DEPARTMENT OF COMPUTER SCIENCE
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Prof. dr hab. Piotr Biler

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Dear Prof. Biler,

Marek Materzok's PhD thesis lies in the general domain of programming and programming languages, and his specific interest and contributions lie in the control-flow aspects of programming, and how these aspects are reflected in principle, in theory, and in practice.

Materzok's PhD dissertation renders these aspects (principle, theory, and practice) in a pretty examplary way:

– Chapter 1 sets the stage. The key concepts (continuations, delimited continuations) are introduced, from their genesis to Materzok's specific contribution: the study of the delimited-control operators shift0 and reset0. This chapter is concluded with an outline of the rest of the dissertation. It is clear and informative.

– Chapter 2 formalizes Materzok's programming-language of discourse and its semantics. The language is the call-by-value lambda-calculus extended with control operators. The semantics are small-step and operational, taking the form of a reduction semantics and of an abstract machine. This chapter builds on the original control operators shift and reset to present the new control operators shift0 and reset0. It is clear and informative.

– Chapter 3 presents another formalization of Materzok's programming-language of discourse. This formalization is a type system with subtypes and effects. This chapter builds on the typing system of the original control operators shift and reset to present the typing system of the new control operators shift0 and reset0. It is clear and informative.

– Chapter 4 formalizes shift0 and reset0 in a denotational fashion with an encoding of Materzok's programming-language of discourse into the λ-calculus, the so-called CPS translation. This chapter builds on the CPS translation of the original control operators shift and reset to present the CPS translation of the new control operators shift0 and reset0. It is clear and informative.

– Chapter 5 presents an array of programming examples that illustrate the formalizations of the three previous chapters. It is extremely easy to give complicated and confusing examples of continuation-based programming. Materzok's examples stand

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out because they are neither complicated nor confusing: they methodically illustrate the various aspects of the control operators shift0 and reset0. To this end, Materzok's programming-language of discourse is mininally extended with standard constructs; I see no reason to doubt that both the previous chapters and the following chapters do not scale to these standard constructs. Making them scale up would more than triple the size of the overall dissertation, and so it was a wise choice to formalize a core language in Chapters 2, 3, 4, 6 and 7, and to opportunistically extend this language in Chapter 5.

– Chapter 6 relates the control operators shift0 and reset0 with the so-called CPS hierarchy, using the formalizations of Chapters 2, 3, and 4 and some of the examples of Chapter 5. It is clear and informative.

– Chapter 7 describes equational axiomatizations of the control operators shift0 and reset0 in relation to the corresponding CPS translations. It is clear and informative.

– Chapter 8 illustrates another facet of Materzok: that of a pretty fearless implementor. Making sensible choices (most notably the one of making continuations one-shot), Materzok describes a radically low-level implementation of shift0 and reset0, and illustrates it with one of the examples of Chapter 5 (fizz-buzz) and with lightweight threads. His implementation choices are well motivated, and I readily accept them: establishing the soundness of his implementation with respect to his semantics would be a daunting task at the level of another PhD thesis.

– Chapter 9 concludes and opens perspectives.

– The bibliographic references testify a global mastery of Materzok's research area.

– An appendix contains proofs that would have broken the flow of reading earlier in the dissertation.

Overall, I applaud the balance of this dissertation: Materzok demonstrates that his understanding is very well founded and he conveys a very clear understanding of all the computational aspects of the new delimited-control operators shift0 and reset0. In so doing, he demonstrates an array of separate skills: those of a programming-language designer; those of a semanticist; those of a type-theorist; those of a programmer; and those of an implementor. Each of these skills shines in each of the chapters of this dissertation, and many of these chapters have been published in international peer-reviewed scientific forums.

That said:

– In Chapter 1, I would have liked a more rigorously progressive introduction of the concepts. Right now, the dissertation reads well for a specialist, but clearly less so for an outsider. To this end, a glossary might help, but of course it would require a lot of work. What could also help is backpointers in the bibliographic references in the form of the page numbers where each bibliographic reference is cited.

– In Chapter 2, I would have liked a section describing the prerequisites assumed from the reader and the notations adopted by the author.

– In Chapter 5, I would have liked to see a mention of the lightweight threads of Chapter 8, for consistency. And in Chapter 8, I would have liked to see more of the examples from Chapter 5.
– I am missing a simple, illuminating example that constrasts shift and shift0. For example, during Dariusz Biernacki's PhD studies, we exhibited several simple programs that had a clear result using shift, and that had an equally clear, but radically different result using a similar-looking control operator proposed by someone else.

None of the criticisms above are damning, obviously. Also, in addition, in the course of my reading, I have naturally gathered a collection of observations that I have separately communicated to Materzok, asking him to address them in a lightweight editorial pass, and to get back to me afterwards to double check.

Overall, based on all of the points above, it is my assessment that Marek Materzok's work is at an excellent PhD level, and can be defended essentially as is. I have introduced several of the concepts that are investigated here (most notably shift and reset), and I have enjoyed reading this dissertation: it reports good work that breaks new ground.

Sincerely yours,

Olivier Danvy