# Polar Codes

CT216 : Introduction to Communication Technology
Dhirubhai Ambani Institute of information and Communication Technology
Lab Group : 5
Sub Group : 2
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***Abstract*—This document provides a comprehensive overview of polar codes and their significance in communication technology. It covers the theory behind polar encoding and decoding in modern communication systems.**

## I. Honor Code

We, Group 2 of Lab 5, declare that
→ The work that we presenting is our own work.
→ we have not copied the work (Matlab code, results, etc.) that someone else has done.
→ Concepts, understanding and insights we will be describing are our own.
→ Wherever we have relied on an existing work that is not our own, we have provided a proper reference citation.
→ we make this pledge truthfully. we know that violation of this solemn pledge can carry grave consequences.

## II. Successive Cancellation Decoder

1) getReliabilitySequence : take N bit as a input and gives an output of an vector of size N reliability sequence

2) K is the message length

3) crcLenght is the crc length

4) Total Length is A = K + CRC

4) vector crc is the "crc" polynomial

5) vector F is the frozen bit position in reliability sequence

6) randomGenerate : generates random binary message of size A

7) generateCrcMessage : This function adds crc bits(all bits are '0's) to the end of the K length message bit and then divide with crc polynomial and get remainder. after getting remainder it appends the remainder in the and of the message then, it passes to encoding

8) message_indices is the vector that contains indices of remaining bits, that are not frozen.

9) generateU : this function will generate N bit sequence of including message and forzen bits

10) encodingPolarCodes : endcodes the message.

11) BPSK : this function BPSK into u gives s vector.

12) AWGN : this function AWGN into s gives r vector.

13) vector msgDecode store our decoded message.

14) decodingPolarCodes : process of decoding message, that gives us List of possible partialy decoded messages. then we have encode these List to get decoded messages.

16) decode_message : this function retrieves non - frozen bits, that are our frozen bit

15) Then iterate over all List, and check for CRC, and which one first gets remainder as all '0' bits, it is our decode message.

16) countBitSuccess : this function counts the total correct message bits in the receiving side (by comparing).

17) countBitError : this function counts the total incorrect message bits in the receiving side (by comparing).

18) BER_sim : is the value of bit error rate

19) FER_sim : is the value of block error rate

Remaining portion is the procces of plotting graph

## III. Analysis

CT- Analysis

Analysis: explain how the Polar Codes can be theoretically proven to achieve Shannon's Channel Capacity bound.
Method-1: By Definition For that first we start our analysis by Shannon channel capacity theorem it goes like,

We talk about this theorem :

-For Block-Size N Polar code grows polynomial in $1/\epsilon$
-Shannon's noisy channel coding theorem implies that for every memory less channel W with binary inputs and a finite output alphabet there is a channel capacity, I(W) $\geq$ 0 For that there is aw : 0¡aw¡infinite & bw : bw¿0
For this following will holds:
When $\epsilon$>0 and N$\geq$ aw /$\epsilon$2, there is rate(R)+ at least to

: I(W) is channel capacity of channel
: W is binary-input discrete memory less channel
: R is Rate for Channel W
And for the probability of error pr =2$^{(bW*\epsilon 2*N)}$

Now Coming to our main Aim,

So in that N$\geq$ aw /$\epsilon$2
$\epsilon$2$\geq$ aw/N
as N$\rightarrow\infty$ß$\epsilon\rightarrow$0

So by Shannon's 48 We can say R$\geq$I(W)- but for N$\rightarrow\infty$,$\epsilon$0 so
RI(W) it means that our codes rate is tending to the channel capacity.
Hence it proved.

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