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Retrofitting Implicit Modules for 1ML

Research Proposal

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- Background Information
- Motivation
- Research Objective
- Literature Review
- Methodology
- Anticipated Results

Ad hoc polymorphism

- Functions with the same name having different semantics depending on argument types.
- Such as `+` or `print`

Approaches

- *Type classes*, like in Haskell (Wadler and Blott [1989](#))
- *Implicits*, like in Scala (Oliveira et al. [2010](#))



ML language family

- ML, SML, OCaml, F#, many others
- Powerful type inference
- Advanced module system
- Applications: compiler development, static program analysis, automatic theorem proving, financial systems, web development

No ad hoc polymorphism!

- Need to use `+`, `+.` , `print_int`, `print_string`, etc.
- Undesirable verbosity

ML modules

- Two languages: core and module
- Module language is more powerful, built on dependent-type machinery (MacQueen [1986](#))
- Module language is verbose and difficult to integrate with core language

1ML

- Later research showed that dependent types are not actually needed (Rossberg et al. [2010](#))
- 1ML (Rossberg [2015](#)) is an experimental ML dialect in which core and module languages are united

- Extending ML with implicits is highly desirable by users
- However, it is not an easy task
- We limit ourselves to a simpler language
- However, because of some 1ML's design choices, we can achieve new results not currently possible in more mature ML languages
- Also this project can be viewed as test of expressiveness for 1ML

Research objective. Design implicit modules for 1ML.



Subgoals

- Reproduce all results already described for OCaml
- Improve completeness of these results by paying special attention to resolve order and unification
- Compare implementation with OCaml one

- Dreyer et al. [2007](#) — designing type classes for ML
 - Type classes require *canonicity*
 - In ML languages, canonicity is impossible to achieve
 - Without canonicity, authors impose rather severe restrictions
- White et al. [2015](#) — designing implicits for OCaml
 - Only prototype implementation, merging in OCaml is years away
 - Both practical and theoretical difficulties
 - Needs *higher-order unification*, which OCaml currently lacks

- Resolving of implicits must be done simultaneously with type inference
- Delaying resolve while it is possible
- Recursive search based on a set of type constraints
- Termination check
- Retrying ambiguous resolve with new information

- Implemented implicits for 1ML, as part of 1ML prototype compiler
- We test our implementation by comparing its strength against OCaml solution
- Our solution works in all cases where OCaml solution works
- There are cases (mostly related to order and retrying) where our solution works while OCaml solution does not
- We support *implicit functors*, which are listed By OCaml solution's authors as a natural future work
- Results related to unification

-  Dreyer, D., Harper, R., Chakravarty, M. M. T., & Keller, G. (2007). Modular type classes. In *Proceedings of the 34th annual acm sigplan-sigact symposium on principles of programming languages*, Nice, France, Association for Computing Machinery.
<https://doi.org/10.1145/1190216.1190229>
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<https://doi.org/10.1145/512644.512670>



Oliveira, B. C., Moors, A., & Odersky, M. (2010). Type classes as objects and implicits. In *Proceedings of the acm international conference on object oriented programming systems languages and applications*, Reno/Tahoe, Nevada, USA, Association for Computing Machinery. <https://doi.org/10.1145/1869459.1869489>



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Rossberg, A., Russo, C. V., & Dreyer, D. (2010). F-ing modules. In *Proceedings of the 5th acm sigplan workshop on types in language design and implementation*, Madrid, Spain, Association for Computing Machinery.
<https://doi.org/10.1145/1708016.1708028>



Wadler, P., & Blott, S. (1989). How to make ad-hoc polymorphism less ad hoc. In *Proceedings of the 16th acm sigplan-sigact symposium on principles of programming languages*, Austin, Texas, USA, Association for Computing Machinery.
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