Information Theory
(ELL714)

Assignment 2

Joint Typicality based channel decoder

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1 Objective

The aim of this assignment is to check if a good decoding scheme can be performed using AEP in a Binary Symmetric Channel and to verify the coding theorem.

2 Introduction

The joint typicality is described by the following conditions. All three conditions must be satisfied for any two sequences at the input and the output of a channel to be jointly typical

$$A_\epsilon^{(n)} = \{(x^n, y^n)\epsilon X^n \times Y^n :$$

$$|\frac{-1}{n}log(p(x^n) - H(x)| < \epsilon$$
$$|\frac{-1}{n}log(p(y^n) - H(y)| < \epsilon$$
$$|\frac{-1}{n}log(p(x^n, y^n) - H(x,y)|\} < \epsilon$$

3 The experiments

1. For each n $\in$ {10, 100, 500, 1000, . . .}, obtained a random codebook C_n containing $\lceil 2^{nR} \rceil$ codewords. Independently generated binary numbers using an underlying uniform probability mass function p(x)=0.5.
2. Using C_n , transmit codewords with uniform distribution over the channel.
3. At the receiver side, observed the binary sequences and then decoded the input message using a decoder based on joint typicality. Pick $\epsilon = 0.01$ when defining joint typicality.
4) Through simulations, compute the average probability of error of the decoder. Also, compute how many times the decoder is unable to decode the message?
5) Plotted the average probability of error of the decoder against different values of n.
6) Commented on the plot change when the value of ϵ was changed.

4 Outputs and observations

Figure 1. shows the typical output terminal. When n was varied from 100 through

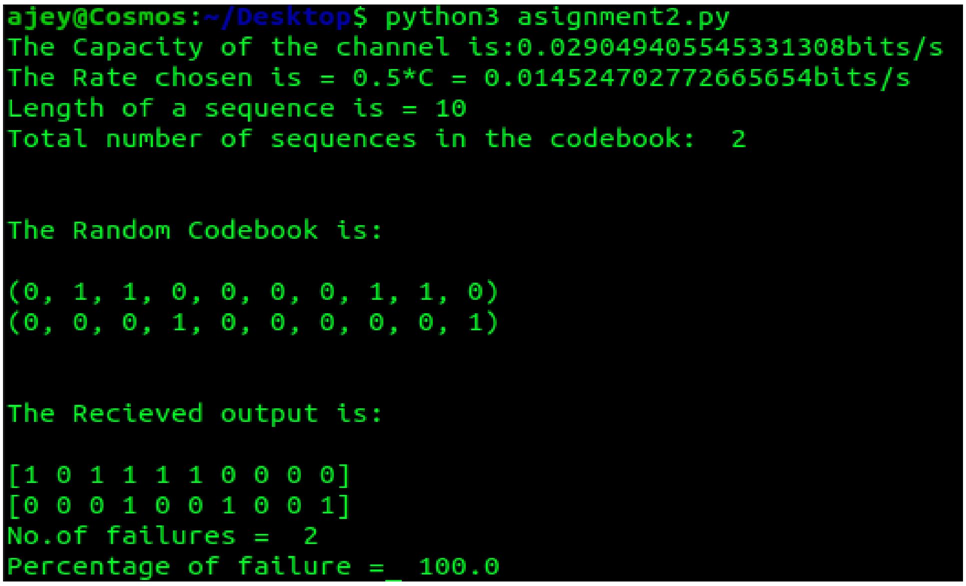

Figure 1: A typical output screen

1000, I found the decoder behaving as in Figure.2. It confirms the idea that as n increases, the error possibility of error becomes smaller. Similarly, the observation

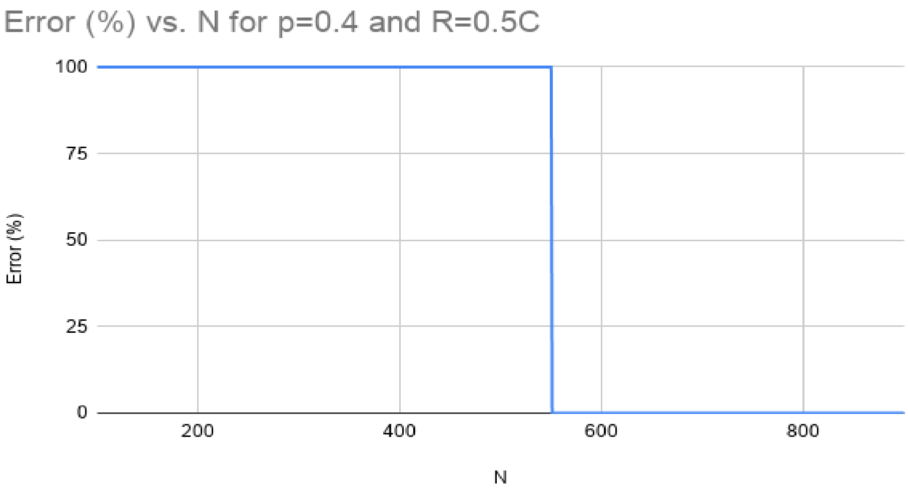

Figure 2: Error Vs N chart, p=0.4, R=0.5C

plots for when ϵ was changed is shown in Figure 3. for $\epsilon = 0.1$, the change in error rate is shown in blue. for $\epsilon = 0.01$, the change in error rate is shown in yellow. When ϵ is increased, the number of bits required to achieve joint typicality increases.

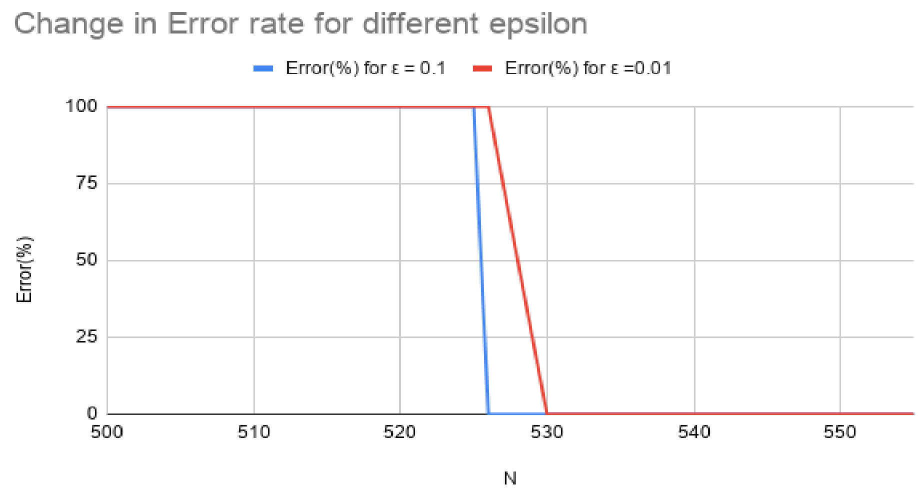

Figure 3: Error Vs N chart for different values of ϵ