

# 6.441 Transmission of Information

## Problem Set 8

Spring 2010

Due date: April 22

### Problem 1 Binary detection

Consider an AWGN channel  $Y_i = X_i + N_i$ , with  $N_i \sim N(0, \sigma^2)$  and power constraint  $\frac{1}{n} \sum_i x_i^2 \leq P$ .

(a) Use MATLAB, plot the capacity as a function of the signal to noise ratio  $P/\sigma^2$

(b) Consider a suboptimal strategy as follows: at each time, transmit  $X_i$  as  $+\sqrt{P}$  or  $-\sqrt{P}$ . At the receiver, use maximum likelihood detection to detect whether + or - is transmitted. Compute the probability of detection error  $P_e$ .

(c) Now each time gives a binary symmetric channel with cross over probability of  $P_e$ , compute the capacity of this channel. Argue that we can achieve this capacity by using a binary code to choose + or - to be transmitted at each time. Plot the capacity as a function of the signal-to-noise ratio, and compare with the result in part (a).

(d) Use the same binary input at each time, but do not assume a hard decision to be made at each time. Give an expression of the capacity. How would this capacity compare with the results in (a) and (c)?

### Problem 2

Problem 9.7 in Cover and Thomas (**second** edition)

### Problem 3

Problem 9.12 in Cover and Thomas (**second** edition)

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