TECHNISCHE UNIVERSITÄT DRESDEN

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Fakultät Informatik Institut für Technische Informatik, Professur Compilerbau

Task Description for Bachelor Thesis

for: **Marcus Rossel**

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Title: **Provable Determinism in Reactors**

The model of Reactors [1] is a novel Model of Computation developed in collaboration between multiple institutions, including the Chair for Compiler Construction. In the model, applications are divided into reactors with individual reactions which specify semantics in a distributed fashion. A central aspect of the model are its time semantics with two distinct timelines [2].

While we claim Reactors to be deterministic [1] under certain conditions, we have not formally proved this. In fact, the formulation of [1] has multiple aspects of the formalization that are imprecise.

The goal of this thesis is to fill the existing gap in the formalization and proof of determinism in the Reactors model. We plan to use the Lean theorem prover, a proof assistant based on the Calculus of Constructions and developed by Microsoft Research. Lean has an open, welcoming community and an ambition project, Mathlib, which aims to formalize most of modern mathematics. As such, it is a great environment for formalizing a proof of determinism for Reactors. Since the Reactors model is complex and in constant evolution, this thesis will focus on a core of the model to prove determism.

In particular, this Bachelor Thesis shall include the following tasks. The student shall:

1. Learn and understand the Reactors model. Learn and understand the Lean language and how to use the theorem prover.
2. Formalize a core model of Reactors in Lean, adapting and filling the imprecise aspects of the original formalization.
3. Prove the model is deterministic for acyclic reaction graphs and without physical actions.
4. Optional: extend the core model formalized and/or relax some of the assumptions and prove determinism in this more general setting.
5. Optional: investigate under which conditions determinism holds also for (logical) timings in the model, not only for the values resulting from channels.

[1] Lohstroh, Marten, et al. "Reactors: A deterministic model for composable reactive systems." Cyber Physical Systems. Model-Based Design. Springer, Cham, 2019. 59-85.

[2] Lohstroh, Marten, et al. "A Language for Deterministic Coordination Across Multiple Timelines." 2020 Forum for Specification and Design Languages (FDL). IEEE, 2020.