Lecture Notes in Computer Science

Edited by G. Goos and J. Hartmanis

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Computing in Systems Described by Equations

Springer-Verlag
Berlin Heidelberg New York 1977

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AMS Subject Classifications (1970): 02-02, 68-02, 68A05,
CR Subject Classifications (1974): 4.13, 5.21, 5,27

ISBN 3-540-08531-9 Springer-Verlag Berlin Heidelberg New York
ISBN 0-387-08531-9 Springer-Verlag New York Heidelberg Berlin

Printed in Germany

Printing and binding: Beltz Offsetdruck, Hemsbach/Bergstr.
2144/3140-543210

Dedication

To the Rocky Mountains

Preface

This monograph is an attempt to provide some useful mathematical foundations for the design of interpreters for functional programming languages such as LISP. These languages are often described by sets of equations. One way to attack the problem of interpreting is to study ways of using equations to compute simple output expressions from input expressions. Such computations are studied here in terms of an abstract formalism called a Subtree Replacement System. With the hints given in Example 17 and Appendix A, a good programmer should be able to design efficient implementations of the abstract computations in a pointer manipulation system with garbage collection, and all of the mathematical results are intended to give useful information on the correctness, termination and efficiency properties of such implementations.

The simplest way to intuitively understand the meanings of equations and the relationship of computations to the equations on which they are based is through the traditional logic of equations presented in Chapter II, Sections 1-3. For readers who prefer the more recent logic based on the work of Dana Scott, which involves notions of continuity and fixpoints in partially ordered domains, and for those who wish to compare the Subtree Replacement System approach to the recent literature on recursive equations, special sections marked with a star (*) are provided to sketch the relationship of continuous logic to this monograph. The starred sections are intended only as a brief outline of this relationship, and proofs given in these sections are deliberately sketchy. Readers without a special interest in continuous logic may omit the starred sections with no loss of continuity.

Acknowledgements

Not only did Barry Rosen's thesis serve as the spark which touched off this work, but his thorough critiques of the early drafts were tremendously helpful to me. Thanks are due also to Robert Constable, who supervised the development of the first version into a doctoral dissertation at Cornell University. Gérard Berry and Jean-Jacques Lévy discovered a significant error in the dissertation, which has been corrected in this monograph. The typed copy was produced cheerfully by Teresa Miao and Olivia Stansbury. The research and writing took place at Cornell University and the University of Toronto, and were supported in part by NSF grants DCR 75-09433 and MCS 76-14293, as well as NCR grant A7755.

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