[MOBI] Trellises And Trellis Based Decoding Algorithms For Linear Block Codes

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Only material considered essential and useful for practical applications is included. This book can also be used as a text for advanced courses on the subject.

Trellises and Trellis-Based Decoding Algorithms for Linear Block Codes - Shu Lin - 2012-12-06
As the demand for data reliability increases, coding for error control becomes increasingly important in data transmission systems and has become an integral part of almost all data communication system designs. In recent years, various trellis-based soft-decoding algorithms for linear block codes have been devised. New ideas developed in the study of trellis structure of block codes can be used for improving decoding and analyzing the trellis complexity of convolutional codes. These recent developments provide practicing communication engineers with more choices when designing error control systems. Trellises and Trellis-Based Decoding Algorithms for Linear Block Codes combines trellises and trellis-based decoding algorithms for linear codes together in a simple and unified form. The approach is to explain the material in an easily understood manner with minimal mathematical rigor. Trellises and Trellis-Based Decoding Algorithms for Linear Block Codes is intended for practicing communication engineers who want to have a fast grasp and understanding of the subject.
A code trellis is a graphical representation of a code, block or convolutional, in which every path represents a codeword (or a code sequence for a convolutional code). This representation makes it possible to implement Maximum Likelihood Decoding (MLD) of a code with reduced decoding complexity. The most well known trellis-based MLD algorithm is the Viterbi algorithm. The trellis representation was first introduced and used for convolutional codes [23]. This representation, together with the Viterbi decoding algorithm, has resulted in a wide range of applications of convolutional codes for error control in digital communications over the last two decades. There are two major reasons for this inactive period of research in this area. First, most coding theorists at that time believed that block codes did not have simple trellis structure like convolutional codes and maximum likelihood decoding of linear block codes using the Viterbi algorithm was practically impossible, except for very short block codes. Second, since almost all of the linear block codes are constructed algebraically or based on finite geometries, it was the belief of many coding theorists that algebraic decoding was the only way to decode these codes. These two reasons seriously hindered the development of efficient soft-decision decoding methods for linear block codes and their applications to error control in digital communications. This led to a general belief that block codes are inferior to convolutional codes and hence, that they were not useful. Chapter 2 gives a brief review of linear block codes. The goal is to provide the essential background material for the development of trellis structure and trellis-based decoding algorithms for linear block codes in the later chapters. Chapters 3 through 6 present the fundamental concepts, finite-state machine model, state space formulation, basic structural properties, state labeling, construction procedures, complexity, minimality, and sectionaliza
The Viterbi algorithm is indeed a very simple and efficient method of implementing the maximum likelihood decoding. However, if we take advantage of the structural properties in a trellis section, other efficient trellis-based decoding algorithms can be devised. Recently, an efficient trellis-based recursive maximum likelihood decoding (RMLD) algorithm for linear block codes has been proposed. This algorithm is more efficient than the conventional Viterbi algorithm in both computation and hardware requirements. Most importantly, the implementation of this algorithm does not require the construction of the entire code trellis, only some special one-section trellises of relatively small state and branch complexities are needed for constructing path (or branch) metric tables recursively. At the end, there is only one table which contains only the most likely code-word and its metric for a given received sequence \( r = (r(1), r(2), \ldots, r(n)) \). This algorithm basically uses the divide and conquer strategy. Furthermore, it allows parallel/pipeline processing of received sequences to speed up decoding. Lin, Shu and Fossorier, Marc Goddard Space Flight Center NAG5-931; NAG5-29

Trellises and Trellis-Based Decoding Algorithms for Linear Block Codes. Part 3; A Recursive Maximum Likelihood Decoding - National Aeronautics and Space Administration (NASA) - 2018-07-15

For long linear block codes, maximum likelihood decoding based on full code trellises would be very hard to implement if not impossible. In this case, we may wish to trade error performance for the reduction in decoding complexity. Sub-optimum soft-decision decoding of a linear block code based on a low-weight sub-trellis can be devised to provide an effective trade-off between error performance and decoding complexity. This chapter presents such a suboptimal decoding algorithm for linear block codes. This decoding algorithm is iterative in nature and based on an optimality test. It has the following important features: (1) a simple method to generate a sequence of candidate code-words, one at a time, for test; (2) a sufficient condition for testing a candidate code-word for optimality; and (3) a low-weight sub-trellis search for finding the most likely (ML) code-word. Lin, Shu and Fossorier, Marc Goddard Space Flight Center NAG5-931; NAG5-29

Trellises and Trellis-Based Decoding Algorithms for Linear Block Codes. Part 3; An Iterative Decoding Algorithm for Linear Block Codes Based on a Low-Weight Trellis Search - National Aeronautics and Space Administration (NASA) - 2018-07-15

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Trellises and Trellis-Based Decoding Algorithms for Linear Block Codes. Part 3; An Iterative Decoding Algorithm for Linear Block Codes Based on a Low-Weight Sub-Trellis - National Aeronautics and Space Administration (NASA) - 2018-10-18
For long linear block codes, maximum likelihood decoding based on full code trellises would be very hard to implement if not impossible. In this case, we may wish to trade error performance for the reduction in decoding complexity. Sub-optimum soft-decision decoding of a linear block code based on a low-weight sub-trellis can be devised to provide an effective trade-off between error performance and decoding complexity. This chapter presents such a suboptimal decoding algorithm for linear block codes. This decoding algorithm is iterative in nature and based on an optimality test. It has the following important features: (1) a simple method to generate a sequence of candidate code-words, one at a time, for test; (2) a sufficient condition for testing a candidate code-word for optimality; and (3) a low-weight sub-trellis search for finding the most likely (ML) code-word. Lin, Shu and Fossorier, Marc Goddard Space Flight Center NAG5-931; NAG5-2938

Trellises and Trellis-Based Decoding Algorithms for Linear Block Codes. Part 3; The Map and Related Decoding Algorithms - National Aeronautics and Space Administration (NASA) - 2018-08-20
In a coded communication system with equiprobable signaling, MLD minimizes the word error probability and delivers the most likely codeword associated with the corresponding received sequence. This decoding has two drawbacks. First, minimization of the word error probability is not equivalent to minimization of the bit error probability. Therefore, MLD becomes suboptimum with respect to the bit error probability. Second, MLD delivers a hard-decision estimate of the received sequence, so that information is lost between the input and output of the ML decoder. This information is important in coded schemes where the decoded sequence is further processed, such as concatenated coding schemes, multi-stage and iterative decoding schemes. In this chapter, we first present a decoding algorithm which both minimizes bit error probability, and provides the corresponding soft information at the output of the decoder. This algorithm is referred to as the MAP (maximum aposteriori probability) decoding algorithm. Lin, Shu and Fossorier, Marc Goddard Space Flight Center NAG5-931; NAG5-2938
linear block codes. Shao, Rose Y. and Lin, Shu and Fossorier, Marc Goddard information is lost between the input and output of the ML decoder. This information is important in coded schemes where the decoded sequence is further processed, such as concatenated coding schemes, multi-stage and iterative decoding schemes. In this chapter, we first present a decoding algorithm which both minimizes bit error probability, and provides the corresponding soft information at the output of the decoder. This algorithm is referred to as the MAP (maximum a posteriori probability) decoding algorithm. Lin, Shu and Fossorier, Marc Goddard Space Flight Center NAG5-931; NAG5-2938

**Tail Biting Trellis Representation of Codes** - National Aeronautics and Space Administration (NASA) - 2018-06-11

This paper presents two new iterative algorithms for decoding linear codes based on their tail biting trellises, one is unidirectional and the other is bidirectional. Both algorithms are computationally efficient and achieve virtually optimum error performance with a small number of decoding iterations. They outperform all the previous suboptimal decoding algorithms. The bidirectional algorithm also reduces decoding delay. Also presented in the paper is a method for constructing tail biting trellises for linear block codes. Shao, Rose Y. and Lin, Shu and Fossorier, Marc Goddard Space Flight Center ALGORITHMS; APPLICATIONS PROGRAMS (COMPUTERS); TRELLIS CODING; MATHEMATICAL MODELS; VITERBI DECODERS; COMPUTERIZED SIMULATION; FLOW CHARTS; ITERATION; BLOCK DIAGRAMS; MATRICES (MATHEMATICS); CONVOLUTION INTEGRALS

**Good Trellises for IC Implementation of Viterbi Decoders for Linear Block Codes** - National Aeronautics and Space Administration (NASA) - 2018-07-05

This paper investigates trellis structures of linear block codes for the IC (integrated circuit) implementation of Viterbi decoders capable of achieving high decoding speed while satisfying a constraint on the structural complexity of the trellis in terms of the maximum number of states at any particular depth. Only uniform sectionalizations of the code trellis diagram are considered. An upper bound on the number of parallel and structurally identical (or isomorphic) subtrellises in a proper trellis for a code without exceeding the maximum state complexity of the minimal trellis of the code is first derived. Parallel structures of trellises with various section lengths for binary BCH and Reed-Muller (RM) codes of lengths 32 and 64 are analyzed. Next, the complexity of IC implementation of a Viterbi decoder based on an L-section trellis diagram for a code is investigated. A structural property of a Viterbi decoder called ACS-connectivity which is related to state connectivity is introduced. This parameter affects the complexity of wire-routing (interconnections within the IC). The effect of five parameters namely: (1) effective computational complexity; (2) complexity of the ACS-circuit; (3) traceback complexity; (4) ACS-connectivity; and (5) branch complexity of a trellis diagram on the VLSI complexity of a Viterbi decoder is investigated. It is shown that an IC implementation of a Viterbi decoder based on a non-minimal trellis requires less area and is capable of operation at higher speed than one based on the minimal trellis when the commonly used ACS-array architecture is considered. Lin, Shu and Moorthy, Hari T. and Uehara, Gregory T. Goddard Space Flight Center NAG5-2938
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The MAP algorithm is a trellis-based maximum a posteriori probability decoding algorithm. It is the heart of the turbo (or iterative) decoding which achieves an error performance near the Shannon limit. Unfortunately, the implementation of this algorithm requires large computation and storage. Furthermore, its forward and backward recursions result in long decoding delay. For practical applications, this decoding algorithm must be simplified and its decoding complexity and delay must be reduced. In this paper, the MAP algorithm and its variations, such as Log-MAP and Max-Log-MAP algorithms, are first applied to sectionalized trellises for linear block codes and carried out as two-stage decodings. Using the structural properties of properly sectionalized trellises, the decoding complexity and delay of the MAP algorithms can be reduced. Computation-wise optimum sectionalizations of a trellis for MAP algorithms are investigated. Also presented in this paper are bi-directional and parallel MAP decodings. Lin, Shu and Moorthy, Hari T. and Uehara, Gregory T. Goddard Space Flight Center - 2018-06

Trellis and Turbo Coding - Christian B. Schlegel - 2004-09-07

Trellis and turbo coding are used to compress and clean communications signals to allow greater bandwidth and clarity. Presents the basics, theory, and applications of these techniques with a focus on potential standard state-of-the-art methods in the future. Provides a classic basis for anyone who works in the area of digital communications.

Map Algorithms for Decoding Linear Block Codes Based on Sectionalized Trellis Diagrams - National Aeronautics and Space Administration (NASA) - 2018-06

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Wireless Communications - Giorgio Vitetta - 2013-03-29
This book introduces the theoretical elements at the basis of various classes of algorithms commonly employed in the physical layer (and, in part, in MAC layer) of wireless communication systems. It focuses on single user systems, so ignoring multiple access techniques. Moreover, emphasis is put on single-input single-output (SISO) systems, although some relevant topics about multiple-input multiple-output (MIMO) systems are also illustrated. Comprehensive wireless specific guide to algorithmic techniques. Provides a detailed analysis of channel equalization and channel coding for wireless applications. Unique conceptual approach focusing in single user systems. Covers algebraic decoding, modulation techniques, channel coding and channel equalization.

Information Theory and Applications II - Jean-Yves Chouinard - 1996-09-25
This book constitutes the refereed postworkshop proceedings of the Fourth Canadian Workshop on Information Theory, held in Lac Delage, Quebec, in May 1995. The book contains 18 revised full papers selected from 30 workshop presentations; also included are three invited contributions. The book is divided into sections on algebraic coding, cryptography and secure communications, decoding methods and techniques, coding and modulation for fading channels, and signal processing and pattern recognition.

Trellis and Turbo Coding - Christian B. Schlegel - 2015-08-12
This new edition has been extensively revised to reflect the progress in error control coding over the past few years. Over 60% of the material has been completely reworked, and 30% of the material is original. Convolutional, turbo, and low density parity-check (LDPC) coding and polar codes in a unified framework. Advanced research-related developments such as spatial coupling. A focus on algorithmic and implementation aspects of error control coding.

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Turbo Coding, Turbo Equalisation and Space-Time Coding - Lajos Hanzo - 2011-05-03
Covering the full range of channel codes from the most conventional through to the most advanced, the second edition of Turbo Coding, Turbo Equalisation and Space-Time Coding is a self-contained reference on channel coding for wireless channels. The book commences with a historical perspective on the topic, which leads to two basic component codes, convolutional and block codes. It then moves on to turbo codes which exploit iterative decoding by using algorithms, such as the Maximum-A-Posteriori (MAP), Log-MAP and Soft Output Viterbi Algorithm (SOVA), comparing their performance. It also compares Trellis Coded Modulation (TCM), Turbo Trellis Coded Modulation (TTCM), Bit-Interleaved Coded Modulation (BICM) and Iterative BICM (BICM-ID) under various channel conditions. The horizon of the content is then extended to incorporate topics which have found their way into diverse standard systems. These include space-time block and trellis codes, as well as other Multiple-Input Multiple-Output (MIMO) schemes and near-instantaneously Adaptive Quadrature Amplitude Modulation (AQAM). The book also elaborates on turbo equalisation by providing a detailed portrayal of recent advances in partial response modulation schemes using diverse channel codes. A radically new aspect for this second edition is the discussion of multi-level coding and sphere-packing schemes, Extrinsic Information Transfer (EXIT) charts, as well as an introduction to the family of Generalized Low Density Parity Check codes. This new edition includes recent advances in near-capacity turbo-transceivers as well as new sections on multi-level coding schemes and of Generalized Low Density Parity Check codes Comparatively studies diverse channel coded and turbo detected systems to give all-inclusive information for researchers, engineers and students Details EXIT-chart based irregular transceiver designs Uses rich performance comparisons as well as diverse near-capacity design examples

Information, Coding and Mathematics - Mario Blaum - 2013-03-09
Information, Coding and Mathematics is a classic reference for both professional and academic researchers working in error-correction coding and decoding, Shannon theory, cryptography, digital communications, information security, and electronic engineering. The work represents a collection of contributions from leading experts in turbo coding, cryptography and sequences, Shannon theory and coding bounds, and decoding theory and applications. All of the contributors have individually and collectively dedicated their work as a tribute to the outstanding work of
advances in the widely used and rapidly developing field of information and communication technology.

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**Information Theory and Coding - Solved Problems** - Predrag Ivaniš - 2016-11-29
This book is offers a comprehensive overview of information theory and error control coding, using a different approach then in existed literature. The chapters are organized according to the Shannon system model, where one block affects the others. A relatively brief theoretical introduction is provided at the beginning of every chapter, including a few additional examples and explanations, but without any proofs. And a short overview of some aspects of abstract algebra is given at the end of the corresponding chapters. The characteristic complex examples with a lot of illustrations and tables are chosen to provide detailed insights into the nature of the problem. Some limiting cases are presented to illustrate the connections with the theoretical bounds. The numerical values are carefully selected to provide in-depth explanations of the described algorithms. Although the examples in the different chapters can be considered separately, they are mutually connected and the conclusions for one considered problem relate to the others in the book.

This book constitutes the refereed proceedings of the 19th International Symposium on Applied Algebra, Algebraic Algorithms and Error-Correcting Codes, AAECC-13, held in Honolulu, Hawaii, USA in November 1999. The 42 revised full papers presented together with six invited survey papers were carefully reviewed and selected from a total of 86 submissions. The papers are organized in sections on codes and iterative decoding, arithmetic, graphs and matrices, block codes, rings and fields, decoding methods, code construction, algebraic curves, cryptography, codes and decoding, convolutional codes, designs, decoding of block codes, modulation and codes, Gröbner bases and AG codes, and polynomials.
Algebra, Algebraic Algorithms, and Error-Correcting Codes", reflecting the papers are organized in sections on codes and iterative decoding, arithmetic, graphs and matrices, block codes, rings and fields, decoding methods, code construction, algebraic curves, cryptography, codes and decoding, convolutional codes, designs, decoding of block codes, modulation and codes, Gröbner bases and AG codes, and polynomials.

The AAECC Symposia Series was started in 1983 by Alain Poli (Toulouse), who, together with R. Desq, D. Lazard, and P. Camion, organized the ?rst conference. Originally the acronym AAECC meant "Applied Algebra and Error-Correcting Codes". Over the years its meaning has shifted to "Applied Algebra, Algebraic Algorithms, and Error-Correcting Codes", reflecting the growing importance of complexity in both decoding algorithms and computational algebra. AAECC aims to encourage cross-fertilization between algebraic methods and their applications in computing and communications. The algebraic orientation is towards ?nite ?elds, complexity, polynomials, and graphs. The applications orientation is towards both theoretical and practical error-correction coding, and, since AAECC 13 (Hawaii, 1999), towards cryptography. AAECC was the ?rst symposium with papers connecting Gröbner bases with E-C codes. The balance between theoretical and practical is intended to shift regularly; at AAECC-14 the focus was on the theoretical side. The main subjects covered were: - Codes: iterative decoding, decoding methods, block codes, code construction. - Codes and algebra: algebraic curves, Gröbner bases, and AG codes. - Algebra: rings and ?elds, polynomials. - Codes and combinatorics: graphs and matrices, designs, arithmetic. - Cryptography. - Computational algebra: algebraic algorithms. - Sequences for communications.

Building on the success of the first edition, which offered a practical introductory approach to the techniques of error concealment, this book, now fully revised and updated, provides a comprehensive treatment of the subject and includes a wealth of additional features. The Art of Error Correcting Coding, Second Edition explores intermediate and advanced level concepts as well as those which will appeal to the novice. All key topics are discussed, including Reed-Solomon codes, Viterbi decoding, soft-output decoding algorithms, MAP, log-MAP and MAX-log-MAP. Reliability-based algorithms GMD and Chase are examined, as are turbo codes, both serially and parallel concatenated, as well as low-density parity-check (LDPC) codes and their iterative decoders. Features additional problems at the end of each chapter and an instructor's solutions manual. Updated companion website offers new C/C ++programs and MATLAB scripts, to help with the understanding and implementation of basic ECC techniques. Easy to follow examples illustrate the fundamental concepts of error correcting codes. Basic analysis tools are provided throughout to help in the assessment of the error performance block and convolutional codes of a particular error-growing importance of complexity in both decoding algorithms and computational algebra. AAECC aims to encourage cross-fertilization between algebraic methods and their applications in computing and communications. The algebraic orientation is towards finite fields, complexity, polynomials, and graphs. The applications orientation is towards both theoretical and practical error-correction coding, and, since AAECC 13 (Hawaii, 1999), towards cryptography. AAECC was the first symposium with papers connecting Gröbner bases with E-C codes. The balance between theoretical and practical is intended to shift regularly; at AAECC-14 the focus was on the theoretical side. The main subjects covered were: - Codes: iterative decoding, decoding methods, block codes, code construction. - Codes and algebra: algebraic curves, Gröbner bases, and AG codes. - Algebra: rings and fields, polynomials. - Codes and combinatorics: graphs and matrices, designs, arithmetic. - Cryptography. - Computational algebra: algebraic algorithms. - Sequences for communications.
The conference was planned for June 2003 with the official title Workshop on Coding, Cryptography and Combinatorics (CCC 2003). Those who are familiar with events in East Asia in the first half of 2003 can guess what happened in the end, namely the conference had to be cancelled in the interest of the health of the participants. The SARS epidemic posed too serious a threat. At the time of the cancellation, the organization of the conference was at an advanced stage: all invited speakers had been selected and all abstracts of contributed talks had been screened by the program committee. Thus, it was decided to call on all invited speakers and presenters of accepted contributed talks to submit their manuscripts for publication in the present volume. Altogether, 39 submissions were received and subjected to another round of refereeing. After careful scrutiny, 28 papers were accepted for publication.

Cryptography and Combinatorics - Keqin Feng - 2012-12-06

It has long been recognized that there are fascinating connections between coding theory, cryptography, and combinatorics. Therefore it seemed desirable to us to organize a conference that brings together experts from these three areas for a fruitful exchange of ideas. We decided on a venue in the Huang Shan (Yellow Mountain) region, one of the most scenic areas of China, so as to provide the additional inducement of an attractive location. The conference was planned for June 2003 with the official title Workshop on Coding, Cryptography and Combinatorics (CCC 2003). Those who are familiar with events in East Asia in the first half of 2003 can guess what happened in the end, namely the conference had to be cancelled in the interest of the health of the participants. The SARS epidemic posed too serious a threat. At the time of the cancellation, the organization of the conference was at an advanced stage: all invited speakers had been selected and all abstracts of contributed talks had been screened by the program committee. Thus, it was decided to call on all invited speakers and presenters of accepted contributed talks to submit their manuscripts for publication in the present volume. Altogether, 39 submissions were received and subjected to another round of refereeing. After careful scrutiny, 28 papers were accepted for publication.

Trellis Decoding of Block Codes - Bahram Honary - 2012-12-06

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codes in both these classes is computationally complex in the general case; decoding of error correcting block codes. The subject is extremely significant both theoretically and practically, and is very timely because of recent developments in the microelectronic implementation and range of application of error-control coding systems based on block codes. The authors have been notably active in signal processing and coding research and development for several years, and therefore very well placed to contribute to the state of the art on the subject of trellis decoding. In particular, the book represents a unique approach to many practical aspects of the topic. As the authors point out, there are two main classes of error control codes: block codes and convolutional codes. Block codes came first historically and have a well-developed mathematical structure. Convolutional codes come later, and have developed heuristically, though a more formal treatment has emerged via recent developments in the theory of symbolic dynamics. Maximum likelihood (ML) decoding of powerful codes in both these classes is computationally complex in the general case; that is, ML decoding fails into the class of NP-hard computational problems. This arises because the decoding complexity is an exponential function of key parameters of the code.

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**Error-correcting Codes on Graphs** - Ari Trachtenberg - 2000

**Error Correction Coding** - Todd K. Moon - 2020-12-07

Providing in-depth treatment of error correction, Error Correction Coding: Mathematical Methods and Algorithms, 2nd Edition provides a comprehensive introduction to classical and modern methods of error correction. The presentation provides a clear, practical introduction to using a lab-oriented approach. Readers are encouraged to implement the encoding and decoding algorithms with explicit algorithm statements and the mathematics used in error correction, balanced with an algorithmic development on how to actually do the encoding and decoding. Both block and stream (convolutional) codes are discussed, and the mathematics required to understand them are introduced on a "just-in-time" basis as the reader progresses through the book. The second edition increases the impact and reach of the book, updating it to discuss recent important technological advances. New material includes: Extensive coverage of LDPC codes, including a variety of decoding algorithms. A comprehensive introduction to polar codes, including systematic encoding/decoding and list decoding. An introduction to fountain codes. Modern applications to systems such as HDTV, DVBT2, and cell phones. Error Correction Coding includes extensive program files (for example, C++ code for all LDPC decoders and polar code decoders), laboratory materials for students to implement algorithms, and an updated solutions manual, all of which are perfect to help the reader understand and retain the content. The book covers classical BCH, Reed Solomon, Golay, Reed Muller, Hamming, and convolutional codes which are still component codes in virtually every modern communication system. There are also fulsome discussions of recently developed polar codes and fountain codes that serve to educate the reader on the newest developments in error correction.
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Providing in-depth treatment of error correction Error Correction Coding: Mathematical Methods and Algorithms, 2nd Edition provides a comprehensive introduction to classical and modern methods of error correction. The presentation provides a clear, practical introduction to using a lab-oriented approach. Readers are encouraged to implement the encoding and decoding algorithms with explicit algorithm statements and the mathematics used in error correction, balanced with an algorithmic development on how to actually do the encoding and decoding. Both block and stream (convolutional) codes are discussed, and the mathematics required to understand them are introduced on a “just-in-time” basis as the reader progresses through the book. The second edition increases the impact and reach of the book, updating it to discuss recent important technological advances. New material includes: Extensive coverage of LDPC codes, including a variety of decoding algorithms. A comprehensive introduction to polar codes, including systematic encoding/decoding and list decoding. An introduction to fountain codes. Modern applications to systems such as HDTV, DVBT2, and cell phones Error Correction Coding includes extensive program files (for example, C++ code for all LDPC decoders and polar code decoders), laboratory materials for students to implement algorithms, and an updated solutions manual, all of which are perfect to help the reader understand and retain the content. The book covers classical BCH, Reed Solomon, Golay, Reed Muller, Hamming, and convolutional codes which are still component codes in virtually every modern communication system. There are also fulsome discussions of recently developed polar codes and fountain codes that serve to educate the reader on the newest developments in error correction.

Source and Channel Coding - John B. Anderson - 2012-12-06
How should coded communication be approached? Is it about probability theorems and bounds, or about algorithms and structures? The traditional course in information theory and coding teaches these together in one course in which the Shannon theory, a probabilistic theory of information, dominates. The theory's predictions and bounds to performance are valuable to the coding engineer, but coding today is mostly about structures and algorithms and their size, speed and error performance. While coding has a theoretical basis, it has a practical side as well, an engineering side in which costs and benefits matter. It is safe to say that most of the recent advances in information theory and coding are in the engineering of coding. These thoughts motivate the present text book: A coded communication book based on methods and algorithms, with information theory in a necessary but supporting role. There has been much recent progress in coding, both in the theory and the practice, and these pages report many new advances. Chapter 2 covers traditional source coding, but also the coding of real one-dimensional sources like speech and new techniques like vector quantization. Chapter 4 is a unified treatment of trellis codes, beginning with binary convolutional codes and passing to the new trellis modulation codes.

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book is unique in presenting algorithms, architectures, and applications of modulation codes.

**Coding Theory** - Andre Neubauer - 2007-10-22
One of the most important key technologies for digital communication systems as well as storage media is coding theory. It provides a means to transmit information across time and space over noisy and unreliable communication channels. Coding Theory: Algorithms, Architectures and Applications provides a concise overview of channel coding theory and practice, as well as the accompanying signal processing architectures. The book is unique in presenting algorithms, architectures, and applications of coding theory in a unified framework. It covers the basics of coding theory before moving on to discuss algebraic linear block and cyclic codes, turbo codes and low density parity check codes and space-time codes. Coding Theory provides algorithms and architectures used for implementing coding and decoding strategies as well as coding schemes used in practice especially in communication systems. Feature of the book include: Unique presentation-like style for summarising main aspects Practical issues for implementation of coding techniques Sound theoretical approach to practical, relevant coding methodologies Covers standard coding schemes such as block and convolutional codes, coding schemes such as Turbo and LDPC codes, and space time codes currently in research, all covered in a common framework with respect to their applications. This book is ideal for postgraduate and undergraduate students of communication and information engineering, as well as computer science students. It will also be of use to engineers working in the industry who want to know more about the theoretical basics of coding theory and their application in currently relevant communication systems.

**Joint Source-Channel Decoding** - Pierre Duhamel - 2009-11-26
Treats joint source and channel decoding in an integrated way Gives a clear description of the problems in the field together with the mathematical tools for their solution Contains many detailed examples useful for practical applications of the theory to video broadcasting over mobile and wireless networks Traditionally, cross-layer and joint source-channel coding were seen as incompatible with classically structured networks but recent advances in theory changed this situation. Joint source-channel decoding is now seen as a viable alternative to separate decoding of source and channel codes, if the protocol layers are taken into account. A joint source/protocol/channel approach is thus addressed in this book: all levels of the protocol stack are considered, showing how the information in each layer influences the others. This book provides the tools to show how cross-layer and joint source-channel coding and decoding are now compatible with present-day mobile and wireless networks, with a particular application to the key area of video transmission to mobiles. Typical applications are broadcasting, or point-to-point delivery of multimedia.
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Pierre Duhamel is director of research at CNRS/ LSS and has previously held research positions at Thomson-CSF, CNET, and ENST, where he was head of the Signal and Image Processing Department. He has served as chairman of the DSP committee and associate Editor of the IEEE Transactions on Signal Processing and Signal Processing Letters, as well as acting as a co-chair at MMSP and ICASSP conferences. He was awarded the Grand Prix France Telecom by the French Science Academy in 2000. He is co-author of more than 80 papers in international journals, 250 conference proceedings, and 28 patents. Michel Kieffer is an assistant professor in signal processing for communications at the Université Paris-Sud and a researcher at the Laboratoire des Signaux et Systèmes, Gif-sur-Yvette, France. His research interests are in joint source-channel coding and decoding techniques for the reliable transmission of multimedia contents. He serves as associate editor of Signal Processing (Elsevier). He is co-author of more than 90 contributions to journals, conference proceedings, and book chapters. Treats joint source and channel decoding in an integrated way Gives a clear description of the problems in the field together with the mathematical tools for their solution Contains many detailed examples useful for practical applications of the theory to video broadcasting over mobile and wireless networks

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**Near-Capacity Variable-Length Coding** - Lajos L. Hanzo - 2010-11-15

Recent developments such as the invention of powerful turbo-decoding and irregular designs, together with the increase in the number of potential applications to multimedia signal compression, have increased the importance of variable length coding (VLC). Providing insights into the very latest research, the authors examine the design of diverse near-capacity VLC codes in the context of wireless telecommunications. The book commences with an introduction to Information Theory, followed by a discussion of Regular as well as Irregular Variable Length Coding and their applications in joint source and channel coding. Near-capacity designs are created using Extrinsic Information Transfer (EXIT) chart analysis. The latest techniques are discussed, outlining radical concepts such as Genetic Algorithm (GA) aided construction of diverse VLC codes. The book concludes with two chapters on VLC-based space-time transceivers as well as on frequency-hopping assisted schemes, followed by suggestions for future work on the topic. Surveys the historic evolution and development of VLCs. Discusses the very latest research into VLC codes. Introduces the novel concept of Irregular VLCs and their application in joint-source and channel coding.

**Turbo Codes** - Branka Vucetic - 2012-12-06

This book grew out of our research, industry consulting and continuing education courses. Turbo coding initially seemed to belong to a restricted research area, while now has become a part of the mainstream telecommunication theory and practice. The turbo decoding principles have found widespread applications not only in error control, but in detection, interference suppression and equalization. Intended for use by advanced students and professional engineers, involved in coding and telecommunication research, the book includes both basic and advanced material. The chapters are sequenced so that the knowledge is acquired in a logical and progressive way. The algorithm descriptions and analysis are supported by examples throughout the book. Performance evaluations of the presented algorithms are carried out both analytically and by simulations. Basic material included in the book has been taught to students and practicing professionals over the last four years in the form of senior undergraduate or graduate courses, lecture series and short continuing education courses.
Essentials of Error-Control Coding - Jorge Castiñeira Moreira - 2006-08-04

Rapid advances in electronic and optical technology have enabled the implementation of powerful error-control codes, which are now used in almost the entire range of information systems with close to optimal performance. These codes and decoding methods are required for the detection and correction of the errors and erasures which inevitably occur in digital information during transmission, storage and processing because of noise, interference and other imperfections. Error-control coding is a complex, novel and unfamiliar area, not yet widely understood and appreciated. This book sets out to provide a clear description of the essentials of the subject, with comprehensive and up-to-date coverage of the most useful codes and their decoding algorithms. A practical engineering and information technology emphasis, as well as relevant background material and fundamental theoretical aspects, provides an in-depth guide to the essentials of Error-Control Coding. Provides extensive and detailed coverage of Block, Cyclic, BCH, Reed-Solomon, Convolutional, Turbo, and Low Density Parity Check (LDPC) codes, together with relevant aspects of Information Theory EXIT chart performance analysis for iteratively decoded error-control techniques Heavily illustrated with tables, diagrams, graphs, worked examples, and exercises Invaluable companion website features slides of figures, algorithm software, updates and solutions to problems

Offering a complete overview of Error Control Coding, this book is an indispensable resource for students, engineers and researchers in the areas of telecommunications engineering, communication networks, electronic engineering, computer science, information systems and technology, digital signal processing and applied mathematics.

Turbo Coding - Chris Heegard - 2013-03-09

When the 50th anniversary of the birth of Information Theory was celebrated at the 1998 IEEE International Symposium on Information Theory in Boston, there was a great deal of reflection on the year 1993 as a critical year. As the years pass and more perspective is gained, it is a
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**Coding for Wireless Channels** - Ezio Biglieri - 2006-07-06
Accessible introduction to the theoretical foundations of modern coding theory Including numerous applications to wireless transmission systems The author is famous in the field of coding and wireless communications for his work in the area of faded channels & communications.

**Error Control Coding** - Shu Lin - 2004
028M> A reorganized and comprehensive major revision of a classic book, this edition provides a bridge between introductory digital communications and more advanced treatment of information theory. Completely updated to cover the latest developments, it presents state-of-the-art error control techniques. 028M> Coverage of the fundamentals of coding and the applications of codes to the design of real error control systems. Contains the most recent developments of coded modulation, trellises for codes, soft-decision decoding algorithms, turbo coding for reliable data transmission and other areas. There are two new chapters on Reed-Solomon codes and concatenated coding schemes. Also contains hundreds of new and revised examples; and more than 200 illustrations of code structures, encoding and decoding circuits and error performance of many important codes and error control coding systems. 028M> Appropriate for those with minimum mathematical background as a comprehensive reference for coding theory.

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Error Control Coding - Lin Shu - 2011

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Fully revised and updated version of the successful "Advanced Wireless Communications" Wireless communications continue to attract the attention of both research community and industry. Since the first edition was published significant research and industry activities have brought the fourth generation (4G) of wireless communications systems closer to implementation and standardization. "Advanced Wireless Communications" continues to provide a comparative study of enabling technologies for 4G. This second edition has been revised and updated and now includes additional information on the components of common air interface, including the area of space time coding, multicarrier modulation especially OFDM, MIMO, cognitive radio and cooperative transmission. Ideal for students and engineers in research and development in the field of wireless communications, the second edition of Advanced Wireless Communications also gives an understanding to current approaches for engineers in telecomm operators, government and regulatory institutions. New features include: Brand new chapter covering linear precoding in MIMO channels based on convex optimization theory. Material based on game theory modelling encompassing problems of adjacent cell interference, flexible spectra sharing and cooperation between the nodes in ad hoc networks. Presents and discusses the latest schemes for interference suppression in ultra wide band (UWB) cognitive systems. Discusses the cooperative transmission and more details on positioning.

Codes, Systems, and Graphical Models - Brian Marcus - 2012-12-06
Coding theory, system theory, and symbolic dynamics have much in common. A major new theme in this area of research is that of codes and systems based on graphical models. This volume contains survey and research articles from leading researchers at the interface of these subjects. Codes, Systems, and Graphical Models - Brian Marcus - 2012-12-06
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Channel Codes - William Ryan - 2009-09-17
Channel coding lies at the heart of digital communication and data storage, and this detailed introduction describes the core theory as well as decoding algorithms, implementation details, and performance analyses. In this book, Professors Ryan and Lin provide clear information on modern channel codes, including turbo and low-density parity-check (LDPC) codes. They also present detailed coverage of BCH codes, Reed-Solomon codes, convolutional codes, finite geometry codes, and product codes, providing a one-stop resource for both classical and modern coding techniques. Assuming no prior knowledge in the field of channel coding, the opening chapters begin with basic theory to introduce newcomers to the subject. Later chapters then extend to advanced topics such as code ensemble performance analyses and algebraic code design. 250 varied and stimulating end-of-chapter problems are also included to test and enhance learning, making this an essential resource for students and practitioners alike.

Fundamentals of Convolutional Coding, Second Edition, regarded as a bible
of convolutional coding brings you a clear and comprehensive discussion of the basic principles of this field. Two new chapters on low-density parity-check (LDPC) convolutional codes and iterative coding Viterbi, BCJR, BEAST, list, and sequential decoding of convolutional codes. Distance properties of convolutional codes. Includes a downloadable solutions manual.

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Turbo-like Codes - Aliazam Abbasfar - 2007-09-09
This book introduces turbo error correcting concept in a simple language, including a general theory and the algorithms for decoding turbo-like code. It presents a unified framework for the design and analysis of turbo codes and LDPC codes and their decoding algorithms. A major focus is on high speed turbo decoding, which targets applications with data rates of several hundred million bits per second (Mbps).

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Fifth International ITG Conference on Source and Channel Coding (SCC) - Wolfgang Koch - 2004-01-01

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