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Mathematica Programs for Trellis Code Design

The major goal of trellis code design for lossy data compression is to find a code yielding minimal average distortion per data sample while encoding at a fixed rate. Perturbation theory provides a new solution approach, whereby one allows the parity check matrix to vary (holding certain rows fixed while changing others). Each of these matrices can be characterized via a positive integer called its signature, and the signatures lie in a multiplicative group G. The position of a signature in G, evaluated using various group operations, can be used to decide if the code should be considered for use in the final application.

My contribution to this design method consists of a suite of Mathematica programs. These programs enable one to quickly perform group operations in order to study a trellis code while allowing it to become increasingly complex. Dr. John Kieffer previously developed a set of programs in MATLAB with the same goal. But numerical obstacles make using MATLAB impractical when working with large trellises. For example, to work around a finite precision limitation when multiplying integers, Kieffer's program would split the two large numbers into row vectors of digits and process them with a convolution function instead. Using Mathematica's symbolic expressions eliminates this constraint, allowing trellis codes of arbitrary size to be designed, given sufficient computing resources.

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