

Software Abstractions

*Logic, Language,
and Analysis*

REVISED EDITION

Daniel Jackson

The MIT Press
Cambridge, Massachusetts
London, England

Contents

Preface	xi
Acknowledgments	xv
Acknowledgments (revised edition)	xvii
1: Introduction	1
2: A Whirlwind Tour	5
2.1 Statics: Exploring States	6
2.2 Dynamics: Adding Operations	9
2.3 Classification Hierarchy	17
2.4 Execution Traces.....	22
2.5 Summary	28
3: Logic	33
3.1 Three Logics in One.....	33
3.2 Atoms and Relations	35
3.3 Snapshots	48
3.4 Operators	50
3.5 Constraints.....	68
3.6 Declarations and Multiplicity Constraints.....	75
3.7 Cardinality and Integers	80
4: Language	85
4.1 An Example: Self-Grandpas	85
4.2 Signatures and Fields	93
4.3 Model Diagrams	103
4.4 Types and Type Checking.....	109
4.5 Facts, Predicates, Functions, and Assertions.....	119
4.6 Commands and Scope.....	130
4.7 Modules and Polymorphism	133
4.8 Integers and Arithmetic	136

5: Analysis	141
5.1 Scope-Complete Analysis	141
5.2 Instances, Examples, and Counterexamples	146
5.3 Unbounded Universal Quantifiers	157
5.4 Scope Selection and Monotonicity	165
6: Examples	171
6.1 Leader Election in a Ring	171
6.2 Hotel Room Locking	187
6.3 Media Asset Management	205
6.4 Memory Abstractions	219
Appendix A: Exercises	233
A.1 Logic Exercises	234
A.2 Extending Simple Models	244
A.3 Classic Puzzles	247
A.4 Metamodels	250
A.5 Small Case Studies	251
A.6 Open-Ended Case Studies	256
Appendix B: Alloy Language Reference	259
B.1 Lexical Issues	259
B.2 Namespaces	260
B.3 Grammar	261
B.4 Precedence and Associativity	263
B.5 Semantic Basis	264
B.6 Types and Overloading	266
B.7 Language Features	270
B.8 Relational Expressions	285
B.9 Integer Expressions	288
B.10 Boolean Expressions	289
Appendix C: Kernel Semantics	295
C.1 Semantics of the Alloy Kernel	295
Appendix D: Diagrammatic Notation	299

CONTENTS	IX
Appendix E: Alternative Approaches	301
E.1 An Example.....	303
E.2 B	310
E.3 OCL.....	316
E.4 VDM.....	322
E.5 Z	328
References	337
Index	345