

Preface

Decision diagrams (DDs) are data structures that are efficient, in terms of space and time, for representing large discrete functions. Decision diagrams form an integral part of many CAD systems for logic design and are the basis of many signal processing algorithms. In the last decade, a variety of different DDs has been introduced for providing compact representations of various classes of discrete functions, including switching and multiple-valued logic functions as particular examples. Considerable progress has been made in classification and uniform characterization of DDs, on one hand, through spectral representations relating them to Fourier-type functional expressions for discrete functions and, on other hand, through group theoretic approach in optimizing DDs. This book is based on these recent advances. It collects, recalls and sets the notation for the basic mathematical concepts and terms that are necessary in understanding theory and applications of decision diagrams. Many concepts in the theory of decision diagrams are based on algebraic concepts that are not routinely taught in engineering curricula and the book covers these topics but avoids going into details that are not vital for understanding the key issues. To simplify the presentation and make it easy to use the book for self study it is written in the form of a series of simple questions and simple answers, while taking care that the simplification does not violate the mathematical correctness of the presentation. Because we shall give definitions of most of the basic concepts, but avoid excessive length, most elementary concepts are assumed to be familiar to the reader. If in doubt, the reader can recall these concepts from any basic text on abstract algebra. While being an introduction to the theory of decision diagrams the book also provides a

parallel track forming a deeper study that has features of a research monograph in this area. To meet these almost contradictory goals, we provide several short sections after the presentation of each subtopic summarizing and reviewing previously discussed topics in a compact manner assuming a higher level of background knowledge.

Overview of the Presentation

Spectral techniques have proven to be highly applicable in switching theory and logic design when logic functions are viewed as discrete signals over binary fields. With this motivation, Chapter 1 briefly reviews basic notions of signals and their mathematical models. Chapter 2 discusses the algebraic structures for signal processing that are needed in applying spectral methods for switching theory and logic design. Chapter 3 presents fundamentals of spectral transforms for switching theory and logic design. In Chapter 4, these transforms are reconsidered from a more general point of view and discussed in terms of Fourier analysis on finite groups. These considerations provide a basis for the presentation of spectral interpretation of decision diagrams. In Chapter 6, a unified view to various decision diagram representations derived from their spectral interpretation is presented. Special attention has been paid to basic characteristics of DDs permitting comparison of DDs on different finite groups. In Chapter 7, spectral interpretation of the optimization of DDs by reordering of variables and generalizations of this method are presented. Chapters 8, 9, and 10 discuss spectral interpretation of word-level DDs, edge-valued DDs, and Ternary DDs, respectively. In Chapter 11, the group-theoretic approach to the optimization of decision diagram representations is discussed. The book ends with closing remarks presenting a systematization of various decision diagrams from the point of view of spectral interpretation and group theoretic approach to DD representations.

Organization and Features

Presentation is organized as a modular system of self-contained chapters. Each chapter ends with a brief summary. Chapters 4, 6, and 11 provide more advanced topics in decision diagram representations of discrete functions. The material in these chapters and sections 7.3, 9.2, and 10.20 require more background but can be digested by a reader with less knowledge in decision diagrams consulting examples in other chapters and sections. Conversely, examples in the remaining part of the book can be considered as illustration of the presentation in these advanced chapters and sections. A peculiar feature of the book is the unified point of view to various classes of

decision diagrams through their spectral interpretation and group theoretic representation.

Audience

The book is written in a way making it suitable for self-learning and useful as a basic text for organization of specialized university courses in this area. The chapters and sections presenting advanced topics on the subject provide attributes of a research monograph to the book. In this way, besides for students, the book may be interesting for researchers in various areas where compact representations of discrete functions are required, including logic design and signal processing.

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