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

Action number: CA20111

Grantee name: Natalia Slusarz

Details of the STSM

Title: Using Coq to formalise differentiable logics for neural networks

Start and end date: 17/09/2023 to 23/09/2023

Description of the work carried out during the STSM

(max. 500 words)

As planned, we have worked on formalisation of differentiable logics [1] for machine learning in Coq using its MathComp library. During the STSM we have built upon the work that we have produced so far, managing to formalise the majority of the syntax present in the paper as well as several proofs, providing us with a great base to proceed with further work which will be descried in more detail in the next section of this form.

Thanks to the STSM we were able to progress at a much higher pace working together in person rather then relying on remote communication. We used the time of STSM as an opportunity to work much more intensively on this project, taking full advantage of multiple members being able to discuss all related issues quickly and at short notice.

[1] N. Ślusarz, E. Komendantskaya, M. L. Daggitt i R. Stewart, „Differentiable Logics for Neural Network Training and Verification," in International Workshop on Numerical Software Verification, Workshop on Formal Methods for ML-Enabled Autonomous Systems, 2022.

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.

[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.

(max. 500 words)

We have achieved the planned goal of establishing a common ground between formalisation and machine learning part of the collaboration. This has allowed us to finish the work on the base of the planned formalisation which will now involve applying several brand new additions to the MathComp library to the use-cases that are several theorems present in [1]. From a technical standpoint we have more than achieved the proposed goals. As planned we have finished the formalisation of the syntax and semantics of differentiable logics and have started our work on some of its properties. Our current plans for the future involve moving on to more complex properties which are appealing from both a machine learning standpoint and to the theorem proving community as they will require several of actively developed recent libraries in Coq.

This visit has allowed us to establish a close working relationship between Heriot-Watt and ITU and, furthermore, deepen the understanding between proof theory and machine learning communities. We have managed to usefully use Coq, together with some of its libraries, to formalise very recent machine learning research.

We fully intend to continue this collaboration with regular online meetings.

[1] N. Ślusarz, E. Komendantskaya, M. L. Daggitt i R. Stewart, „Differentiable Logics for Neural Network Training and Verification," in International Workshop on Numerical Software Verification, Workshop on Formal Methods for ML-Enabled Autonomous Systems, 2022.