The Challenge of Typed Expressiveness in Concurrency

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Abstract. The expressiveness of models of concurrency has long intrigued researchers. In particular, studies on the expressiveness of process calculi (such as the π-calculus) have had considerable impact. Now, process models are increasingly being developed with *behavioral type systems* that discipline the behavior of processes. This raises, once again, the issue of their expressiveness, now with an additional dimensions (i.e., types and logic) playing an explicit role. In this talk, I will first motivate the general open problem of *typed expressiveness* in concurrency. Then, I will discuss an expressiveness study in which we formally compare the expressiveness of the π-calculus coupled with behavioral type systems.

The *expressiveness* of models of concurrency has intrigued researchers for a number of years now. In particular, studies on the expressiveness of *process calculi* (such as CCS and the π-calculus) have had considerable impact. The interest is in questions such as, e.g., under what conditions two process languages $\mathcal{L}_1$ and $\mathcal{L}_2$ can express the same (concurrent) behaviors? It is fair to say that formal answers to such questions are (still) quite relevant in concurrency theory at large.

Now, many process calculi have been equipped with so-called *behavioral type systems*, which discipline the behavior of processes. There is an intimate connection between these type systems for concurrency and substructural logics, in particular Girard's linear logic. Most remarkably, the *Curry-Howard correspondence for concurrency* connects, on the one hand, linear logic propositions and, on the other hand, session types for message-passing processes in the π-calculus [1,4].

These developments raise, once again, the issue of expressiveness, now with additional dimensions (i.e., types and logic) playing an explicit role. We would like to know when is that two typed process languages $\mathcal{T}_1$ and $\mathcal{T}_2$ express the same behaviors, but also how their behavioral type systems induce expressiveness relations. Moreover, it would be interesting to establish whether an analogue to Barendregt's λ-cube can relate their type systems. Ultimately, we would like to determine what classes of message-passing programs can be analyzed with the many typed process calculi proposed thus far.

In the proposed talk, I will first motivate and discuss the general open challenge of *typed expressiveness* in concurrency theory, following the position paper [3]. Then I will discuss the expressiveness study in [2], in which we formally compare the expressiveness of the π-calculus coupled with behavioral types systems, using the Curry-Howard correspondence for concurrency as a yardstick.

References

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