

Contents

1. Preface	VII
2. Introduction	1
2.1 Motivation	1
2.2 Applications for Symbolic Analysis of Programs	6
2.3 Contributions	8
2.3.1 Symbolic Analysis Framework	8
2.3.2 Symbolic Analysis for Parallelizing Compilers	9
2.4 Organization	11
3. Symbolic Analysis of Programs	13
3.1 Introduction	13
3.2 Initializations, Assignments, and Input/Output Operations ..	14
3.3 Conditional Statements	17
3.4 Loops and Recurrences	21
3.5 Arrays	25
3.6 Procedures	31
3.7 Dynamic Data Structures	34
3.8 Summary	40
4. Generating Program Contexts	41
4.1 Introduction	41
4.2 Extended Control Flow Graph	41
4.3 Algorithm	43
4.4 Summary	47
5. Symbolic Analysis Algorithms and Transformations	49
5.1 Introduction	49
5.2 Preliminaries	51
5.3 Symbolic Expression Evaluation	52
5.3.1 Compute Lower and Upper Bounds of Symbolic Expressions	53
5.3.2 Rewrite φ -Expressions	56
5.3.3 Rewrite Policies	57

5.3.4	Simplify Expressions	58
5.3.5	Determine Result	59
5.4	Count Solutions to a System of Constraints	59
5.4.1	Symbolic Sum Computation	60
5.4.2	The Algorithm	61
5.4.3	Algebraic Sum	64
5.4.4	Miscellaneous	64
5.5	Simplify Systems of Constraints	66
5.6	Experiments	67
5.6.1	Eliminate Redundant Constraints	67
5.6.2	Counting Solutions to a System of Constraints	70
5.6.3	Optimizing FTRVMT	72
5.7	Summary	73
6.	Symbolic Analysis for Parallelizing Compilers	75
6.1	Introduction	75
6.2	Programming DMMPs	76
6.3	Data Dependence Analysis	79
6.4	Vienna High Performance Compiler	81
6.5	Implementation	88
6.6	Symbolic Analysis to Optimize OLDA	92
6.7	Symbolic Analysis to Optimize HNS	93
6.8	Summary	96
7.	Related Work	99
7.1	Advanced Symbolic Analysis Algorithms	106
7.2	Parallelizing Compilers	107
8.	Conclusion	109
9.	Appendix	113
9.1	Control Flow Graphs	114
9.2	Denotational Semantics	116
9.3	Notation	119
9.4	Denotational Semantic: Notation	120
References		121
Index		129