Information theory and error control coding/Teoria da informação e códigos corretores de erros

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Tutorial Questions/Lista de Exercícios - 8

1. A turbo encoder uses component convolutional codes with a parity generator G(x) = 1/(1+x+x2) . The length of the input sequence is 10, and the interleaver is described by the sequence π = {9; 4; 2; 7; 0; 6; 1; 8; 3; 5}.

a) Draw the block diagram for the turbo encoder and the state diagram for the convolutional code, labelling the transitions with the output sequences of each part of the encoder, i.e., the raw bits **v**(0), the output of the first convolutional code **v** (1), and the output of the second convolutional code **v**(2).

b) The sequence **x** = [1 1 0 0 1 0 1 0 1 1] is the input to the turbo encoder. Determine the output sequences of each part of the encoder **v**(0), **v** (1), **v**(2) and the corresponding concatenated sequence **v = [v**(0), **v** (1), **v**(2)].

c) The sequence is punctured to obtain a rate R = 1/2 code by taking the even bits of **v** (1) and the odd bits of **v**(2). Determine the output sequence **v** for the punctured code.

d) Let be the output of a turbo coded sequence coming from an AWGN channel. Suppose that BPSK modulation is employed. Let the transmitted signal  have energy , where , and . Let . Show that where and 

2. Consider the Matlab code provided on the website of the course that simulates turbo codes with arbitrary parameters of block length and rate using BPSK modulation and additive white Gaussian noise.

a) Plot the bit error ratio (BER) against the signal-to-noise ratio (SNR) for a range of values. Suggestion: pick 5 or 6 SNR points, use rates R = 1/2 and 1/3 for each decoder (MAP and SOVA).

b) Develop an s-random interleaver and compare its BER x SNR performance with the interleaver provided. Suggestion: check the literature for s-random interleavers.