Spectral Interpretation and Applications of Decision Diagrams

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Different Decision Diagrams (DDs) for representation of discrete functions are discussed. DDs can be derived by applying some reduction rules to Decision Trees (DTs) which in turn are graphical representations of some function expressions for discrete functions. Various DTs and their generalizations based on lesser known AND-EXOR rather than AND-OR expressions are surveyed. Finally, the concept of spectral interpretation of DDs and some of their applications and ways of calculation are also presented.

Keywords: Logic design, decision diagrams, spectral techniques, AND-EXOR expressions, bit-level decision diagrams, word-level decision diagrams

1. INTRODUCTION

Manipulations and calculations with discrete functions are fundamental tasks in Computer Science and Engineering. Many problems in digital system design and testing can be expressed as a sequence of operations on discrete functions. The performance of CAD systems used in solving various problems in this area strongly depends on the efficiency of representation of discrete functions.

Decision diagrams (DDs) [1, 5] have proved very convenient data structure for discrete function representations, permitting manipulations and calculations with large discrete functions efficiently in terms of time and space. In many applications, as for example those involving large matrices, conventional algorithms are significantly improved by using DDs [11]. In logic design, such applications relate to the basic problems of the design, verification and testing of logical networks [13, 72, 79]. Therefore, DDs based packages are to become, or have already been, a standard part of many CAD tools in logic design.

This paper surveys basic concepts in theory and applications of DDs representations. Presentation is based on the following principle which, at the same time, determined the organization of the paper.

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Spectral Interpretation Of Decision Diagrams

Patrick Vollmar

Spectral Interpretation Of Decision Diagrams:

   Spectral Interpretation of Decision Diagrams Radomir Stankovic,Jaakko T. Astola,2003-06-16 Decision diagrams DDs are data structures for efficient time space representations of large discrete functions In addition to their wide application in engineering practice DDs are now a standard part of many CAD systems for logic design and a basis for severe signal processing algorithms Spectral Interpretation of Decision Diagrams derives from attempts to classify and uniformly interpret DDs through spectral interpretation methods relating them to different Fourier series like functional expressions for discrete functions and a group theoretic approach to DD optimization The book examines DDs found in literature and engineering practice and provides insights into relationships between DDs and different polynomial or spectral expressions for representation of discrete functions In addition it offers guidelines and criteria for selection of the most suitable representation in terms of space and time complexity The work complements theory with numerous illustrative examples from practice Moreover the importance of DD representations to the verification and testing of arithmetic circuits is addressed as well as problems related to various signal processing tasks **Spectral Interpretation of Decision Diagrams** Radomir Stankovic,Jaakko T Astola,2014-01-15 Decision diagrams DDs are data structures for efficient time space representations of large discrete functions In addition to their wide application in engineering practice DDs are now a standard part of many CAD systems for logic design and a basis for severe signal processing algorithms Spectral Interpretation of Decision Diagrams derives from attempts to classify and uniformly interpret DDs through spectral interpretation methods relating them to different Fourier series like functional expressions for discrete functions and a group theoretic approach to DD optimization The book examines DDs found in literature and engineering practice and provides insights into relationships between DDs and different polynomial or spectral expressions for representation of discrete functions In addition it offers guidelines and criteria for selection of the most suitable representation in terms of space and time complexity The work complements theory with numerous illustrative examples from practice Moreover the importance of DD representations to the verification and testing of arithmetic circuits is addressed as well as problems related to various signal processing tasks *Spectral Logic and Its Applications for the Design of Digital Devices* Mark G. Karpovsky,Radomir S. Stankovic,Jaakko T. Astola,2008-04-15 Spectral techniques facilitate the design and testing of today s increasingly complex digital devices There is heightened interest in spectral techniques for the design of digital devices dictated by ever increasing demands on technology that often cannot be met by classical approaches Spectral methods provide a uniform and consistent theoretic environment for recent achievements in this area which appear divergent in many other approaches Spectral Logic and Its Applications for the Design of Digital Devices gives readers a foundation for further exploration of abstract harmonic analysis over finite groups in the analysis design and testing of digital devices After an introduction this book provides the essential mathematical background for discussing spectral methods It then delves into spectral logic and its applications

covering Walsh Haar arithmetic transform Reed Muller transform for binary valued functions and Vilenkin Chrestenson transform generalized Haar and other related transforms for multiple valued functions Polynomial expressions and decision diagram representations for switching and multiple value functions Spectral analysis of Boolean functions Spectral synthesis and optimization of combinational and sequential devices Spectral methods in analysis and synthesis of reliable devices Spectral techniques for testing computer hardware This is the authoritative reference for computer science and engineering professionals and researchers with an interest in spectral methods of representing discrete functions and related applications in the design and testing of digital devices It is also an excellent text for graduate students in courses covering spectral logic and its applications   Fundamentals of Switching Theory and Logic Design Jaakko Astola,Radomir S. Stankovic,2006-03-07 Fundamentals of Switching Theory and Logic Design discusses the basics of switching theory and logic design from a slightly alternative point of view and also presents links between switching theory and related areas of signal processing and system theory Switching theory is a branch of applied mathematic providing mathematical foundations for logic design which can be considered as a part of digital system design concerning realizations of systems whose inputs and outputs are described by logic functions   Representations of Multiple-Valued Logic Functions Radomir S. Stankovic,Jaakko Astola,Claudio Moraga,2022-06-01 Compared to binary switching functions the multiple valued functions MV offer more compact representations of the information content of signals modeled by logic functions and therefore their use fits very well in the general settings of data compression attempts and approaches The first task in dealing with such signals is to provide mathematical methods for their representation in a way that will make their application in practice feasible Representation of Multiple Valued Logic Functions is aimed at providing an accessible introduction to these mathematical techniques that are necessary for application of related implementation methods and tools This book presents in a uniform way different representations of multiple valued logic functions including functional expressions spectral representations on finite Abelian groups and their graphical counterparts various related decision diagrams Three valued or ternary functions are traditionally used as the first extension from the binary case They have a good feature that the ratio between the number of bits and the number of different values that can be encoded with the specified number of bits is favourable for ternary functions Four valued functions also called quaternary functions are particularly attractive since in practical realization within today prevalent binary circuits environment they may be easy coded by binary values and realized with two stable state circuits At the same time there is much more considerable advent in design of four valued logic circuits than for other p valued functions Therefore this book is written using a hands on approach such that after introducing the general and necessarily abstract background theory the presentation is based on a large number of examples for ternary and quaternary functions that should provide an intuitive understanding of various representation methods and the interconnections among them Table of Contents Multiple Valued Logic Functions Functional Expressions for Multiple Valued Functions Spectral

Representations of Multiple Valued Functions Decision Diagrams for Multiple Valued Functions Fast Calculation Algorithms

Fourier Analysis on Finite Groups with Applications in Signal Processing and System Design Radomir S. Stankovic,Claudio Moraga,Jaakko Astola,2005-08-08 Discover applications of Fourier analysis on finite non Abeliangroups The majority of publications in spectral techniques considerFourier transform on Abelian groups However non Abelian groupsprovide notable advantages in efficient implementations of spectralmethods Fourier Analysis on Finite Groups with Applications in SignalProcessing and System Design examines aspects of Fourieranalysis on finite non Abelian groups and discusses differentmethods used to determine compact representations for discretefunctions providing for their efficient realizations and relatedapplications Switching functions are included as an example ofdiscrete functions in engineering practice Additionally consideration is given to the polynomial expressions and decisiondiagrams defined in terms of Fourier transform on finitenon Abelian groups A solid foundation of this complex topic is provided bybeginning with a review of signals and their mathematical modelsand Fourier analysis Next the book examines recent achievementsand discoveries in Matrix interpretation of the fast Fourier transform Optimization of decision diagrams Functional expressions on quaternion groups Gibbs derivatives on finite groups Linear systems on finite non Abelian groups Hilbert transform on finite groups Among the highlights is an in depth coverage of applications ofabstract harmonic analysis on finite non Abelian groups in compactrepresentations of discrete functions and related tasks in signalprocessing and system design including logic design All chaptersare self contained each with a list of references to facilitatethe development of specialized courses or self study With nearly 100 illustrative figures and fifty tables this isan excellent textbook for graduate level students and researchersin signal processing logic design and system theory as well asthe more general topics of computer science and appliedmathematics   Introduction to Logic Design Svetlana N. Yanushkevich,Vlad P. Shmerko,2008-01-25 With an abundance of insightful examples problems and computer experiments Introduction to Logic Design provides a balanced easy to read treatment of the fundamental theory of logic functions and applications to the design of digital devices and systems Requiring no prior knowledge of electrical circuits or electronics it supplies the essential material to understand the basic operation and design of digital systems Satisfying the Requirements of an Introductory Course The text presents a clear picture of basic concepts effective problem solving techniques modern technologies and applications It focuses on the relationships between and the manipulation of various data structures By examining the similarities and differences between assorted theoretical approaches for the representation manipulation and optimization of Boolean functions the authors provide a unified overview of the relationships among digital system design computer organization micro and nanoelectronics and numerical methods The book also describes classical minimization techniques along with advanced and emerging problems of logic design Meeting the Needs of Developing Technology Reflecting the integrated nature of modern engineering this text shows how theoretical ideas physical devices and design methodologies come together to form a

successful design approach It provides the basis to explore even more sophisticated aspects in the field   Proceedings of the ASP-DAC ... Asia and South Pacific Design Automation Conference ,1998   **Mathematical Reviews** ,2006   **International Journal of Applied Mathematics and Computer Science** ,2006   **1994 IEEE 13th Annual International Phoenix Conference on Computers and Communications** ,1994   **1999 4th International Conference on Telecommunications in Modern Satellite, Cable and Broadcasting Services - Telsiks** ,1999 Aimed at personal communication engineers the subjects covered in these proceedings include satellite communication systems cable communication systems radio communication systems moblie communication systems satellite and terrestrial broadcast systems and television techniques   **Proceedings of the ... Midwest Symposium on Circuits and Systems** ,2004

EUROMICRO 99, Proceedings of the 25th EUROMICRO Conference ,1999 Annotation This is a two volume set of the proceedings of the September 1999 conference on the current and future developments in informatics theories and application areas Volume I 80 contributions discusses digital system design architectures and methods and tools Volume II 30 contributions covers music technology and audio processing dependable computing systems software process and product improvement multimedia and telecommunication and network computing Lacks a subject index Annotation copyrighted by Book News Inc Portland OR   **ISMVL 2004** International Symposium on Multiple Valued Logic (34, 2004, Toronto),IEEE Computer Society,2004   **Proceedings** IEEE Staff,2002 This text contains information on computational mathematics and complexity theory as presented at the 32nd IEEE International Symposium on Multi Valued Logic ISMVL 2002

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