

Part I Modeling Techniques

1	An Example	3
1.1	A Cookie Vending Machine	3
1.2	A Look Inside	4
1.3	The Interface	5
1.4	Hot and Cold Transitions	6
1.5	Runs	6
1.6	Alternatives	7
1.7	Fine Tuning	8
1.8	Diverse Components	10
	Exercises	11
	Further Reading	11
2	The Basic Concepts	13
2.1	A Variant of the Cookie Vending Machine	13
2.2	Components of a Net	14
2.3	The Data Structure for Petri Nets: Multisets	16
2.4	Markings as Multisets	18
2.5	Steps with Constant Arc Labelings	18
2.6	Steps with Variable Arc Labelings	19
2.7	System Nets	21
2.8	Marking Graph	22
2.9	Final Markings	23
	Exercises	23
	Further Reading	23
3	Common Special Case: Elementary System Nets	25
3.1	Elementary System Nets	25

3.2	An Abstract Model of the Cookie Vending Machine	26
3.3	Mutual Exclusion	27
3.4	The Crosstalk Algorithm	28
3.5	1-Bounded Elementary System Nets	32
	Exercises	32
	Further Reading	33
4	Sequential and Distributed Runs	35
4.1	Sequential Runs	35
4.2	Tokens as Labeled Places	37
4.3	Actions	37
4.4	Distributed Runs	39
4.5	Example: A Bell Clock	42
4.6	The Kindergarten Game	43
4.7	Causal Order	45
4.8	The Composition of Distributed Runs	46
	Exercises	47
	Further Reading	48
5	Scenarios	51
5.1	Defining Scenarios	51
5.2	The Scenarios of the Crosstalk Algorithm	53
5.3	The Scenarios of the Cookie Vending Machine	54
	Exercises	55
	Further Reading	55
6	Further Notations for Elementary System Nets	57
6.1	Place Capacities	57
6.2	Arc Weights	58
6.3	Real Extensions	61
	Exercises	62
	Further Reading	62
7	The Synthesis Problem	65
7.1	Example: The Light/Fan System	65
7.2	The General Question of the Synthesis Problem	67
7.3	Regions of State Automata	68
7.4	The System Net of a State Automaton	69
7.5	The Solution to the Synthesis Problem	70
7.6	The Synthesis Problem of the Light/Fan State Automaton	70
	Exercises	71
	Further Reading	72

8	Composition of Nets	75
8.1	Nets with Interfaces	75
8.2	Communicating Nets	78
8.3	Unambiguous Decomposition into Open Nets	78
	Exercises	80
	Further Reading	80
 Part II Analysis Methods		
9	State Properties	83
9.1	Equations and Inequalities of the Cookie Vending Machine	83
9.2	Valid Equations	86
9.3	Example: Dining Philosophers	86
9.4	Valid Inequalities	88
9.5	Equations and Inequalities of Elementary System Nets	88
9.6	Modulo Equations	90
9.7	Propositional State Properties	91
	Exercises	93
	Further Reading	94
10	Traps and Cotraps of Elementary System Nets	97
10.1	Traps of Elementary System Nets	97
10.2	Cotraps	98
10.3	The Trap/Cotrap Property	99
	Exercises	100
	Further Reading	101
11	Place Invariants of Elementary System Nets	103
11.1	Vector Representation for Elementary System Nets	103
11.2	The Matrix N	104
11.3	Place Invariants	104
11.4	Positive Place Invariants	107
	Exercises	108
	Further Reading	109
12	Combining Traps and Place Invariants of Elementary System Nets	111
12.1	Calculating with Equations and Inequalities	111
12.2	State Properties of the Mutual Exclusion System	113
12.3	State Properties of the Crosstalk Algorithm	113
12.4	Unstable Properties	114
	Exercises	116

	Exercises	191
	Further Reading	191
22	Network Algorithms	193
	22.1 Some Conventions for the Representation of Network Algorithms	194
	22.2 The Echo Algorithm	194
	22.3 Synchronization in Acyclic Networks	198
	22.4 Consensus in the Network	201
	Exercises	204
	Further Reading	204
 Part IV Conclusion		
23	Closing Remarks	207
	23.1 A Brief History of Petri Nets	207
	23.2 Properties of the Elementary Formalisms of Petri Nets	207
	23.3 Speculative Questions	209
	23.4 Petri Nets in Software Engineering	209
	23.5 Reference to Other System Models and Analysis Techniques	210
	23.6 Other Introductory Texts	210
	Formal Framework	213
	Bibliography	225
	Index	229