Spring 2003: EE223 Homework 7
Solutions due Apr 29
Collaboration among students is encouraged

Problem 6.1 *8.37 and 8.38 in Proakis*

Problem 6.2 *Convolutional Code: Soft Decisions (Computer Exercise: part II)*

a. *What is a noise variance for 2-PAM (i.e. +1,-1) over an AWGN such that the probability of error on a single bit is* 0.1*?*

b. *Modify the code for your optimal dynamic-programming based decoder to use soft decisions.*

c. *As before, suppose that you are given a rate 1/N convolutional code (on a binary alphabet) with constraint length B in terms of N different "impulse responses" each of length B.*

   Generate a rate 1/3 convolutional code with $B = 9$ at random using independent fair coin tosses. Generate an input of length 20 consisting of all zeros (since this is a linear code) and then run it through the encoder. Suppose that the signal is modulated using 2-PAM and then sent over the AWGN Gaussian channel you chose in part a.

   Run the decoder from part b. to get an estimate of the received sequence. Estimate through simulation the average probability of error on the different bit positions: $1, 2, 3, \ldots, 20$. *As before, take the average over channel noise realizations, and if you want, code realizations.*

d. *Comment on the difference in performance relative to the last homework.*

Problem 6.3 *LDPC codes In class, LDPC codes were specified as the subspaces $x^T H = 0$ where H is a sparse matrix.*

a. *Give a strategy for encoding and an iterative algorithm for approximately decoding a code that was instead specified by $x^T H + s^T = 0$ where + represents modulo 2 addition and s^T is a row vector with some* 1*s and some* 0*s. What changes from the discussion in class?*

b. *Suppose that instead of having a binary alphabet, we had an alphabet drawn from a finite field with q elements. The LDPC code continues to be specified by $x^T H = 0$ where the matrix H continues to be sparse with mostly zeros and some* 1*s but no other letters. Give a strategy for encoding bits into codewords and an iterative algorithm for approximately decoding the code.*

c. *What would change in part b. if the "parity check matrix" H was allowed to have entries other than* 1*s?*

d. *BONUS: Implement the iterative algorithm for LDPC decoding and evaluate it on a randomly generated code.*