KNOWLEDGE STRUCTURES FOR COMMUNICATIONS IN HUMAN-COMPUTER SYSTEMS

GENERAL AUTOMATA-BASED

Eldo C. Koenig

WILEY-INTERSCIENCE
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To Gloria

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PREFACE

The book presents knowledge structures for communications in human-computer systems (HCS) based on general automata. The general automaton was considered basic in disciplining the natural language, in that knowledge to be communicated is about automata and histories of automata. The work of others on finite automata does not include the detail required for finite general automata. To accomplish completeness and unification for the broad concept of a general automaton, the analysis applies the algebra of sets and functions and follows with the application of combinatorial mathematics for graph theory to define a general graph model for knowledge representation. Since interacting automata must be interfaced in space and time, the graph model is fundamental to the analysis of systems of automata and is supported by more than 50 theorems and proofs. The material presented makes reference to 34 publications by the author or jointly by the author and graduate students.

The resulting model provides knowledge representations for software engineering. Of the many features required of a method to achieve the desired communication in HCS, six are identified and illustrations presented for achieving them by the general automata method (GAM):

1. Extracting and storing the knowledge of sentences
2. Knowledge association
3. Deductive processes
4. Inferences
5. Feedback
6. Sequencing of knowledge

After the analysis for each feature is presented, the result is illustrated with practical applications. Algorithms and programs are described in achieving some of the features, and additional algorithms and further research are indicated.

The material is presented in the style and form that is suitable for either an academic or an industrial setting, and for either self-study or group learning. It has been taught to advanced undergraduate and graduate students. For those with interest and background in applied computer science and software engineering, the book describes algorithms and programs, and suggests others.

Emphasis for this group would be placed on Chapters 1, 4, 6, 7, and 8. Some knowledge of algebraic language and systems programming, algebra of sets and functions, and combinatorial mathematics for graph theory would be helpful. For those with interest in research and advanced development, the book supplies guiding principles and suggests additional research, as in e-translation and human-computer interactions. Emphasis for this group would be placed on Chapters 2, 3, 5, and the Appendices. Some knowledge of algebra of sets and functions, combinatorial mathematics for graph theory, recursive theory, and logical foundations is desirable.

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CHAPTER 1

Introduction

1.1 CONSIDERATIONS FOR ESTABLISHING KNOWLEDGE STRUCTURES FOR COMPUTERS

Thousands of languages have been developed by as many isolated societies over thousands of years (Wuethrich 2000). The object of any society in developing a language is to communicate perceived knowledge about its environment. Environments are considered to contain living things (automata) that perform individually and in groups (interactive automata) and that make changes in the environments through their responses (histories of automata). That is, perceived knowledge is about automata and histories of automata, and languages are established to communicate the knowledge.

A model for communication in human-computer systems involves more than a syntactical analysis for extracting the meanings of sentences as is demonstrated by the following two pairs of sentences:

"John struck the table with a hammer."
"John struck the table with a glass top."
"The deer came out of the wood."
"The worm came out of the wood."

A model should also accommodate the duplication of the following example performances:

1. An observer sees Mrs. Bee shop at Supermarket Dee one day, the next day sees Mrs. Cee shop at the same supermarket, and then says,

   "Mrs. Bee and Mrs. Cee shop at Supermarket Dee."

2. An observer one day reads that during the Renaissance period, the people of Venice built the Library of St. Mark, and years later reads that

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