EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

Report on the outcomes of a Short-Term Scientific Mission[1]

Action number: CA20111

Grantee name: (Matthew) Chase Ford

Details of the STSM

Title: **Algorithmic foundations of graded coalgebraic semantics**

Start and end date: 23/03/2025 to 29/03/2025

Description of the work carried out during the STSM

The grantee engaged in roundtable discussions with the host (Prof.dr. Lutz Schröder) and other members of the host institute: from most to least amount of time spent, these include Thorsten Wißmann, Stefan Milius, and Henning Urbat. The bulk of the time (approximately four afternoons) was spent in dedicated chalkboard sessions towards the primary goals of this STSM (in presence: Shröder, Wißmann, and Milius). These discussions culminated in the main achievements described below.

The grantee additionally led a discussion on the development of algebraic theories over nominal sets with Wißmann, Milius and Urbat (approximately one afternoon). This development will play a central role in a prospective extension of our minimization framework (still under development) to one that additionally supports the minimization of nominal systems.

This is in accordance with the proposed working plan apart from one minor deviation: a previously anticipated session with Paul Wild and Jonas Forster on behavioural metrics was not possible due to a scheduling clash.

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

The primary goal of this STSM was to begin the development of a framework for coalgebraic minimization modulo graded behavioural equivalence. After revisiting existing techniques for coalgebraic minimization (restricted to

[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.

coalgebraic behavioural equivalence), we identified the importance of the final chain construction which is notably lacking for graded semantics. Drawing insights from our (existing) pre-determinization construction, we were led to a novel notion of 'coalgebra for a graded monad'. This is essentially a dialgebra for the 0- and 1-part of the graded monad. From this, we were able to extract a naïve notion of homomorphism between such structures with induced behavioural equivalence strictly coarser than graded behavioural equivalence. We identified a suitable refinement on these homomorphisms to ensure that they preserve and reflect graded behavioural equivalence. In short, we made progress on a fresh perspective on graded semantics which is closer in spirit to classical coalgebra. We will pursue this idea further with the aim of employing partition refinement techniques in a framework for minimization under graded semantics. We did not make progress on our secondary objective.

The STSM contributed to Capacity Building Objective 1 and 5 by providing the grantee an opportunity to connect with the host institute and, consequently, an opportunity for academic growth and knowledge acquisition. We find the technical outcomes of this STSM to be a promising first step towards our primary objective. As such, we have agreed to continue the development of our findings (contributing to Capacity Building Objective 3) and, ultimately, to report them in a paper (contributing to Capacity Building Object 8).

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