

Contents

I	Introduction to CHR	13
1	Constraint Handling Rules	15
1.1	Syntax and semantics of CHR	15
1.2	Program properties	25
1.3	CHR systems	27
1.4	Example CHR programs	29
1.5	The union-find algorithm	31
1.6	Extensions of CHR	34
1.7	Applications of CHR	35
1.8	Related formalisms	38
II	Implementation and Optimization of CHR	51
2	Basic Compilation	53
2.1	Introduction	54
2.2	Parsing and Normalisation	54
2.3	Runtime Environment	57
2.4	Code Generation	60
2.5	Compiling the Guard	64
2.6	Summary	69
3	The K.U.Leuven CHR System	71
3.1	Introduction	71
3.2	Implementation	73
3.3	Optimizations	73
3.4	Ports	80
3.5	Experimental Evaluation	82
3.6	Conclusion	85
III	Execution Strategies	89
4	Rule Priorities	91
4.1	Introduction	91
4.2	Motivation and Examples	93
4.3	CHR ^{rp} CHR with Rule Priorities	98
4.4	Program Properties	101
4.5	Basic Compilation of CHR ^{rp}	104

4.6	Optimizing the Compilation of CHR^{FP}	109
4.7	Benchmark Evaluation	113
4.8	Related Work	116
4.9	Conclusion	117
5	Concurrent CHR	121
5.1	CHR and Concurrency	122
5.2	Concurrent Goal-Based Refined CHR Semantics	125
5.3	Correspondence Results	129
5.4	Implementation of CHR, a Quick Review	132
5.5	Parallel CHR System in Haskell GHC	137
5.6	Experimental Results	147
IV	Formal Analysis of CHR	157
6	Computational Complexity	159
6.1	Introduction to Complexity Theory	160
6.2	CHR Machines	168
6.3	Complexity-wise Completeness	174
7	Complexity Analysis of CHR^{FP} Programs	197
7.1	Introduction	197
7.2	Logical Algorithms and CHR^{FP}	199
7.3	Translating Logical Algorithms into CHR^{FP}	203
7.4	Translating a subset of CHR^{FP} into Logical Algorithms	210
7.5	Implementing CHR^{FP} , the Logical Algorithms Way	215
7.6	A New Meta-Complexity Result for CHR^{FP}	225
7.7	Conclusions	233
8	A Complete and Terminating Operational Semantics	239
8.1	Introduction	240
8.2	Equivalence-based Operational Semantics	241
8.3	Constraint Handling Rules with Persistent Constraints	252
8.4	Merge Operator	258
8.5	Discussion	261
8.6	Related and Future Work	277
9	Abstract Interpretation	283
9.1	Introduction	283
9.2	The Refined Denotational Semantics ω_d	284
9.3	The Abstract Interpretation Framework	289
9.4	Late Storage Analysis	293
9.5	Groundness analysis	299
9.6	Implementation and Evaluation	305
9.7	Conclusion	307

Appendix	311
A.1 Most Influential Papers, So Far	312
A.2 Literature available on CHR	313
A.3 CHR Researchers by Country	315