AI and Expert Systems

A Comprehensive Guide to Turbo Pascal

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Robert I. Levine
Senior Research Engineer, Unisys Corporation

Diane E. Drang
Director of Educational Services, Jewish Board Family & Children's Services

Barry Edelson
Editor and author

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Preface

Welcome to the inner workings of the brain. Let us take an odyssey into the understanding of how we learn, think, and reason. We will take you into the world of expert systems and neural networks, the second generation of artificial intelligence. Over the next few years, neural network programming techniques will invade many areas presently limited by expert system knowledge. The ability to increase domain knowledge beyond that of experts is necessary for the rapid advancement of artificial intelligence. Neural networks are already showing up in such areas as speech and vision systems. As artificial intelligence which contains expert systems and neural networks reaches more and more areas of daily living, the need to understand and the ability to apply the concepts will become more of a necessity.

This book introduces and explains the concepts of neural networks and advanced artificial intelligence in a language and a set of pictures that everyone can understand. We will take you into a more advanced world of artificial intelligence, showing you how to use many methods (multiple paradigms) for solving problems. Then we will bring all the concepts together by giving you an understanding of object oriented systems. These concepts will enable you to approach the design of both simple and advanced systems.

This book teaches applied concepts. All the programming you will see in these pages can be implemented on a first-generation personal and home computer. Short programs, written in Pascal, are provided in each of the chapters that contain concepts. These programs are easy to use and understand.

This book provides you with a simple uncomplicated view of the first and second generation of artificial intelligence. It has been carefully planned so that each chapter is self-contained. This technique allows you to learn concepts without having to make frequent references to previous chapters. The combination of this technique, a simple approach, and examples that will appeal to a wide range of people makes this book required reading for anyone trying to understand the basic

concepts. It is designed to be used by advanced students, corporate managers, and programmers as well as noncomputer people. There are many step-by-step illustrations and more than 50 examples. These are designed to make the subject matter very easy to understand.

Chapter 1 provides the reader with an overview of the concept of intelligence and how this concept can be identified.

Chapter 2 shows how this concept can be transferred to a computer to create artificial intelligence.

Chapter 3 discusses the concept of expert systems and its relationship to artificial intelligence.

Chapter 4 provides a brief and simple overview of natural language processing.

Chapter 5 discusses forward chaining, providing an extensive set of examples and a forward chaining tool written in Pascal. The tool can be used in a limited way to experiment with the concepts; it can also be easily modified into a more powerful structure.

Chapter 6 discusses backward chaining in a way that is similar to Chapter 5. A backward chaining tool is also provided in this chapter.

Chapter 7 discusses bayesian probability and fuzzy conditions as they apply to expert systems. A programming example illustrating how the concepts can be applied to a rule-based system is provided.

Chapter 8 provides a discussion of the design of a truncated expert system for personal finance. This topic applies to anyone who has money dealings.

Chapter 9 provides a discussion of the design of a truncated expert system for optimizing a sales effort with a customer. This topic applies to all corporations and people since everyone is always selling something.

Chapter 10 discusses the design of an expert system that diagnoses learning problems. This is of interest to schools, corporations analyzing employee capabilities, concerned parents, and individuals.

Chapter 11 discusses object-oriented programming as it applies to expert systems. A set of examples which clearly illustrate some of the concepts is provided. An object-oriented system is written in Pascal to allow you to experiment with the concepts.

Chapter 12 discusses an engineering application using object-oriented programming. A worked-out example is provided.

Chapter 13 provides an expert system example that issues flood warnings using object-oriented programming.

Chapters 14, 15, and 16 discuss semantic nets, certainty factors, and automated learning. A program in Pascal is provided for each of these topics.

Chapter 17 discusses how PROLOG can be used as a tool for answering questions about a knowledge base. Examples illustrating the concepts are provided.

Chapter 18 discusses some basic concepts in LISP and provides you with some understanding of the language.

Chapter 19 discusses a conceptual overview of neural networks.

Chapter 20 provides software examples of neural networks.

Also included is a bibliography that provides you with a list of books and articles, which can be used to augment this book, and a short description of the pertinent topics contained in each.

If you're a student, a programmer, a home computer novice, a professional using a personal computer in your business, a person already involved in artificial intelligence, or just curious about it, this book is for you.

A disc containing all the listed programs in the book is available. If you would like to order one, please see the back of this book for further information and instructions.

Robert I. Levine
Diane E. Drang
Barry Edelson

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Section

1

Human and Machine Intelligence

Section 1 introduces artificial intelligence and expert systems, acquainting us with how they work. Artificial intelligence is simply the transfer of intelligence to machines. Expert systems deal with a small area of expertise that can be converted from human to artificial intelligence.

We will take a close look at these concepts, using some common everyday experiences as examples. This will allow us to dissect the pieces of artificial intelligence and see how we can make them work for us. The process is simple, so let's get started.

Chapter

1

An Overview of Intelligence

What Is Artificial Intelligence?

Artificial intelligence (AI) is simply a way of making a computer think intelligently. This is accomplished by studying how people think when they are trying to make decisions and solve problems, breaking those thought processes down into basic steps, and designing a computer program that solves problems using those same steps. AI thereby provides a simple, structured approach to designing complex decision-making programs.

What Is Programming Like without Artificial Intelligence?

A standard computer program can only provide answers to problems for which it is specifically programmed. If a standard program needs to be modified in order to accommodate new information, the entire program may have to be scanned until the optimum space is found to insert the modification. This is not only time consuming, but other parts of the program may be adversely affected in the process and errors may result.

Artificial intelligence, as its name implies, really does enable a computer to think. By simplifying the way programs are put together, AI imitates the basic human learning process by which new information is absorbed and made available for future reference. The human mind can incorporate new knowledge without changing the way the mind works or disturbing all the other facts that are already stored in the brain. An AI program works in very much the same way. It will become apparent as you read this book that changes made to AI pro-

grams are far simpler to implement than those made to standard programs.

How Does Artificial Intelligence Make Programming Better?

AI techniques allow the construction of a program in which each piece of the program represents a highly independent and identifiable step toward the solution of a problem or set of problems. Let's consider this carefully. Each piece of the program is like a piece of information in a person's mind. If that information is disputed, the mind can automatically adjust its thinking to accommodate a new set of facts. One doesn't have to go about reconsidering every piece of information one has ever learned, only those few pieces that are relevant to the particular change.

A standard program can do everything an artificial intelligence program can do, but it cannot be programmed as easily or as quickly. In both types of programs, all pieces are interdependent in the way they carry out their designed function. But an AI program possesses a notable characteristic which is equivalent to a vital characteristic of human intelligence. Each minute piece can be modified without affecting the structure of the entire program. This flexibility provides greater programming efficiency and understandability—in a word, intelligence.

How Does Human Intelligence Work?

Since AI is a science rooted in human thought processes, an examination of how people think is essential. Of course, no one knows exactly how the mind works. Human intelligence is a complex function that scientists have only begun to understand, but enough is known for us to make certain assumptions about how we think and to apply those assumptions in designing AI programs.

Goals

All thinking helps us accomplish something. When the alarm clock rings in the morning, a thought process must be employed to guide your hand to the button to turn it off. It isn't an automatic reaction; a specific response was sought to solve a particular problem. The final results to which all our thought processes are directed are called "goals."

Once you have reached the goal of turning off the alarm, your mind is immediately confronted with other goals to be reached, such as getting to the bathroom, brushing your teeth, getting dressed, making and eating breakfast, going to the bus stop, and so on. These are all goals which, when accomplished, lead you to the ultimate goal of getting to work and getting there on time. None of the thoughts guiding you to this final result are random or arbitrary. They have been pressed into service because every step of the way you had a specific goal in mind. When engaged in the most simple physical task or the most complex mental activity, the mind is sharply focused on a goal. Without goals, we have no reason to think. Examples of various types of goals are listed below:

1. Mapping the shortest route between New York and Boston
2. Deciding on the best type of wine to drink with certain fish
3. Learning to tie my shoes
4. Deciding how to determine if my child understands the concepts of arithmetic

When designing an AI system, the goal of the system must always be kept in mind. Remember, we don't do things because we think, we think because there are things we have to do.

Now that we understand where our minds are going when they're at work, let's consider just how we arrive at the multitude of goals we must reach every day.

Facts and Rules

We all know that the human mind possesses a vast store of knowledge relating to a countless array of objects and ideas. Survival depends on our ability to apply this knowledge to any situation that arises and to continuously learn from new experiences so that we will be able to respond to similar situations in the future. What is generally considered to be "intelligence" can be broken down into a collection of facts and a means of utilizing these facts to reach goals. This is done, in part, by formulating sets of rules relating to all the facts stored in the brain. An example of the type of facts and related rules we use every day follows:

Fact/rule set 1
Fact 1: A burning stove is hot.
Rule 1: If I put my hand on a burning stove, THEN it will hurt.