

# Cooperative learning of encoding and decoding functions

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# Importance of NN in encoding / decoding

- Neural networks can learn a form of decoding algorithm, rather than only a simple classifier

The neural network is able to generalize to codewords that it has never seen during training for structured, but not for random codes

- Artificial Neural Networks have been used because of their adaptive learning, self-organization, and real time operation

NN is able to learn the mapping or to extract the channel statistics during the learning process

# Error Correction Codes

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## What is ECC?

In coding theory forward error correction or channel coding is a technique used for controlling errors in data transmission over unreliable or noisy communication channels

## AWGN Channel

Additive White Gaussian noise channel is the most common type of noise added over the channel. It is white because it has a constant power spectral density.

## BPSK Modulation

Binary Phase Shift Keying(BPSK), is a two phase **modulation** scheme, where the 0's and 1's in a binary message are represented by two different phase states in the carrier signal: for binary 1 and. for binary 0

# Structure

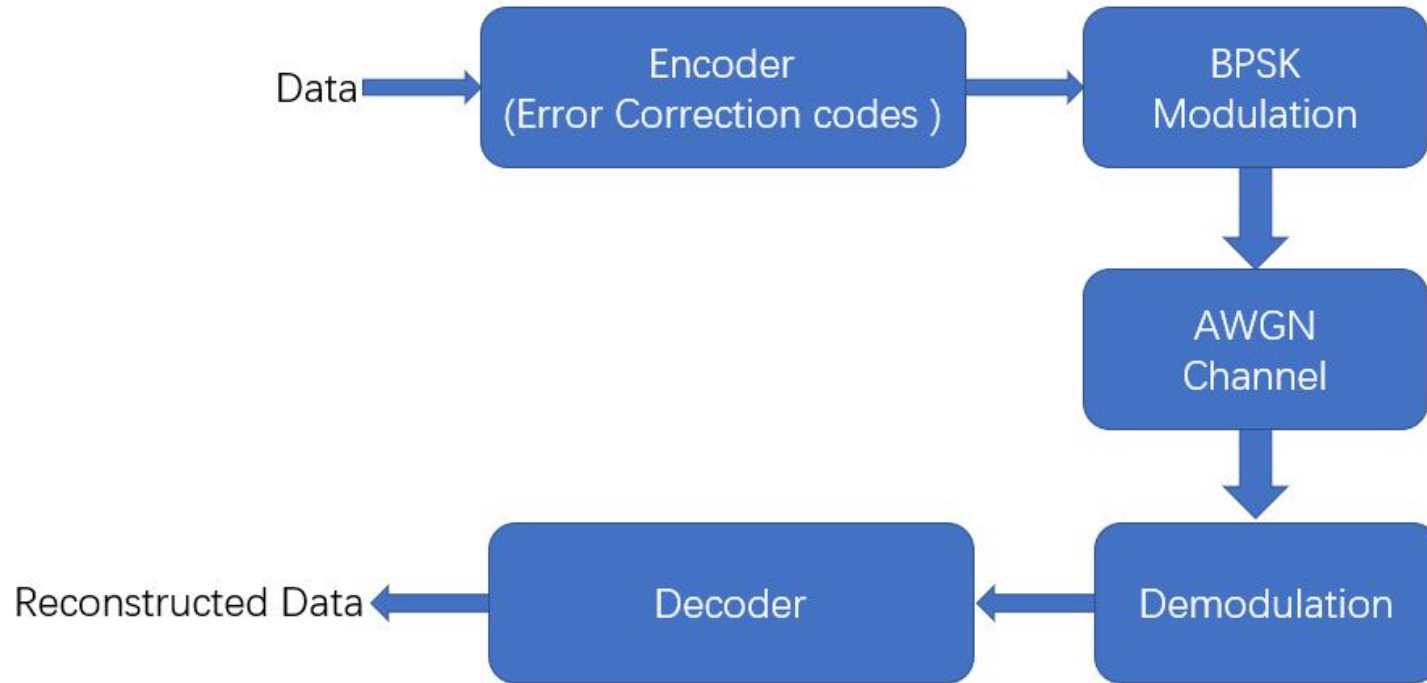


Figure 1: An illustration on the experiment structure

# What is method for the project



- We try simple architecture with default performance values, Simulating the performance for parameters: BI-AWGN channel, BPSK modulation, and random codes and Polar codes were used during testing process.

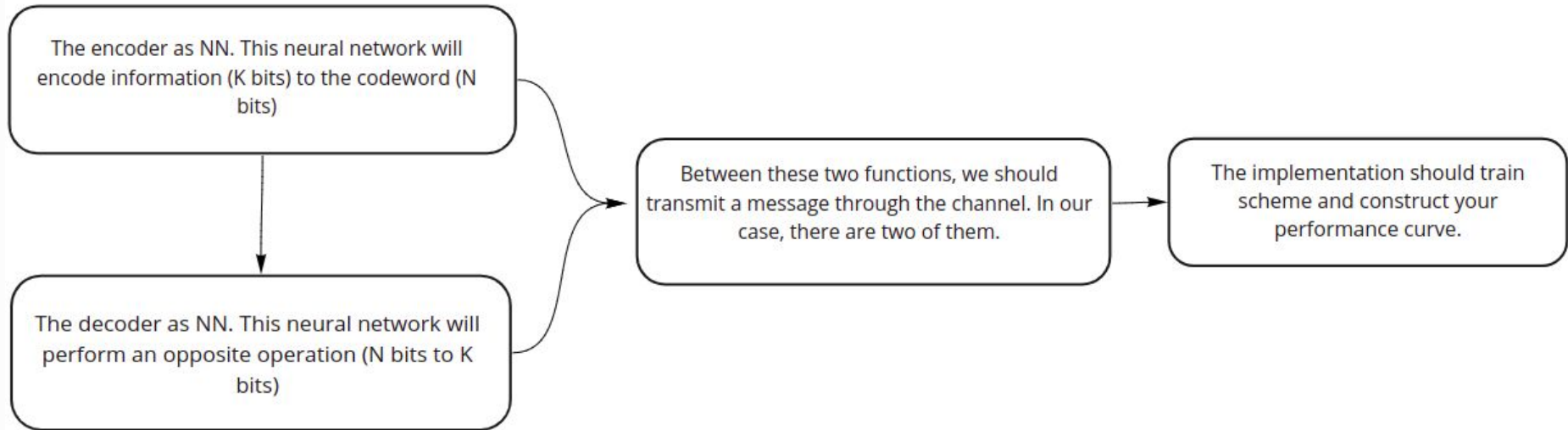


Figure 2: Explanation of process structure

# Our Results

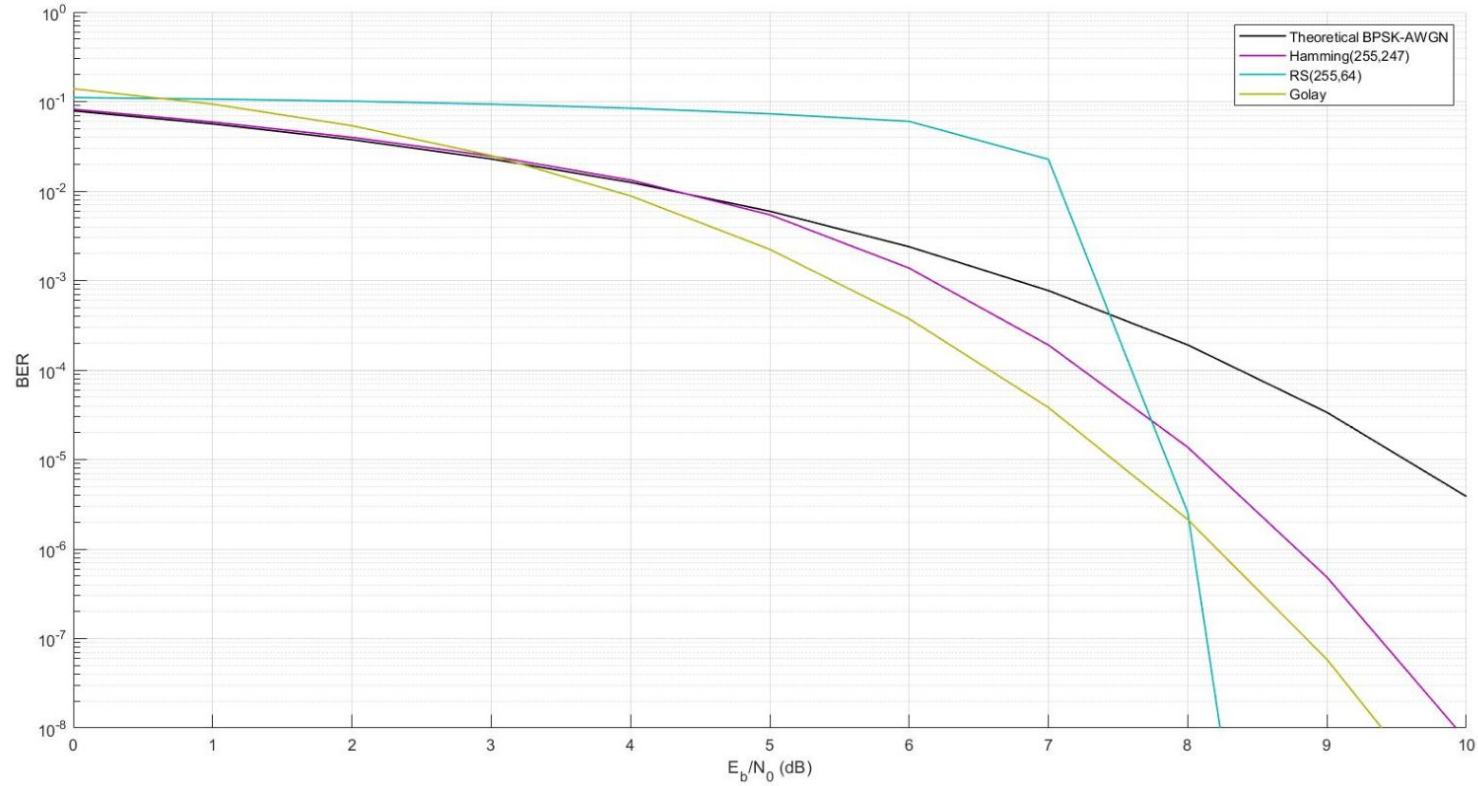


Figure 3: BER Curve of uncoded-BPSK-AWGN channel, Hamming(255,247)code, RS(255,64)code and Golay code.

# Our Results

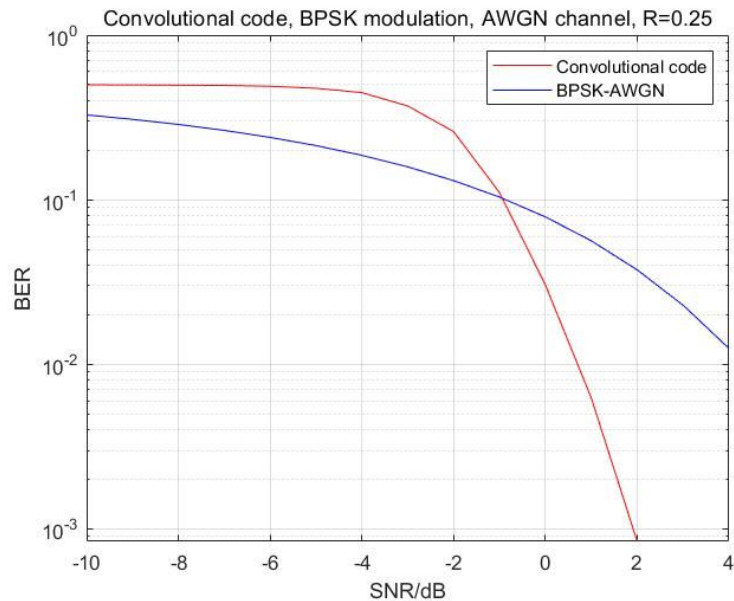


Figure 4: BER Curve of Convolutional code( $R=0.25$ , BI-AWGN, BPSK).

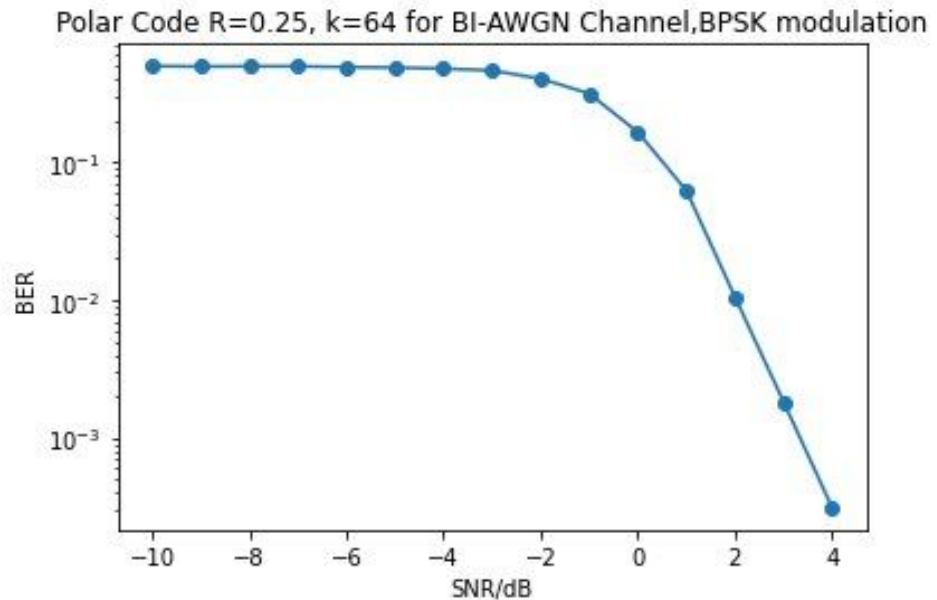


Figure 5: BER Curve of Polar code( $k=64$ ,  $R=0.25$ , BI-AWGN, BPSK).

# Studied Results

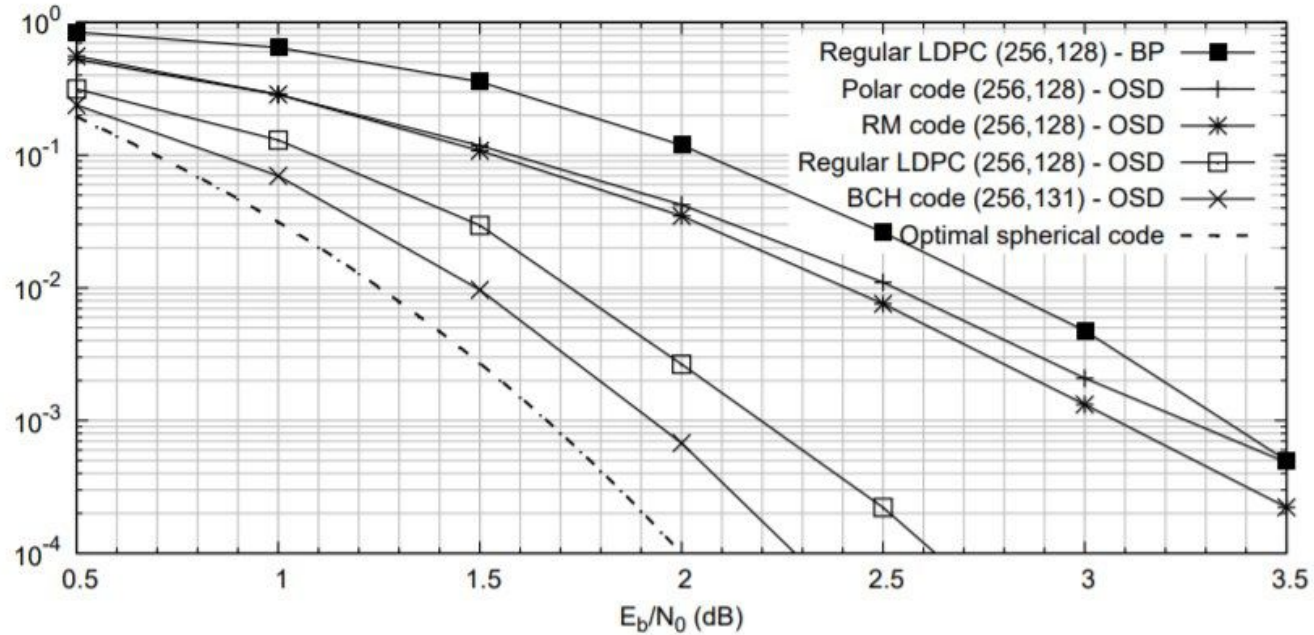


Figure 6: Word error rate versus signal-to-noise ratio. Performance comparison of codes with length 256 and rate 1/2.



# Research Overviews

- We have studied the article by On Deep Learning-Based Channel Decoding, and AI Coding: Learning to Construct Error Correction Codes

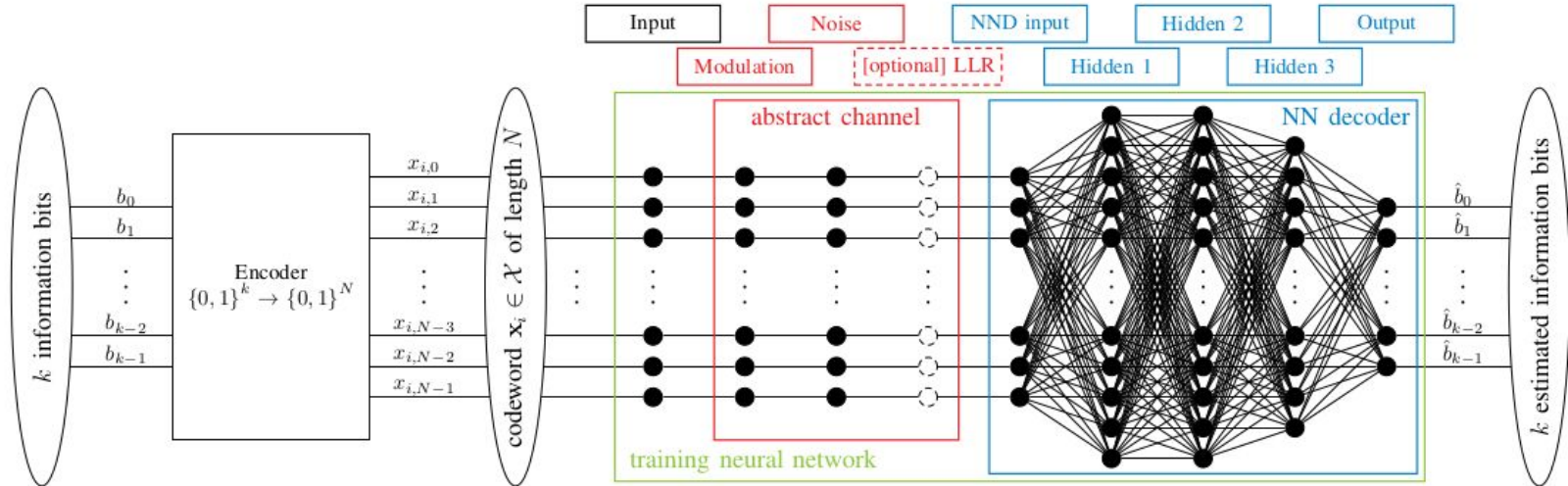
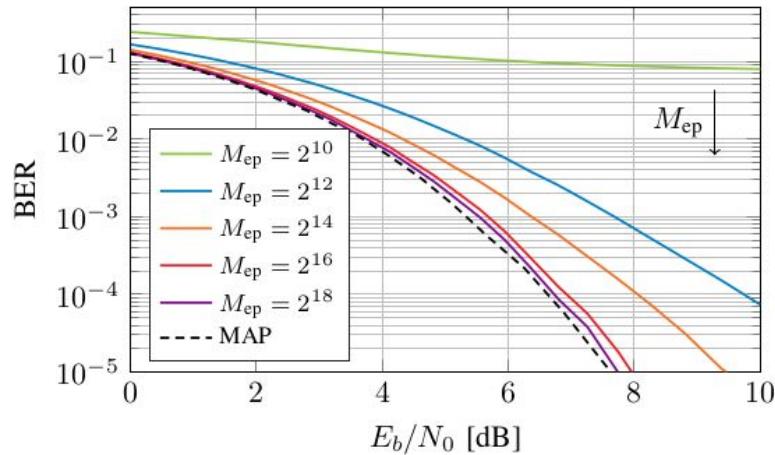


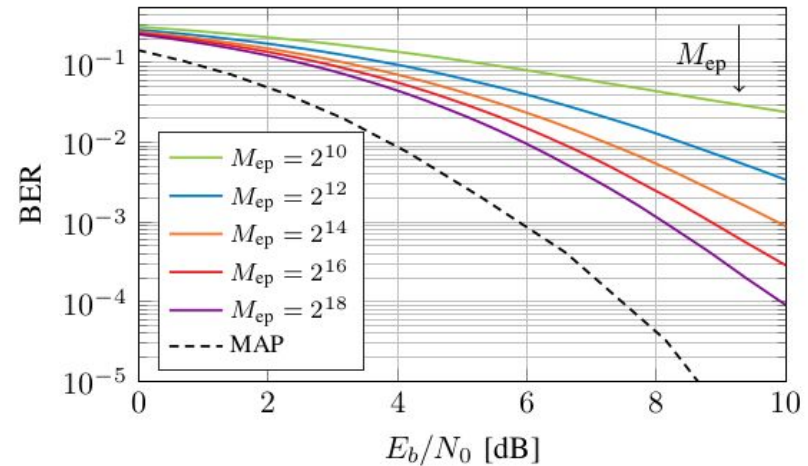
Figure 7: Deep learning setup for channel coding.

# Studied Results

Results of our code should be trained for polar codes (a) and investigated for random codes as well (b), on performance Energy per bit to noise spectral density ratio ( $E_b/N_0$ ) versus Bit Error Rate (BER) Influence of the number of epochs  $M_{ep}$  on them.



(a) Polar Code



(b) Random Code

Figure 8: Influence of the number of epochs  $M_{ep}$  on the BER of a 128-64-32 NN for 16 bit-length codes with code rate  $r = 0.5$

# Conclusion

We have learnt about the channel decoding using Neural Networks and compared the results of our implementation with different research publications and discussed/compared their results. Moreover, during the project process we learnt many necessary tools for implementation. BI-AWGN channel, BPSK modulation, Neural Networks, how structure is modulated, BER Curve of Polar code, BER Curve of Convolutional code with parameters of ( $k=64$ ,  $R=0.25$ , BI-AWGN, BPSK).

Moreover, BER Curve of uncoded-BPSK-AWGN channel, Hamming(255,247)code, RS(255,64)code, and Golay code are performed.

# Thank you!