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Xuan Guang
Zhen Zhang

Linear Network Error Correction Coding



Springer

Linear Network Error Correction Coding Springerbriefs In Computer Science

Venkatesan Guruswami



Linear Network Error Correction Coding Springerbriefs In Computer Science:

Linear Network Error Correction Coding Xuan Guang,Zhen Zhang,2014-03-21 There are two main approaches in the theory of network error correction coding In this SpringerBrief the authors summarize some of the most important contributions following the classic approach which represents messages by sequences similar to algebraic coding and also briefly discuss the main results following the other approach that uses the theory of rank metric codes for network error correction of representing messages by subspaces This book starts by establishing the basic linear network error correction LNEC model and then characterizes two equivalent descriptions Distances and weights are defined in order to characterize the discrepancy of these two vectors and to measure the seriousness of errors Similar to classical error correcting codes the authors also apply the minimum distance decoding principle to LNEC codes at each sink node but use distinct distances For this decoding principle it is shown that the minimum distance of a LNEC code at each sink node can fully characterize its error detecting error correcting and erasure error correcting capabilities with respect to the sink node In addition some important and useful coding bounds in classical coding theory are generalized to linear network error correction coding including the Hamming bound the Gilbert Varshamov bound and the Singleton bound Several constructive algorithms of LNEC codes are presented particularly for LNEC MDS codes along with an analysis of their performance Random linear network error correction coding is feasible for noncoherent networks with errors Its performance is investigated by estimating upper bounds on some failure probabilities by analyzing the information transmission and error correction Finally the basic theory of subspace codes is introduced including the encoding and decoding principle as well as the channel model the bounds on subspace codes code construction and decoding algorithms Network Coding and Subspace Designs

Marcus Greferath,Mario Osvin Pavčević,Natalia Silberstein,María Ángeles Vázquez-Castro,2018-01-29 This book written by experts from universities and major research laboratories addresses the hot topic of network coding a powerful scheme for information transmission in networks that yields near optimal throughput It introduces readers to this striking new approach to network coding in which the network is not simply viewed as a mechanism for delivering packets but rather an algebraic structure named the subspace which these packets span This leads to a new kind of coding theory employing what are called subspace codes The book presents selected highly relevant advanced research output on Subspace Codes and Rank Metric Codes Finite Geometries and Subspace Designs Application of Network Coding Codes for Distributed Storage Systems The outcomes reflect research conducted within the framework of the European COST Action IC1104 Random Network Coding and Designs over $GF(q)$ Taken together they offer communications engineers R D engineers researchers and graduate students in Mathematics Computer Science and Electrical Engineering a comprehensive reference guide to the construction of optimal network codes as well as efficient encoding and decoding schemes for a given network code **Error-Control**

Coding for Data Networks Irving S. Reed,Xuemin Chen,2012-12-06 The purpose of Error Control Coding for Data

Networks is to provide an accessible and comprehensive overview of the fundamental techniques and practical applications of the error control coding needed by students and engineers. An additional purpose of the book is to acquaint the reader with the analytical techniques used to design an error control coding system for many new applications in data networks. Error control coding is a field in which elegant theory was motivated by practical problems so that it often leads to important useful advances. Claude Shannon in 1948 proved the existence of error control codes that under suitable conditions and at rates less than channel capacity would transmit error free information for all practical applications. The first practical binary codes were introduced by Richard Hamming and Marcel Golay from which the drama and excitement have infused researchers and engineers in digital communication and error control coding for more than fifty years. Nowadays error control codes are being used in almost all modern digital electronic systems and data networks. Not only is coding equipment being implemented to increase the energy and bandwidth efficiency of communication systems but coding also provides innovative solutions to many related data networking problems.

An Introduction to Error Correcting Codes with Applications Scott A. Vanstone, Paul C. van Oorschot, 1989-05-31

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Error-Correction Coding and Decoding Martin Tomlinson, Cen Jung Tjhai, Marcel A. Ambroze, Mohammed Ahmed, Mubarak Jibril, 2017-02-21

This book discusses both the theory and practical applications of self correcting data commonly known as error correcting codes. The applications included demonstrate the importance of these codes in a wide range of everyday technologies from smartphones to secure communications and transactions. Written in a readily understandable style the book presents the authors twenty five years of research organized into five parts. Part I is concerned with the theoretical performance attainable by using error correcting codes to achieve communications efficiency in digital communications systems. Part II explores the construction of error correcting codes and explains the different families of codes and how they are designed. Techniques are described for producing the very best codes. Part III addresses the analysis of low density parity check LDPC codes primarily to calculate their stopping sets and low weight codeword spectrum which determines the performance of these codes. Part IV deals with decoders designed to realize optimum performance. Part V describes applications which include combined error correction and detection public key cryptography using Goppa codes correcting errors in passwords and watermarking. This book is a

valuable resource for anyone interested in error correcting codes and their applications ranging from non experts to professionals at the forefront of research in their field This book is open access under a CC BY 4 0 license **Error Coding for Engineers** A. Houghton,2001-09-30 Error Coding for Engineers provides a useful tool for practicing engineers students and researchers focusing on the applied rather than the theoretical It describes the processes involved in coding messages in such a way that if errors occur during transmission or storage they are detected and if necessary corrected Very little knowledge beyond a basic understanding of binary manipulation and Boolean algebra is assumed making the subject accessible to a broad readership including non specialists The approach is tutorial numerous examples illustrations and tables are included along with over 30 pages of hands on exercises and solutions Error coding is essential in many modern engineering applications Engineers involved in communications design DSP based applications IC design protocol design storage solutions and memory product design are among those who will find the book to be a valuable reference Error Coding for Engineers is also suitable as a text for basic and advanced university courses in communications and engineering

Error-Correcting Linear Codes Anton Betten,Michael Braun,Harald Friepertinger,Adalbert Kerber,Axel Kohnert,Alfred Wassermann,2006-09-21 The fascinating theory of error correcting codes is a rather new addition to the list of mathematical disciplines It grew out of the need to communicate information electronically and is currently no more than 60 years old ing an applied discipline by de nition a surprisingly large number of pure mathematical areas tie into Coding Theory If one were to name just the most important connections one would start of course with Linear Algebra then list Algebra and Combinatorics and further mention Number Theory and ometry as well as Algebraic Geometry Being a thorough introduction to the eld this book starts from the very beginning which is the channel model of communication in the presence of noise From there we develop the fundamental concepts of error correcting codes like the Hamming metric and the maximum likelihood decoding pr ciple After discussing dual codes and simple decoding procedures this book takes an unusual turn The standard approach would be to move on from there and introduce either more theory or present standard constructions of codes The approach taken here is different Error-Correction Coding for Digital Communications George C. Clark Jr.,J. Bibb Cain,2013-06-29 Error correction coding is being used on an almost routine basis in most new communication systems Not only is coding equipment being used to increase the energy efficiency of communication links but coding ideas are also providing innovative solutions to many related communication problems Among these are the elimination of intersymbol interference caused by filtering and multipath and the improved demodulation of certain frequency modulated signals by taking advantage of the natural coding provided by a continuous phase Although several books and nu merous articles have been written on coding theory there are still noticeable deficiencies First the practical aspects of translating a specific decoding algorithm into actual hardware have been largely ignored The information that is available is sketchy and is widely dispersed Second the information required to evaluate a particular technique under situations that are en countered in

practice is available for the most part only in private company reports This book is aimed at correcting both of these problems It is written for the design engineer who must build the coding and decoding equipment and for the communication system engineer who must incorporate this equipment into a system It is also suitable as a senior level or first year graduate text for an introductory one semester course in coding theory The book Uses a minimum of mathematics and entirely avoids the classical theorem proof approach that is often seen in coding texts **Error Correcting Codes** D J. Baylis,1997-12-04

Assuming little previous mathematical knowledge Error Correcting Codes provides a sound introduction to key areas of the subject Topics have been chosen for their importance and practical significance which Baylis demonstrates in a rigorous but gentle mathematical style Coverage includes optimal codes linear and non linear codes general techniques of decoding errors and erasures error detection syndrome decoding and much more Error Correcting Codes contains not only straight maths but also exercises on more investigational problem solving Chapters on number theory and polynomial algebra are included to support linear codes and cyclic codes and an extensive reminder of relevant topics in linear algebra is given Exercises are placed within the main body of the text to encourage active participation by the reader with comprehensive solutions provided Error Correcting Codes will appeal to undergraduate students in pure and applied mathematical fields software engineering communications engineering computer science and information technology and to organizations with substantial research and development in those areas *Error Correcting Coding and Security for Data Networks* Grigorii

Kabatiansky,Evgenii Krouk,Sergei Semenov,2005-10-31 Error correcting coding is often analyzed in terms of its application to the separate levels within the data network in isolation from each other In this fresh approach the authors consider the data network as a superchannel a multi layered entity which allows error correcting coding to be evaluated as it is applied to a number of network layers as a whole By exposing the problems of applying error correcting coding in data networks and by discussing coding theory and its applications this original technique shows how to correct errors in the network through joint coding at different network layers Discusses the problem of reconciling coding applied to different layers using a superchannel approach Includes thorough coverage of all the key codes linear block codes Hamming BCH and Reed Solomon codes LDPC codes decoding as well as convolutional turbo and iterative coding Considers new areas of application of error correcting codes such as transport coding code based cryptosystems and coding for image compression Demonstrates how to use error correcting coding to control such important data characteristics as mean message delay Provides theoretical explanations backed up by numerous real world examples and practical recommendations Features a companion website containing additional research results including new constructions of LDPC codes joint error control coding and synchronization Reed Muller codes and their list decoding By progressing from theory through to practical problem solving this resource contains invaluable advice for researchers postgraduate students engineers and computer scientists interested in data communications and applications of coding theory *Advanced Hardware Design for Error Correcting Codes* Cyrille

Chavet,Philippe Coussy,2014-10-30 This book provides thorough coverage of error correcting techniques It includes essential basic concepts and the latest advances on key topics in design implementation and optimization of hardware software systems for error correction The book s chapters are written by internationally recognized experts in this field Topics include evolution of error correction techniques industrial user needs architectures and design approaches for the most advanced error correcting codes Polar Codes Non Binary LDPC Product Codes etc This book provides access to recent results and is suitable for graduate students and researchers of mathematics computer science and engineering Examines how to optimize the architecture of hardware design for error correcting codes Presents error correction codes from theory to optimized architecture for the current and the next generation standards Provides coverage of industrial user needs advanced error correcting techniques Advanced Hardware Design for Error Correcting Codes includes a foreword by Claude Berrou **List**

Decoding of Error-Correcting Codes Venkatesan Guruswami,2004-11-29 How can one exchange information e ectively when the medium of com nication introduces errors This question has been investigated extensively starting with the seminal works of Shannon 1948 and Hamming 1950 and has led to the rich theory of error correcting codes This theory has traditionally gone hand in hand with the algorithmic theory of decoding that tackles the problem of recovering from the errors e ciently This thesis presents some spectacular new results in the area of decoding algorithms for error correctingcodes Speci cally itshowshowthenotionof list decoding can be applied to recover from far more errors for a wide variety of err correcting codes than achievable before A brief bit of background error correcting codes are combinatorial str tures that show how to represent or encode information so that it is silient to a moderate number of errors Speci cally an error correcting code takes a short binary string called the message and shows how to transform it into a longer binary string called the codeword so that if a small number of bits of the codewordare ipped the resulting string does not look like any other codeword The maximum number of errorsthat the code is guaranteed to detect denoted d is a central parameter in its design A basic property of such a code is that if the number of errors that occur is known to be smaller than $d/2$ the message is determined uniquely This poses a computational problem calledth decodingproblem computethemessagefromacorrupted codeword when the number of errors is less than $d/2$ **Error Correction Coding** Todd K. Moon,2005-06-06 An

unparalleled learning tool and guide to error correction coding Error correction coding techniques allow the detection and correction of errors occurring during the transmission of data in digital communication systems These techniques are nearly universally employed in modern communication systems and are thus an important component of the modern information economy Error Correction Coding Mathematical Methods and Algorithms provides a comprehensive introduction to both the theoretical and practical aspects of error correction coding with a presentation suitable for a wide variety of audiences including graduate students in electrical engineering mathematics or computer science The pedagogy is arranged so that the mathematical concepts are presented incrementally followed immediately by applications to coding A large number of

exercises expand and deepen students understanding A unique feature of the book is a set of programming laboratories supplemented with over 250 programs and functions on an associated Web site which provides hands on experience and a better understanding of the material These laboratories lead students through the implementation and evaluation of Hamming codes CRC codes BCH and R S codes convolutional codes turbo codes and LDPC codes This text offers both classical coding theory such as Hamming BCH Reed Solomon Reed Muller and convolutional codes as well as modern codes and decoding methods including turbo codes LDPC codes repeat accumulate codes space time codes factor graphs soft decision decoding Guruswami Sudan decoding EXIT charts and iterative decoding Theoretical complements on performance and bounds are presented Coding is also put into its communications and information theoretic context and connections are drawn to public key cryptosystems Ideal as a classroom resource and a professional reference this thorough guide will benefit electrical and computer engineers mathematicians students researchers and scientists

Error Detecting Codes Torleiv Kløve, Valery Korzhik, 1995-09-30 Error detecting codes are very popular for error control in practical systems for two reasons First such codes can be used to provide any desired reliability of communication over any noisy channel Second implementation is usually much simpler than for a system using error correcting codes To consider a particular code for use in such a system it is very important to be able to calculate or estimate the probability of undetected error For the binary symmetric channel the probability of undetected error can be expressed in terms of the weight distribution of the code The first part of the book gives a detailed description of all known methods to calculate or estimate the probability of undetected error for the binary symmetric channel in particular but a number of other channel models are also considered The second part of the book describes a number of protocols for feedback communication systems ARQ systems with methods for optimal choice of error detecting codes for the protocols Results have been collected from many sources and given a unified presentation The results are presented in a form which make them accessible to the telecommunication system designer as well as the coding theory researcher and student The system designer may find the presentation of CRC codes as well as the system performance analysis techniques particularly useful The coding theorist will find a detailed account of a part of coding theory which is usually just mentioned in most text books and which contains a number of interesting and useful results as well as many challenging open problems Audience Essential for students practitioners and researchers working in communications and coding theory An excellent text for an advanced course on the subject

Error- Correction Coding for Digital Communications George C. Clark, J. Bibb Cain, 1981 *Error-Correction Coding for Digital Communications* George C. Clark Jr, J. Bibb Cain, 2014-01-15 *A Short Course on Error Correcting Codes* N.J.A. Sloane, 2014-05-04

Channel Estimation for Physical Layer Network Coding Systems Feifei Gao, Chengwen Xing, Gongpu Wang, 2014-10-15 This SpringerBrief presents channel estimation strategies for the physical layer network coding PLNC systems Along with a review of PLNC architectures this brief examines new challenges brought by the special structure of bi directional two hop

transmissions that are different from the traditional point to point systems and unidirectional relay systems The authors discuss the channel estimation strategies over typical fading scenarios including frequency flat fading frequency selective fading and time selective fading as well as future research directions Chapters explore the performance of the channel estimation strategy and optimal structure of training sequences for each scenario Besides the analysis of channel estimation strategies the book also points out the necessity of revisiting other signal processing issues for the PLNC system Channel Estimation of Physical Layer Network Coding Systems is a valuable resource for researchers and professionals working in wireless communications and networks Advanced level students studying computer science and electrical engineering will also find the content helpful

Block Error-Correcting Codes Sebastian Xambo-Descamps,2003-04-16 Error correcting codes have been incorporated in numerous working communication and memory systems This book covers the mathematical aspects of the theory of block error correcting codes together in mutual reinforcement with computational discussions implementations and examples of all relevant concepts functions and algorithms This combined approach facilitates the reading and understanding of the subject The digital companion of the book is a non printable pdf document with hyperlinks The examples included in the book can be run with just a mouse click and modified and saved by users for their own purpose

Forward Error Correction Based On Algebraic-Geometric Theory Jafar A. Alzubi,Omar A. Alzubi,Thomas M.

Chen,2014-06-12 This book covers the design construction and implementation of algebraic geometric codes from Hermitian curves Matlab simulations of algebraic geometric codes and Reed Solomon codes compare their bit error rate using different modulation schemes over additive white Gaussian noise channel model Simulation results of Algebraic geometric codes bit error rate performance using quadrature amplitude modulation 16QAM and 64QAM are presented for the first time and shown to outperform Reed Solomon codes at various code rates and channel models The book proposes algebraic geometric block turbo codes It also presents simulation results that show an improved bit error rate performance at the cost of high system complexity due to using algebraic geometric codes and Chase Pyndiah s algorithm simultaneously The book proposes algebraic geometric irregular block turbo codes AG IBTC to reduce system complexity Simulation results for AG IBTCs are presented for the first time

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