

$\begin{array}{c} \text{Information Theory} \\ (\text{ELL714}) \end{array}$

Assignment 2

Joint Typicality based channel decoder

Submitted To:

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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

$$\begin{split} A_{\epsilon}^{(n)} &= \{(x^n,y^n)\epsilon X^n \times Y^n: \\ &|\frac{-1}{n}log(p(x^n)-H(x))| < \epsilon \\ &|\frac{-1}{n}log(p(y^n)-H(y))| < \epsilon \\ &|\frac{-1}{n}log(p(x^n,y^n)-H(x,y))| \} < \epsilon \end{split}$$

3 The experiments

- 1. For each $n \in \{10, 100, 500, 1000, \dots \}$, 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

```
ajey@Cosmos:~/Desktop$ python3 asignment2.py
The Capacity of the channel is:0.029049405545331308bits/s
The Rate chosen is = 0.5*C = 0.014524702772665654bits/s
Length of a sequence is = 10
Total number of sequences in the codebook: 2

The Random Codebook is:

(0, 1, 1, 0, 0, 0, 0, 1, 1, 0)
(0, 0, 0, 1, 0, 0, 0, 0, 1)

The Recieved output is:

[1 0 1 1 1 1 0 0 0 0]
[0 0 0 1 0 0 1 0 0 1]
No.of failures = 2
Percentage of failure = 100.0
```

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

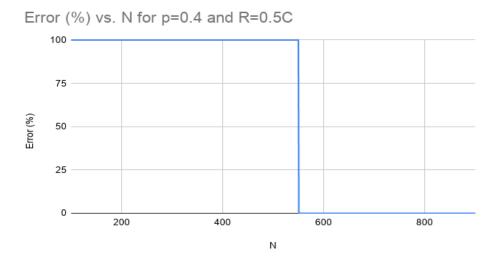


Figure 2: Error Vs N chart, p=0.4, R=0.5C

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.

Change in Error rate for different epsilon — Error(%) for ε = 0.1 — Error(%) for ε = 0.01

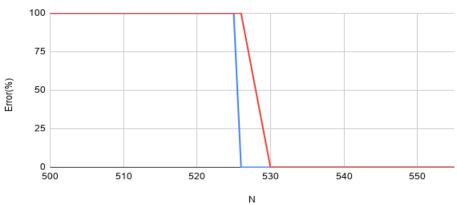


Figure 3: Error Vs N chart for different values of ϵ