

Contents

<i>Summary</i>	<i>ix</i>
1. Ecorithms	1
2. Prediction and Adaptation	13
3. The Computable: <i>Not everything that can be defined can be computed.</i>	23
3.1 The Turing Paradigm	23
3.2 Robust Computational Models	27
3.3 The Character of Computational Laws	28
3.4 Polynomial Time Computation	31
3.5 Possible Ultimate Limitations	37
3.6 Simple Algorithms with Complicated Behavior	43
3.7 The Perceptron Algorithm	44
4. Mechanistic Explanations of Nature: <i>What might we look for?</i>	51
5. The Learnable: <i>How can one draw general lessons from particular experiences?</i>	57
5.1 Cognition	57
5.2 The Problem of Induction	59
5.3 Induction in an Urn	62
5.4 Error Control	65
5.5 Toward PAC Learnability	66
5.6 PAC Learnability	71
5.7 Occam: When to Trust a Hypothesis	72
5.8 Are There Limits to Learnability?	76
5.9 Teaching and Learning	81
5.10 Learnable Target Pursuit	83
5.11 PAC Learning as a Basis of Cognition	84

6. The Evolvable: <i>How can complex mechanisms evolve from simpler ones?</i>	87
6.1 Is There a Gap?	87
6.2 How Can the Gap Be Filled?	89
6.3 Does Evolution Have a Target?	92
6.4 Evolvable Target Pursuit	94
6.5 Evolution Versus Learning	98
6.6 Evolution as a Form of Learning	100
6.7 Definition of Evolvability	101
6.8 Extent and Limits	106
6.9 Real-Valued Evolution	108
6.10 Why Is This Theory So Different?	112
7. The Deducible: <i>How can one reason with imprecise concepts?</i>	115
7.1 Reasoning	115
7.2 The Need for Reasoning Even with the Theoryless	118
7.3 The Challenge of Complexity	120
7.4 The Challenge of Brittleness	121
7.5 The Challenge of Semantics	122
7.6 The Challenge of Grounding	123
7.7 The Mind's Eye: A Pinhole to the World	125
7.8 Robust Logic: Reasoning in an Unknowable World	129
7.9 Thinking	135
8. Humans as Ecorithms	137
8.1 Introduction	137
8.2 Nature Versus Nurture	138
8.3 Naïveté	139
8.4 Prejudice and Rush to Judgment	140
8.5 Personalized Truth	141
8.6 Personal Feelings	143
8.7 Delusions of Reason	143
8.8 Machine-Aided Humans	146
8.9 Is There Something More?	147
9. Machines as Ecorithms: <i>Why is artificial intelligence difficult to achieve?</i>	149
9.1 Introduction	149
9.2 Machine Learning	150
9.3 Artificial Intelligence—Where Is the Difficulty?	155
9.4 The Artificial in Artificial Intelligence	158

9.5 Unsupervised Learning	158
9.6 Artificial Intelligence—Where Next?	163
9.7 Need We Fear Artificial Intelligence?	165
10. Questions	167
10.1 Science	167
10.2 A More Strongly Ecorithmic Future	168
10.3 How to Act?	170
10.4 Mysteries	171
Notes	175
Glossary	185
Acknowledgments	189
Index	191