

EECS 650

Channel Coding Theory and Applications

Tu-Th, 9:00am-10:30am,

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Course Description:

Coding theory is the science of the systematic study of structured sets called codes, providing reliable communications and data storage in noisy environments. Today, error-correcting codes are among the fundamental parts of any communication system and data storage system.

The classical approach to construct such structured sets has been to consider certain algebraic objects such as vector spaces and finite fields. In the first part of this course, we cover some required background to study linear binary block codes and algebraic codes over finite fields. In particular, some of the well-known classical codes such as Reed-Solomon codes and BCH codes are studied.

Another approach to construct structured sets or codes has been to exploit properties of certain graphical models and trellises. This approach was essentially born by the invention of convolutional codes in 50's but was mostly discarded till 90's due to the lack of computational power. The invention of turbo codes and the re-discovery of low-density parity-check codes in 90's led to the birth of a new subfield of coding theory called modern coding theory. In the second part of the course, we study some essential aspects of modern coding theory.

A classical goal of information theory set by Shannon 70 years ago has been to construct explicit codes with practical encoder and decoder that achieve the fundamental limit of channel capacity. This goal was finally accomplished by the invention of polar codes in 2009. This has revolutionized the field of coding and information theory as many open problems have been solved using polar codes and the new notion of channel polarization. Besides being asymptotically optimal, polar codes have also been shown to perform very well at short block length which has led to their adoption in 5G wireless communication systems. In the third part of the course, we study polar codes and channel polarization together with practical aspects of their implementation.

