Abstract

Game semantics is an interactive denotational semantics: a denotation specifies the behaviour of a term/proof with respect to its environment. As such it is one of the most intensional model available in the Curry-Howard community. Despite their intensional perspective, game models still omit a number of computational information such as witnesses in first-order logic or resource consumption in programs. In this thesis we present a general framework for enriching causal concurrent games models with annotations able to reflect these pieces of information. These annotations can be of various nature, in particular our enrichment is parametrised over any multi-sorted equational theory and can also reflect structure upon it such as a partial order.

In our model, annotations on strategies can be viewed as side-computations: the information they reflect is modified throughout interactions but does not affect the general flow of control. From a semantics point of view, this construction is motivated by exploring the expressiveness of concurrent games models in a Curry-Howard correspondence perspective; as test-cases we address two semantic problems from both logic and programming languages:

1. On the logic side, our annotated games model specialised to first-order terms enables us to give a novel interpretation of first-order classical proofs as concurrent strategies carrying first-order witnesses. In particular, this answer the question of giving a compositional version to Herbrand’s theorem while avoiding the usual proof sequentialization of other denotational approaches.

2. On the programming language side, annotations on games offer intrinsic quantitative models. We show that those can be used to provide denotational semantics for resource consumption analysis of concurrent higher order programming language with shared memory.

These enrichments, strongly connected to the causal structure of concurrent games, give an argument in favor of a causal and event-base meaning of computations.