Composing constraint solvers
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Staat de wereld dan stil? Broeien de draken dan geen draakjes meer uit in de foreesten van het Land van Logres? Berijden er dan geen belaagde jonkvrouwen meer witte palfroeten door diezelfde foreesten? Moet keiptevige ondeugd dan niet worden gefnuikt en zijn er geen interessante queste's meer te volbrengen?

Louis Couperus, in Het Zwevende Schaakbord.

This thesis describes my research in the four years that I had the privilege to be working at CWI, het Centrum voor Wiskunde en Informatica in Amsterdam. Soon after I started, I was told that doing research in computer science involves building your own castle. Since these words came from Kees Everaars, who is among the wisest of my CWI colleagues, I considered them with care, and concluded that it meant that first of all, some software had to be written.

The castle on the cover is drawn after Figure 3.1 on page 36, and depicts the software that I wrote to perform my experiments: my castle, OpenSolver. The creature sitting on top of Castle OpenSolver is a dragon. Instead of its more widespread use as a metaphor for the complexity of compiler design, the dragon illustrates that I have always thought of my PhD work as a personal quest: it is well known that in addition to castles, quests typically involve dangerous activities, such as conquering dragons. I like to think that I would have preferred to go on a real quest, build a real castle, and conquer a real dragon, but as is evident from the above quotation, dragons have become scarce long ago, so pursuing a PhD was the next best thing for me to do.

As things go on quests, I received help and friendship from many people on my way. At CWI, my colleagues from the group of Jan Rutten provided much of the social context of the work reported here. I was very lucky to have their everyday company, and I am particularly grateful to Kees Blom, Freek Burger, and Kees Everaars for help with technical issues. Dave Clarke played an important part (guitar, to be precise) in dragging me through the last months of writing up, and it was a great pleasure to share the office with Juan Guillen Scholten, who
often helped me to see matters of computer science, and life in general, in proper perspective.

During my time at CWI, three other PhD students were finishing a thesis in the area of constraints. They are Rosella Gennari, Sebastian Brand, and Willem Jan van Hoeve, and it was great to have them around for discussions on the subject, and to be able to follow their lead in going through the process of producing a PhD thesis. However, for some reason it seems to me that we spent more time together traveling to the CP conferences and CSCLP workshops than we did at CWI. No quest should be without faithful travel companions, and I want to thank them especially for their pleasant company on these occasions.

I am also very grateful to Eric Monfroy, Frédéric Goualard, and Laurent Granvilliers for discussions, advise, and software, and for facilitating a visit to Nantes in February 2004. While we have not met often, I have also greatly benefited from the few encouraging discussions I had with Maarten van Emden, and from his comments on an earlier version of Chapter 5.

Furthermore, I would like to thank everyone who has read parts, or even all of the material assembled in this thesis. Their comments have been of considerable influence on the quality of the final version.

Of course, none of this would have been possible without the support of my advisors, Krzysztof Apt and Farhad Arbab. I joined CWI only after a 4 year detour from the academic world, and I am most grateful for their confidence, encouragement, and advise. In particular, I want to thank Krzysztof for always looking after his student, even though most of the time we were separated by six or seven time zones, and Farhad for always being there to counter my skepticism with vision and optimism. And I thank both for letting me use the material of our joint papers.

Finally, before my story of knights, queens, and castles begins, I want to thank Rob for his work on the cover, and Marjan for her support, and for her patience with me, especially during the last few months of my quest, which has now finally come to an end.

Rotterdam, October 2005

Peter Zoeteweij