


GEORGE F LUGER

ARTIFICIAL INTELLIGENCE

Structures and Strategies for Complex Problem Solving



Fifth
Edition


ADDISON
WESLEY

CONTENTS

	Preface	vii
	Publisher's Acknowledgements	xvi
PART I	ARTIFICIAL INTELLIGENCE: ITS ROOTS AND SCOPE	1
	<hr/>	
1	AI: EARLY HISTORY AND APPLICATIONS	3
1.1	From Eden to ENIAC: Attitudes toward Intelligence, Knowledge, and Human Artifice	3
1.2	Overview of AI Application Areas	20
1.3	Artificial Intelligence—A Summary	30
1.4	Epilogue and References	31
1.5	Exercises	33
PART II	ARTIFICIAL INTELLIGENCE AS REPRESENTATION AND SEARCH	35
	<hr/>	
2	THE PREDICATE CALCULUS	45
2.0	Introduction	45
2.1	The Propositional Calculus	45
2.2	The Predicate Calculus	50
2.3	Using Inference Rules to Produce Predicate Calculus Expressions	62
2.4	Application: A Logic-Based Financial Advisor	73
2.5	Epilogue and References	77
2.6	Exercises	77
3	STRUCTURES AND STRATEGIES FOR STATE SPACE SEARCH	79
3.0	Introduction	79

3.1	Graph Theory	82
3.2	Strategies for State Space Search	93
3.3	Using the State Space to Represent Reasoning with the Predicate Calculus	107
3.4	Epilogue and References	121
3.5	Exercises	121
4	HEURISTIC SEARCH	123
4.0	Introduction	123
4.1	Hill-Climbing and Dynamic Programming	127
4.2	The Best-First Search Algorithm	133
4.3	Admissibility, Monotonicity, and Informedness	145
4.4	Using Heuristics in Games	150
4.5	Complexity Issues	157
4.6	Epilogue and References	161
4.7	Exercises	162
5	STOCHASTIC METHODS	165
5.0	Introduction	165
5.1	The Elements of Counting	167
5.2	Elements of Probability Theory	170
5.3	Applications of the Stochastic Methodology	182
5.4	Bayes' Theorem	184
5.5	Epilogue and References	190
5.6	Exercises	191
6	BUILDING CONTROL ALGORITHMS FOR STATE SPACE SEARCH	193
6.0	Introduction	193
6.1	Recursion-Based Search	194
6.2	Production Systems	200
6.3	The Blackboard Architecture for Problem Solving	217
6.4	Epilogue and References	219
6.5	Exercises	220
PART III	REPRESENTATION AND INTELLIGENCE: THE AI CHALLENGE	223
7	KNOWLEDGE REPRESENTATION	227
7.0	Issues in Knowledge Representation	227
7.1	A Brief History of AI Representational Schemes	228
7.2	Conceptual Graphs: A Network Language	248

7.3	Alternatives to Explicit Representation	258
7.4	Agent-Based and Distributed Problem Solving	265
7.5	Epilogue and References	270
7.6	Exercises	273
8	STRONG METHOD PROBLEM SOLVING	277
8.0	Introduction	277
8.1	Overview of Expert System Technology	279
8.2	Rule-Based Expert Systems	286
8.3	Model-Based, Case-Based, and Hybrid Systems	298
8.4	Planning	314
8.5	Epilogue and References	329
8.6	Exercises	331
9	REASONING IN UNCERTAIN SITUATIONS	333
9.0	Introduction	333
9.1	Logic-Based Abductive Inference	335
9.2	Abduction: Alternatives to Logic	350
9.3	The Stochastic Approach to Uncertainty	363
9.4	Epilogue and References	379
9.5	Exercises	381
PART IV	MACHINE LEARNING	385
10	MACHINE LEARNING: SYMBOL-BASED	387
10.0	Introduction	387
10.1	A Framework for Symbol-based Learning	390
10.2	Version Space Search	396
10.3	The ID3 Decision Tree Induction Algorithm	408
10.4	Inductive Bias and Learnability	417
10.5	Knowledge and Learning	422
10.6	Unsupervised Learning	433
10.7	Reinforcement Learning	442
10.8	Epilogue and References	449
10.9	Exercises	450
11	MACHINE LEARNING: CONNECTIONIST	453
11.0	Introduction	453
11.1	Foundations for Connectionist Networks	455
11.2	Perceptron Learning	458
11.3	Backpropagation Learning	467
11.4	Competitive Learning	474

11.5	Hebbian Coincidence Learning	484
11.6	Attractor Networks or "Memories"	495
11.7	Epilogue and References	505
11.8	Exercises	506
12	MACHINE LEARNING: SOCIAL AND EMERGENT	507
12.0	Social and Emergent Models of Learning	507
12.1	The Genetic Algorithm	509
12.2	Classifier Systems and Genetic Programming	519
12.3	Artificial Life and Society-Based Learning	530
12.4	Epilogue and References	541
12.5	Exercises	542
PART V	ADVANCED TOPICS FOR AI PROBLEM SOLVING	545
13	AUTOMATED REASONING	547
13.0	Introduction to Weak Methods in Theorem Proving	547
13.1	The General Problem Solver and Difference Tables	548
13.2	Resolution Theorem Proving	554
13.3	PROLOG and Automated Reasoning	575
13.4	Further Issues in Automated Reasoning	581
13.5	Epilogue and References	588
13.6	Exercises	589
14	UNDERSTANDING NATURAL LANGUAGE	591
14.0	The Natural Language Understanding Problem	591
14.1	Deconstructing Language: A Symbolic Analysis	594
14.2	Syntax	597
14.3	Syntax and Knowledge with ATN Parsers	606
14.4	Stochastic Tools for Language Analysis	616
14.5	Natural Language Applications	623
14.6	Epilogue and References	630
14.7	Exercises	632
PART VI	LANGUAGES AND PROGRAMMING TECHNIQUES FOR ARTIFICIAL INTELLIGENCE	635
15	AN INTRODUCTION TO PROLOG	641
15.0	Introduction	641
15.1	Syntax for Predicate Calculus Programming	642
15.2	Abstract Data Types (ADTs) in PROLOG	654

15.3	A Production System Example in PROLOG	658
15.4	Designing Alternative Search Strategies	663
15.5	A PROLOG Planner	668
15.6	PROLOG: Meta-Predicates, Types, and Unification	671
15.7	Meta-Interpreters in PROLOG	679
15.8	Learning Algorithms in PROLOG	694
15.9	Natural Language Processing in PROLOG	704
15.10	Epilogue and References	716
15.11	Exercises	719
16	AN INTRODUCTION TO LISP	723
16.0	Introduction	723
16.1	LISP: A Brief Overview	724
16.2	Search in LISP: A Functional Approach to the Farmer, Wolf, Goat, and Cabbage Problem	746
16.3	Higher-Order Functions and Abstraction	751
16.4	Search Strategies in LISP	755
16.5	Pattern Matching in LISP	759
16.6	A Recursive Unification Function	761
16.7	Interpreters and Embedded Languages	765
16.8	Logic Programming in LISP	767
16.9	Streams and Delayed Evaluation	776
16.10	An Expert System Shell in LISP	780
16.11	Semantic Networks and Inheritance in LISP	787
16.12	Object-Oriented Programming Using CLOS	791
16.13	Learning in LISP: The ID3 Algorithm	803
16.14	Epilogue and References	815
16.15	Exercises	816
PART VII	EPILOGUE	821
17	ARTIFICIAL INTELLIGENCE AS EMPIRICAL ENQUIRY	823
17.0	Introduction	823
17.1	Artificial Intelligence: A Revised Definition	825
17.2	The Science of Intelligent Systems	838
17.3	AI: Current Challenges and Future Directions	848
17.4	Epilogue and References	853
	Bibliography	855
	Author Index	883
	Subject Index	891