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To the editor:

In the paper “A Simplified Account of Polymorphic References” (IPL v.51 pp.201–206) a proof of the soundness of type inference for a functional language combining polymorphism and references is presented. The main result is stated as follows:

Theorem If $\mu \vdash e \Rightarrow v, \mu', \lambda \vdash e : \tau, \mu : \lambda$, and λ is imperative, then there exists $\lambda' \supseteq \lambda$ such that $\mu' : \lambda'$, and $\lambda' \vdash v : \tau$.

The theorem establishes a type preservation property for evaluation that ensures that the result of a program may be ascribed the same type as the program itself. (A similar result was obtained by Tofte [3] using rather different techniques.)

The sense in which this theorem establishes soundness merits further clarification. This may be achieved by extending the evaluation relation with transitions of the form $\mu \vdash e \Rightarrow \mathbf{wrong}$, where \mathbf{wrong} is a distinguished ill-typed token representing a run-time error. For example, the following rule expresses that it is an error to attempt to apply a value other than a functional abstraction:

$$\frac{\mu \vdash e \Rightarrow v, \mu'}{\mu \vdash e e_1 \Rightarrow \mathbf{wrong}} \quad (v \neq \lambda x.e') \quad (\text{APP-WRONG})$$

The proof of the theorem may be extended to cover these additional rules, with the consequence that the final value of a well-typed expression cannot be \mathbf{wrong} since by design \mathbf{wrong} is ill-typed. The extension of the proof to account for \mathbf{wrong} transitions relies on a *canonical forms* lemma [1] characterizing the shapes of closed values of a type. In particular if v is a closed value of functional type, then v must be a

λ -abstraction. Consequently, the rule APP-WRONG cannot apply if the expression $e e_1$ is well-typed.

Since the proof of impossibility of **wrong** transitions is routine, an explicit treatment of them was omitted from the Tofte's and my own work. An alternative approach, advocated by Felleisen and Wright [4], is to work with single-step operational semantics. In this case the canonical forms lemma is used to establish that a well-typed program is either a value or can make progress by a single-step transition. By taking the informal notion "go wrong" to mean "unable to make progress", it follows that well-typed programs do not go wrong. This approach has the advantage that explicit transitions to **wrong** are not needed, but at the expense of requiring a separate progress lemma.

Sincerely,

Robert Harper
Associate Professor

1. Per Martin-Löf. *Intuitionistic Type Theory*. Bibliopolis, 1984.
2. Robin Milner. "A Theory of Type Polymorphism in Programming Languages". *Journal of Computer and System Sciences*, vol. 17, pp. 348–375, 1978.
3. Mads Tofte. "Type Inference for Polymorphic References". *Information and Computation*, vol. 89, pp. 1–34, November, 1990.
4. Andrew Wright and Matthias Felleisen. "A Syntactic Approach to Type Soundness". *Information and Computation*, vol. 115, no. 1, pp. 38–94, November, 1994.