

ARTIFICIAL
INTELLIGENCE
SERIES

Includes
extensive
coverage of
NEURAL
NETWORKS

AI AND EXPERT SYSTEMS

A COMPREHENSIVE GUIDE

TURBO PASCAL

SECOND EDITION

ROBERT I. LEVINE

DIANE E. DRANG

BARRY EDELSON

001-535
LEV

Preface

Acknowledgments

Section 1 Human and Machine Intelligence

Chapter 1 An Overview of Intelligence

What Is Artificial Intelligence?

What Is Programming Like without Artificial Intelligence?

How Does Artificial Intelligence Make Programming Better?

How Does Human Intelligence Work?

Goals

Facts and Rules

Pruning

Inference Mechanism

Summary

Chapter 2 Developing an Artificial Intelligence System

Defining Goals

Defining Facts

Obtaining Data

Rules and Inferences

Verification through the Inference Mechanism

Pruning

Chapter 3 Defining Expert Systems

Heuristic Rules

Blackboard

You Can Do It

Chapter 4 Natural Language Processing

Lexical Analysis

Syntax Analysis

Semantic Analysis

Section 2	Inference Mechanisms: Tools for Machine Thinking	31
Chapter 5	Forward Chaining	33
	Example Using Forward Chaining	35
	The Knowledge Base	36
	Processing the Knowledge Base	37
	Forward Chaining Example	43
	Concepts for Design Implementation	46
	Programming Applications	47
	Forward Chaining Worksheet	53
Chapter 6	Backward Chaining	58
	A Procedure for Designing the Knowledge Base:	
	The Decision Tree	59
	Conversion to IF-THEN Rules	62
	Rule Generating Technique	64
	Processing the Knowledge Base	65
	Conclusion List	66
	Variable List	67
	Clause Variable List	68
	Conclusion Stack	70
	An Example Using the Knowledge Base	72
	Concepts for Design Implementation	79
	The Tool Itself	79
	Programming Applications	80
	Backward Chaining Worksheet	87
Chapter 7	Use of Probability and Fuzzy Logic in Expert Systems	92
	Fundamentals of Probability	93
	Bayesian Probability	94
	Example	95
	Fuzzy Concepts	97
	Probability Membership Table	98
	Summary	100
	Programming Applications	100
Section 3	Expert Systems: Knowledge Plus Inference	109
Chapter 8	Financial Planning Expert System	111
	How Do You Choose a Domain?	112
	How Do You Research Your Topic?	112
	Organizing the Relevant Facts for the Domain	113
	Decision Tree	117
	Backward and Forward Chaining Considerations	120
	Programming Applications	122

Chapter 9	Sales Expert System	124
	Establishing the Facts	125
	Salesperson Personality Types	125
	Instantiating the Facts	126
	Weighting Factors	127
	How Are Weighting Factors Used?	127
	An Example of the System at Work	127
	Assessing the Salesperson Personality Scores	128
	The Customer	128
	Assessing Customer Personality Scores	128
	Assessing the Possible Sales and Customer Combinations	133
	Expert System Assessments	134
	Programming Applications	135
 Chapter 10	 Learning Evaluation Expert System	 140
	Organizing the Data into Topics and Subtopics	141
	Listing the Facts	142
	Assigning Weighting Factors and Establishing Decision Levels	143
	An Example of the System at Work	144
	Verification Using the Inference Mechanism	146
	Additional Applications	148
	Summary	152
	Programming Applications	152
 Section 4	 Advanced Programming Techniques for Powerful Systems	 157
 Chapter 11	 Fundamentals of Object-Oriented Programming	 159
	Creating a Structure	162
	Creating an Object	164
	Overview of Objects and Their Operations	165
	Operations on Objects	165
	Viewing Objects and Structures	166
	Object Operations	167
	Invoking Procedures	168
	A Method for Invoking Procedures	169
	Programming Applications	171
 Chapter 12	 Object-Oriented Programming: An Engineering Example	 185
	Analog-to-Digital Conversion	185
	An Engineering System Using Object-Oriented Programming	186
	Structure	188
	Real-Time Data Acquisition	191
	Process Control	191
	Programming Applications	191

Chapter 13	Object-Oriented Expert Systems	
	Designing the Structure	14
	Creating an Object	15
	Building the Knowledge Base	16
	Writing the Rules	17
	Using the Knowledge Base	18
	Backward or Forward Chaining	19
Section 5	Advanced Knowledge Representation for Smart Systems	205
Chapter 14	Semantic Nets	
	Structure and Objects of Semantic Nets	20
	Rule-Based System Using Semantic Nets	21
	Programming Applications	22
Chapter 15	Certainty Factors	215
	Certainty Level Restrictions	21
	Programming Applications	21
Chapter 16	Automated Learning	221
	Example of a Learning System	22
	Programming Applications	23
Section 6	Languages Used in Artificial Intelligence	225
Chapter 17	Using PROLOG in Design Expert Systems	231
	Conceptual Example	23
	Review	24
	Converting Rules to PROLOG	24
	Summary	25
Chapter 18	LISP	238
	Introduction to LISP	238
	Function Evaluation	238
	Lists	240
	List Functions	241
	Predicates or Testing Functions	242
	Variable Assignments	242
	if-then Rules through the Condition Function	244
	New Functions	245
	Summary	246

Section 7	Artificial Neural Networks	247
Chapter 18	Neural Networks Overview	249
	Neural Systems and Expert Systems	249
	The Unification of Learning Theory	250
	In the Beginning	250
	Design Philosophy of an Artificial Neural System	252
	Training the System	252
	Self-Modification	253
	Modeling the Neural System	254
	Modeling the Single Neuron	254
	Bias Voltage, Axon, Synapse, and Weighting Factor	255
	Summary	257
Chapter 20	Neural Networks—Software Design	258
	The Problem Statement	258
	Design of the Neural Network	259
	Initialization	259
	Training the Network	260
	Forward Propagation	261
	Applying the Input	261
	Calculating the Sum for Each Neuron	262
	Comparison with the Threshold	262
	Backward Propagation	263
	Is the Output Correct?	263
	Calculating the Error	263
	Changing the Weight Values	265
	Calculating the Blame	265
	Calculating the New Weight Values	266
	Is the Training Over?	267
	Programming Applications	267
	Other Applications—Image Recognition	267
	Pixels and Image Recognition	269
	Multiple Levels of Neurons—Hidden Neurons	269
	Forward Propagation	270
	Backward Propagation	270
	Intermediate Error Determination	272
	Other Neural Network Configurations—Hebbian Networks	273
	Weight Matrix	274
	Calculating the Weights	276
	A Noisy Input	277
	Summary	
		283
	Bibliography and Recommended Readings	287
	Index	