Short-Term Scientific Mission Grant
- APPLICATION FORM[1] -

Action number: COST Action CA20111 EuroProofNet

Applicant name: Riccardo Treglia

Details of the STSM

Title: Liquid Monadic Intersection Types

Start and end date: 21/05/2023 to 31/05/2023

Goals of the STSM

Purpose and summary of the STSM.

The first aim of this STSM is to obtain a type system combining refinement types and the expressiveness of intersection type discipline, for a generic monadic calculus (i.e. a lambda calculus where the monad functor is a parameter and effectful operations are generic) following the monadic approach already investigated by the applicant.

Refinement types state complex program invariants, by augmenting type systems with logical predicates. One idea behind the use of such type systems is to perform type-checking using SMTs (Satisfiability Modulo Theories) solvers. Liquid Types present a system capable of automatically inferring refinement types. The use of intersections in conjunction with refinement types is motivated by a problem clearly identified for Liquid Types: the absence of most-general types, as in the ML tradition.

Besides the new type system, the second, and main, contribution of the STSM is a new type-inference algorithm for Liquid Monadic Intersection Types, extending the one already obtained for liquid intersection types, by means of the monad functor to instantiate on occasion. Finally, shape a tool implementing such an algorithm.

Working Plan

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

The first step of the working plan is to consider an extension of the computational core [1], a computational lambda calculus deeply connected to the original Moggi's one, with generic algebraic operators in order to capture effects involving additional runtime structures with which programs interact to.

[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.

Once this application is accepted, work with Mario Florido will begin remotely: the purpose is to reach the mission period already with an extension of the computational core that includes generic algebraic operations and a liquid intersection type assignment system for this calculus. The system should enjoy subject reduction property.

Once this design moment is assessed, the system should be such that any derivation in this undecidable system has a counterpart in a fixed decidable one.

Here we come to the real goal of the mission, which is to define a type inference algorithm for this decidable system. Such an algorithm has not to be designed from scratch but as an extension of the one that already appeared in [2]. The variation lies in considering a monadic calculus and a type system, in which the functor of the monad is given as a parameter. Once one intends, however, to instantiate the calculus with precise effects, and thus the particular monad to be taken into account, one must be able to easily recast the algorithm. Finally, we should be able to prove that our algorithm is sound with respect to the conceived typing rules.

The last question is whether, once the theoretical work has been defined, it will be possible to extend the specific tool in [2] to obtain a prototype resulting in the implementation of the theoretical work carried out.

[1] Ugo de'Liguoro, Riccardo Treglia:

The untyped computational λ-calculus and its intersection type discipline. Theor. Comput. Sci. 846: 141-159 (2020).

[2] Mário Pereira, Sandra Alves, Mário Florido:

Liquid Intersection Types. ITRS (2014).

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.

This STSM clearly contributes to WG3 – Program Verification, precisely matches D6-Output 4.

In fact, the main expected result is a type-inference algorithm to assign a type to each expression that occurs in an effectful program. The process of type inference is a common and crucial feature of most modern functional programming languages, since it allows to check if a program is well-typed without requiring the programmer to supply (almost or none) any type annotations.
*Remarkably, what is investigating during this mission is the possibility to have an algorithm, and hence an experimental **tool**, to infer the type of an effectful program, hence performing a statical analysis of the program (i.e. without running it).*

Finally, this STSM involves the integration of Mário Florido into Working Group 3, as called for in the conclusions of the Timisoara meeting 'Invite other participants in the action to contribute to D5 and D6'.