

Contents

Abstract	vii
Resumen	ix
Resum	xi
Agradecimientos	xiii
I What is Program Slicing?	1
1 Introduction	3
1.1 Motivation	3
1.2 Program Slicing	5
1.3 Contributions and goals	6
1.4 Structure of this thesis	9
2 Preliminary concepts and definitions	11
2.1 The basics	11
2.2 Measuring and comparing slices	13
2.3 A sense on sensitivity	15
2.4 Graphs to compute slices	19
II Control Dependence	25
3 Exception handling and conditional control dependence	27
3.1 A new kind of dependence generated by <i>catch</i> statements . . .	28
3.2 Extending the SDG to make it exception-sensitive	30
3.2.1 Modifications to the ACFG to create the ES-CFG	31
3.2.2 Modifications to the APDG to create the ES-PDG	38
3.2.3 From ES-PDGs to the final ES-SDG	41
3.3 Slicing conditional control dependence arcs	41
3.4 Empirical Evaluation	45

3.5	Completeness of the ES-SDG	47
3.6	Related work	48
4	Unconditional jumps and non-executable control flow	49
4.1	Non-executable control-flow	50
4.1.1	Augmented graphs (ACFG and APDG)	52
4.1.2	Pseudo-predicate program dependence graph	52
4.2	Interference with other slicing techniques	55
4.2.1	Representation of procedure calls	55
4.2.2	Object-oriented program slicing	57
4.2.3	Exception handling and conditional control dependence	57
4.3	Implementation in JavaSlicer	60
4.4	Related work	61
5	Communicating Sequential Processes and execution modelling	63
5.1	A brief introduction	65
5.2	Recording the history of a CSP computation	66
5.2.1	Reversing CSP computations with R-tracks	68
	Deterministic reversibility of CSP	73
	Causal-consistent reversibility of CSP	74
5.3	Implementation and empirical evaluation	78
5.3.1	Empirical evaluation	82
5.3.2	Study of the time and memory overhead	83
5.4	Related Work	85
III	Data Dependence	87
6	Modelling Context-Sensitive, Shared-Memory Data Dependence	89
6.1	Background	91
6.1.1	The time travel problem	92
6.1.2	The sequential summary incompleteness problem	95
6.2	Limitations of the current tSDG	97
6.3	The tSDG, revisited	100
6.3.1	Flow dependences generated by interference nodes	101
6.3.2	Timestamps in interference nodes	102
6.3.3	An algorithm to generate the tSDG	103
6.4	Slicing the tSDG	107
6.5	Related work	111

7	Undecidability of data dependence	115
7.1	Data Dependence and Data-Flow Analyses	118
7.2	The Parenthesis-Post Correspondence Problem	120
7.3	Undecidability of Data Analyses	121
7.3.1	RDA with functions and composite data structures	122
7.3.2	RDA without functions and with composite data structures	124
7.3.3	RDA without composite data structures	126
7.3.4	Undecidability of data-dependence analysis	127
7.3.5	Undecidability of data-flow analysis	129
8	Context- & Field-sensitive Program Slicing	131
8.1	The constrained-edges PDG	131
8.1.1	Building the CE-PDG	132
8.1.2	Labels as constraints	135
8.1.3	Slicing the CE-PDG	137
8.2	Tabular slicing	139
8.3	The context-sensitive CE-PDG	145
8.3.1	The slicing algorithm	146
8.3.2	Loops and stack limits	150
8.3.3	Asymptotic temporal cost	151
8.4	Empirical evaluation	151
8.5	Related work	154
IV	Tools & Software	155
9	JavaSlicer	157
9.1	Usage	157
9.1.1	Alternatives: Docker and demo	160
9.1.2	Use cases	160
9.2	Implementation	161
9.3	Limitations	164
10	e-Knife Erlang	165
10.1	Usage	165
10.1.1	The online demo	168
10.1.2	Erlang versions other than OTP 26	168
10.1.3	Use cases	168
10.2	Implementation	169

11 reverCSP	171
11.1 Usage	171
11.1.1 Use cases	173
11.2 Architecture	174
V Conclusions and Future Work	177
12 Conclusions	179
13 Future Work	185
Bibliography	189
VI Appendices	201
A Publications in this thesis	203
A.1 Journal Publications	203
A.2 Conference publications	204
A.3 Talks and dissemination events	205
A.4 List of derived artifacts	206
B Proof of Theorem 3.1: ES-SDG's Completeness	207
B.1 Exception sources and simple exception-catching structures	208
B.1.1 Unconditional exception source.	208
B.1.2 Conditional exception source.	211
B.1.3 Procedures that throw exceptions.	215
B.2 Nested exception-catching structures	220
B.2.1 Case 1.	221
B.2.2 Case 2.	224
B.2.3 Case 3.	224
B.2.4 Case 4.	226
B.2.5 Case 5.	228
B.2.6 Case 6.	229