Formal Proofs

Grantee name: Vikraman Choudhury

Details of the STSM

Title: Modern algebraic perspectives on dualities and control effects

Start and end date: 03/03/2025 to 09/03/2025

Description of the work carried out during the STSM

Description of the activities carried out during the STSM. Any deviations from the initial working plan shall also be described in this section.

(max. 500 words)

We worked on the connection between continuation monads, substitution algebras, and inception algebras, which is the first research question mentioned in the original proposal. Since the mission timeline was limited to one week instead of a month, we chose to focus on one aspect only. The discussions happened in the Computer Laboratory in Cambridge, with Gregor, Vikraman, and Marcelo, and we worked together on a whiteboard to sketch some ideas and do some concrete calculations.

Description of the STSM main achievements and planned follow-up activities

Description and assessment of whether the STSM achieved its planned goals and expected outcomes, including specific contribution to Action objective and deliverables, or publications resulting from the STSM. Agreed plans for future follow-up collaborations shall also be described in this section.

(max. 500 words)

The discussions during this week provide a scaffold for a continuing collaboration, as it led to important technical outcomes.

1. We revisited existing work on substitution algebras and control effects [1], and its

¹ This report is submitted by the grantee to the Action MC for approval and for claiming payment of the awarded grant. The Grant Awarding Coordinator coordinates the evaluation of this report on behalf of the Action MC and instructs the GH for payment of the Grant.

generalisation to inception algebras in a talk by Marcelo [2], and tried to understand the abstract categorical structure behind them. From this understanding, we have sketched a formal calculus for substitution and inception algebras, by extending fine-grain call-by-value.

2. Using the categorical structure obtained by studying the free substitution and inception algebra monads, and the continuation monad, we were able to produce a CPS translation of this calculus which gives an explicit representation of the lambda-term encoding the stack of continuations. From this, we have started sketching an abstract machine (CK/CEK) showing the evaluation of terms in this calculus. We are continuing to work on this machine, and prove some properties connecting the operational semantics to the denotational semantics obtained from the categorical structure.

We have started writing up the results we have so far in a draft, as well as formalising the syntax and reductions of the abstract machine in a proof assistant (Agda). We are tentatively planning to submit this work to an upcoming conference in programming languages.



M. Fiore