

Do-it-yourself Module Systems

Extending Dependently-Typed Languages to Implement Module System Features In The Core Language

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April 6, 2020

PHD THESIS

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Abstract

Structuring-mechanisms, such as Java’s `package` and Haskell’s `module`, are often afterthought secondary citizens whose primary purpose is to act as namespace delimiters, while relatively more effort is given to their abstraction encapsulation counterparts, e.g., Java’s classes and Haskell’s typeclasses. A *dependently-typed language* (DTL) is a typed language where we can write *types* that depend on *terms*; thereby blurring conventional distinctions between a variety of concepts. In contrast, languages with non-dependent type systems tend to distinguish *external vs. internal* structuring-mechanisms —as in Java’s `package` for namespacing vs. `class` for abstraction encapsulation— with more dedicated attention and power for the internal case —as it is expressible within the type theory.

To our knowledge, relatively few languages —such as Ocaml, Maude, and the B Method— allow for the manipulation of external structuring-mechanisms as they do for internal ones. Sufficiently expressive type systems, such as those of dependently typed languages, allow for the internalisation of many concepts thereby conflating a number of traditional programming notions. Since DTLs permit types that depend on terms, the types may require non-trivial term calculation in order to be determined. Languages without such expressive type systems necessitate certain constraints on its constructs according to their intended usage. It is not clear whether such constraints have been brought to more expressive languages out of necessity or out of convention. Hence we propose a systematic exploration of the structuring-mechanism design space for dependently typed languages to understand *what are the module systems for DTLs?*

First-class structuring-mechanisms have values and types of their own which need to be subject to manipulation by the user, so it is reasonable to consider manipulation combinators for them from the beginning. Such combinators would correspond to the many generic operations that one naturally wants to perform on structuring-mechanisms —e.g., combining them, hiding components, renaming components— some of which, in the external case, are impossible to perform in any DTL without resorting to third-party tools for pre-processing. Our aim is to provide a sound footing for systems of structuring-mechanisms so that structuring-mechanisms become another common feature in dependently typed languages. An important contribution of this work is an Agda implementation of our module combinators —which we hope to be accepted into a future release of the Agda standard library.

If anything, our aim is practical —to save developers from ad hoc copy-paste preprocessing hacks.

—Source: <https://github.com/alhassy/next-700-module-systems>—

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Chapter 1

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