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Initiality for typed syntax and semantics.

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Summary: We give an algebraic characterization of the syntax and semantics of a class of simply-typed languages, such as the language PCF: we characterize simply-typed binding syntax equipped with reduction rules via a universal property, namely as the initial object of some category. For this purpose, we employ techniques developed in two previous works: in [2], we model syntactic translations between languages over different sets of types as initial morphisms in a category of models. In [1], we characterize untyped syntax with reduction rules as initial object in a category of models. In the present work, we show that those techniques are modular enough to be combined: we thus characterize simply-typed syntax with reduction rules as initial object in a category. The universal property yields an operator which allows to specify translations – that are semantically faithful by construction – between languages over possibly different sets of types. We specify a language by a 2-signature, that is, a signature on two levels: the syntactic level specifies the types and terms of the language, and associates a type to each term. The semantic level specifies, through inequations, reduction rules on the terms of the language. To any given 2-signature we associate a category of models. We prove that this category has an initial object, which integrates the types and terms freely generated by the 2-signature, and the reduction relation on those terms generated by the given inequations. We call this object the (programming) language generated by the 2-signature.

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