Token Machines for Multiport Interaction Combinators

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Game semantics [7, 1] and the Geometry of Interaction [6] are semantic frameworks centered around the dynamic, interactive behaviour of the interpreted object rather than on its static, extensional properties. The obtained semantics is often fully abstract, and its concreteness can be exploited in the definition of compilation schemes towards low-level languages, like in the Geometry of Synthesis [5].

Most game semantics models are defined as to reflect the behaviour of sequential languages—the classic notion of a strategy is after all deterministic and sequential. The interest around concurrent forms of game semantics is not at all new, however. Concurrency has been incepted into games both at the level of the interpreting object (e.g. [2, 13, 3]), and at the level of the interpreted object (e.g. [11]).

In the Geometry of Interaction, on the other hand, the way towards concurrency has been explored less extensively. If one looks at the most concrete incarnation of GoI, namely the so-called token-machines [4], there is however a very natural way to go parallel, namely considering machines whose internal state consists of possibly many tokens rather than just one [14, 9, 10]. If the interpreted language is sequential and deterministic, however, there is no way the various tokens could interact, and parallelism is then vacuous. If one injects a primitive for synchronization in the underlying calculus, on the other hand, multiple tokens become a necessity, and the model becomes adequate for quantum computation [9].

The authors are currently engaged in defining and studying a Geometry of Interaction model for multiport interaction combinators [12], a concurrent extensions of Lafont’s interaction combinators [8]. The talk will be about this ongoing work.

Multiport Interaction Combinators Interaction combinators are a specific system of interaction nets in which cells are of three types, called γ, δ, and ε cells. The distinctive feature of interaction combinators is their universality: any other interaction net system can be encoded into interaction combinators (ICs) in a faithful way [8]. The geometry of interaction combinators is very simple and has nice properties, e.g., reduction turns a net into another having an equivalent GoI. As described in Mazza’s thesis [12], the most satisfactory way of generalizing interaction nets to a framework capable of modeling concurrent computation consists of introducing multiport cells. Even in presence of multiports, noticeably, one can get universality by way of a system of combinators, the so-called multiport interaction combinators (MICs), which are actually mild variations of ICs in which δ cells can have more than one principal port.

Multitoken Machines for MICs Contrarily to ICs, giving a Geometry of Interaction model for MICs is quite challenging. The usual idea, which consists in seeing cells as stack transducers, does not seem to work. Indeed, the same multiport cell can behave very differently when interacting through either of its principal ports: this is after all the way nondeterminism is captured by MICs. It is thus necessary to instrument token machines so as to be able to handle this nondeterministic pairing mechanism. And in turn, this requires multiple tokens, since the discovery process underlying pairing cannot be done sequentially. We are currently working on soundness and adequacy proofs, on which we will report at the end of the talk.

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References


