## Contents

rej	face	page XIII
	PART I BEGINNINGS	1
1	Dreams and Dreamers	3
2	Clues	10
	2.1 From Philosophy and Logic	10
	2.2 From Life Itself	15
	2.3 From Engineering	25
	part II EARLY EXPLORATIONS: 1950s AND 1960s	47
3	Gatherings	49
	3.1 Session on Learning Machines	49
	3.2 The Dartmouth Summer Project	52
	3.3 Mechanization of Thought Processes	56
4	Pattern Recognition	62
	4.1 Character Recognition	62
	4.2 Neural Networks	64
	4.3 Statistical Methods	73
	4.4 Applications of Pattern Recognition to Aerial Reconnaissance	74
5	Early Heuristic Programs	81
	5.1 The Logic Theorist and Heuristic Search	81
	5.2 Proving Theorems in Geometry	85
	5.3 The General Problem Solver	87
	5.4 Game-Playing Programs	89
6	Semantic Representations	96
	6.1 Solving Geometric Analogy Problems	96
	6.2 Storing Information and Answering Questions	98
	6.3 Semantic Networks	100
7	Natural Language Processing	103
	7.1 Linguistic Levels	103
	7.2 Machine Translation	107
	7.3 Question Answering	110

viii Contents

8	1960s' Infrastructure	114
	8.1 Programming Languages	114
	8.2 Early AI Laboratories	115
	8.3 Research Support	118
	8.4 All Dressed Up and Places to Go	120
	PART III EFFLORESCENCE: MID-1960s TO MID-1970s	123
9	Computer Vision	125
	9.1 Hints from Biology	126
	9.2 Recognizing Faces	127
	9.3 Computer Vision of Three-Dimensional Solid Objects	128
10	"Hand-Eye" Research	141
	10.1 At MIT	141
	10.2 At Stanford	142
	10.3 In Japan	145
	10.4 Edinburgh's "FREDDY"	145
11	Knowledge Representation and Reasoning	149
	11.1 Deductions in Symbolic Logic	149
	11.2 The Situation Calculus	152
	11.3 Logic Programming	153
	11.4 Semantic Networks	154
	11.5 Scripts and Frames	156
12	Mobile Robots	162
	12.1 Shakey, the SRI Robot	162
	12.2 The Stanford Cart	176
13	Progress in Natural Language Processing	181
	13.1 Machine Translation	181
	13.2 Understanding	182
14	Game Playing	193
15	The Dendral Project	197
16	Conferences, Books, and Funding	202
	PART IV APPLICATIONS AND SPECIALIZATIONS:	
	1970s to early 1980s	207
17	Speech Recognition and Understanding Systems	209
	17.1 Speech Processing	209
	17.2 The Speech Understanding Study Group	211
	17.3 The DARPA Speech Understanding Research Program	212
	17.4 Subsequent Work in Speech Recognition	220

Contents	ix
----------	----

18	Consulting Systems	224
	18.1 The SRI Computer-Based Consultant	224
	18.2 Expert Systems	229
19	Understanding Queries and Signals	244
	19.1 The Setting	244
	19.2 Natural Language Access to Computer Systems	247
	19.3 HASP/SIAP	252
20	Progress in Computer Vision	258
	20.1 Beyond Line-Finding	258
	20.2 Finding Objects in Scenes	262
	20.3 DARPA's Image Understanding Program	267
21	Boomtimes	271
	PART V "NEW-GENERATION" PROJECTS	275
22	The Japanese Create a Stir	277
	22.1 The Fifth-Generation Computer Systems Project	277
	22.2 Some Impacts of the Japanese Project	281
23	DARPA's Strategic Computing Program	286
	23.1 The Strategic Computing Plan	286
	23.2 Major Projects	289
	23.3 AI Technology Base	294
	23.4 Assessment	297
	PART VI ENTR'ACTE	303
24	Speed Bumps	305
	24.1 Opinions from Various Onlookers	305
	24.2 Problems of Scale	319
	24.3 Acknowledged Shortcomings	325
	24.4 The "AI Winter"	327
25	Controversies and Alternative Paradigms	331
	25.1 About Logic	331
	25.2 Uncertainty	332
	25.3 "Kludginess"	333
	25.4 About Behavior	334
	25.5 Brain-Style Computation	339
	25.6 Simulating Evolution	341
	25.7 Scaling Back AI's Goals	344
	PART VII THE GROWING ARMAMENTARIUM: FROM THE 1980s ONWARD	347
26	Reasoning and Representation	349
	26.1 Nonmonotonic or Defeasible Reasoning	349

x Contents

	26.2 Qualitative Reasoning	352
	26.3 Semantic Networks	354
27	Other Approaches to Reasoning and Representation	365
	27.1 Solving Constraint Satisfaction Problems	365
	27.2 Solving Problems Using Propositional Logic	368
	27.3 Representing Text as Vectors	373
	27.4 Latent Semantic Analysis	376
28	Bayesian Networks	381
	28.1 Representing Probabilities in Networks	381
	28.2 Automatic Construction of Bayesian Networks	387
	28.3 Probabilistic Relational Models	391
	28.4 Temporal Bayesian Networks	393
29	Machine Learning	398
	29.1 Memory-Based Learning	398
	29.2 Case-Based Reasoning	400 402
	29.3 Decision Trees 29.4 Neural Networks	408
	29.5 Unsupervised Learning	413
	29.6 Reinforcement Learning	415
	29.7 Enhancements	422
30	Natural Languages and Natural Scenes	431
	30.1 Natural Language Processing	431
	30.2 Computer Vision	436
31	Intelligent System Architectures	455
	31.1 Computational Architectures	456
	31.2 Cognitive Architectures	467
	PART VIII MODERN AI: TODAY AND TOMORROW	479
32	Extraordinary Achievements	481
	32.1 Games	481
	32.2 Robot Systems	488
33	Ubiquitous Artificial Intelligence	501
	33.1 AI at Home	501
	33.2 Advanced Driver Assistance Systems	502
	33.3 Route Finding in Maps	503
	33.4 You Might Also Like	503
	33.5 Computer Games	504
34	Smart Tools	507
	34.1 In Medicine	507
	34.2 For Scheduling	509

	Contents	AI
	34.3 For Automated Trading	509
	34.4 In Business Practices	510
	34.5 In Translating Languages	511
	34.6 For Automating Invention	511
	34.7 For Recognizing Faces	512
35	The Quest Continues	515
	35.1 In the Labs	516
	35.2 Toward Human-Level Artificial Intelligence	525
	35.3 Summing Up	534
Index		539