POP Seminar

Abstraction Elimination for Kappa Calculus

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Abstract:

Languages based on typed lambda calculus are very pleasant to program in. Unfortunately the higher-order functions found in these languages are not appropriate for all situations. For example, higher-order functions are unavailable or prohibitively inefficient in reconfigurable hardware, the map/fold/scan operations of nested data parallelism, Kahn-McQueen dataflow networks, and on general-purpose graphics processors.

Kappa calculus [Lam74, Has95] is a first-order analogue of lambda calculus. Because it has no first-class functions, kappa calculus deprives the programmer of many useful abstraction mechanisms and idioms. I assert that much of this lost expressivity can be regained by programming in a two-level language using kappa calculus at level 1 (the object language) and lambda calculus at level 0 (the meta language).

In order to demonstrate this style of programming I have modified the GHC Haskell compiler, extending the parser and type inference routines with support for environment classifier types [TN03]. I have also added a "flattening" compiler pass which converts well-typed two-level expressions into one-level expressions which represent object language expressions in typed combinator form. These one-level expressions are passed on to the unmodified back end of the compiler.

The ability to perform abstraction elimination (also called combinator conversion) is essential to the flattening pass. In this talk I will present the set of combinators I have chosen, motivate the choice, describe the abstraction elimination algorithm, and show how the typed combinator set turns out to be a generalization of Haskell's "arrows".

{Lam74] J. Lambek, Functional Completeness of Cartesian Categories. Annals of Mathematical Logic 6 (1974) 259-292.

[Has95] M. Hasegawa, Decomposing Typed Lambda Calculus into a Couple of Categorical Programming Languages. Lecture Notes in Computer Science, volume 953.

[TN03] Walid Taha and Michael Florentin Nielsen, Environment Classifiers. POPL'03.

Host: Karl Crary

Appointments: Tracy Farbacher tracyf@cs.cmu.edu

Wednesday, November 9, 2011

Gates Hillman Center 9115

3:30 – 5:00 p.m.