16:332:548 Error Control Coding
Spring 2014

Preliminary Course Syllabus

Error-control codes are essentially important in achieving the high degree of reliability required in modern data transmission and storage systems. Apart from the study of codes that efficiently achieve reliable transmission across channels corrupted by noise, the Error-Control Coding (ECC) Theory studies the design of encoding and decoding schemes which could be easily implemented.

The course will begin with an introduction to the fundamental problems of the ECC Theory, and their mathematical formulations. This will include a review of the finite field arithmetic and vector space preliminaries. It continues with binary linear block codes (focus on Hamming codes), cyclic codes (focus on Reed-Solomon and BCH codes), and binary linear convolutional codes (focus on the Viterbi algorithm). We will also cover the basics of multivariate-polynomials based codes (Reed-Muller). Next, we will discuss codes on graphs, a more modern approach to encoding and decoding, which will include some of the following topics: the sum-product and min-sum algorithms; the BCJR algorithm; turbo codes; LDPC codes and RA codes; and iterative decoding of codes on graphs.

To motivate students' interest in the ECC topics beyond this course, we will touch upon some advanced topics, such as code bounds based on the notion of minimum distance, and introduce the concept of Maximum Distance Separable (MDS) codes which offer maximum protection against symbol errors for a given amount of redundancy. While discussing theoretical aspects, we will emphasize practical issues, such as designing codes for particular channels vs. unknown channels, and trade-offs in memory, rate and complexity.

Textbook

S. Lin and D.J. Costello, Error Control Coding, Second Edition, Prentice Hall, 2004.
or
T.K. Moon, Error Correction Coding: Mathematical Methods and Algorithms, John Wiley 2005

References

S.B. Wicker, Error Control Systems for Digital Communication and Storage, Prentice-Hall 1995
R. M. Roth, Introduction to Coding Theory, Cambridge University Press, 2006.
S. Ling and C. Xing, Coding Theory, A First Course, Cambridge University Press, 2004.
D. J. C. MacKay, Information Theory, Inference, and Learning Algorithms, Cambridge Univ. Press, 2003.
R. J. McEliece, Finite Fields for Computer Scientists and Engineers, Kluwer Academic Publishers, 1987.
R. E. Blahut, Theory and Practice of Error Control Codes, Addison-Wesley, 1983.
F. J. MacWilliams and N. J. A. Sloane, The Theory of Error-Correcting Codes, North-Holland, 1978.
E. R. Berlekamp, Algebraic Coding Theory, McGraw-Hill, 1968.

Co-requisites

16:332:545 (DIGITAL COMMUNICATION SYSTEMS) or by the instructor's permission.

Instructor

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