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

Action number: CA20111

Grantee name: Paola Giannini

Details of the STSM

Title: Using behavioural types for automatic validation of distributed systems

Start and end date: 19/09/2022 to 30/09/2022

Description of the work carried out during the STSM

At the beginning of her STSM Paola Giannini gave 2 seminars on her ongoing work in the area of Global Types:

- "Global Types for Asynchronous Multiparty Sessions", related to [5], and
- "Multiparty-session-types Coordination for Core Erlang", related to [6], and

Laura Castro gave a seminar on

- "Property-Based testing of Erlang Systems", related to [4]

We explored two possible paths in this area.

On one side we think we can use session types to drive the property based testing, by generating, from these types, patterns of calls respecting the flow of interactions. This should provide a better property testing for Erlang processes.

On the other we started defining a formalism for session types based on finite state automata, since, by adapting the examples of [3] to a style of programming closer to the one adopted in the Erlang community, we found out that the gap between formalism used in the mentioned paper and this style of programming was too big. In particular, the use of the OPT library `gen_server`, instead if the primitives `send` and `receive` leads to formalize the interaction in a style closer to finite state automata than to classical session types.

We also discussed the possibility of adapting some early work of Paola Giannini in the area of dead-code elimination in functional languages, see [1] and [2], to some recent work of Laura Castro in the context of Erlang, see [3]. Specifically, the work presented in [3] follows a *no false positives* best effort design philosophy. By formalizing it using refinement types, we can prove that removing the oxbow code does indeed preserve the semantics of the program, and thus it is absolutely safe

[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.

to use in production projects.

References:

[1] Ferruccio Damiani, Paola Giannini: Automatic useless-code elimination for HOT functional programs. J. Funct. Program. 10(6): 509-559 (2000)
[2] Stefano Berardi, Mario Coppo, Ferruccio Damiani, Paola Giannini: Type-Based Useless-Code Elimination for Functional Programs. SAIG 2000: 172-189
[3] Fernando Benavides Rodríguez, Laura M. Castro: Detecting oxbow code in Erlang codebases with the highest degree of certainty. Erlang Workshop 2021: 28-40
[4] Ammar Boucherit, Laura M. Castro, Osman Hasan, Abdallah Khababa: Towards a hybrid formal analysis technique for safety-critical software architectures. Int. J. Crit. Comput. Based Syst. 10(2): 95-119 (2021)
[5] Francesco Dagnino, Paola Giannini, Mariangiola Dezani-Ciancaglini: Deconfined Global Types for Asynchronous Sessions. COORDINATION 2021: 41-60
[6] Lavinia Egidi, Paola Giannini, Lorenzo Ventura: Multiparty-session-types Coordination for Core Erlang. ICSOFT 2022: 532-541

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

The collaboration started by the current STSM was very fruitful. From the side of the applicant, to see and understand the use of Erlang, and in general actor languages, in the context of a "real" application, is very useful to give perspective to the theoretical work. From the host side, to familiarize with the type-directed formal techniques related to both expressing interaction, and other properties, as the mentioned dead code elimination, will provide motivations for exploring the use of proof assistants in the "real" world.
We started collaborating on a technical report, which should formalize the proof of the paper in [3] and should include some of the ideas about session types previously mentioned. However, due to the short time, we could not produce an actual paper.
We are planning of continuing the collaborations, if possible also with the involvement of some student, as well as future visits, possibly in the context of an ERASMUS agreement between our institutions.