

# KO codes

**Ashok Vardhan Makkuva (UIUC)**

Joint work with Xiyang Liu, Mohammad Wahid Jamali,  
Hessam MahdaviFar, Sewoong Oh, Pramod Viswanath

# Outline

- Motivation
- Learning codes
- **KO codes**: novel neural codes
  - KO codes, *ICML 2021*

# Age of Information



# 1948: Then there was light



## The Bell System Technical Journal

Vol. XXVII

July, 1948

No. 3

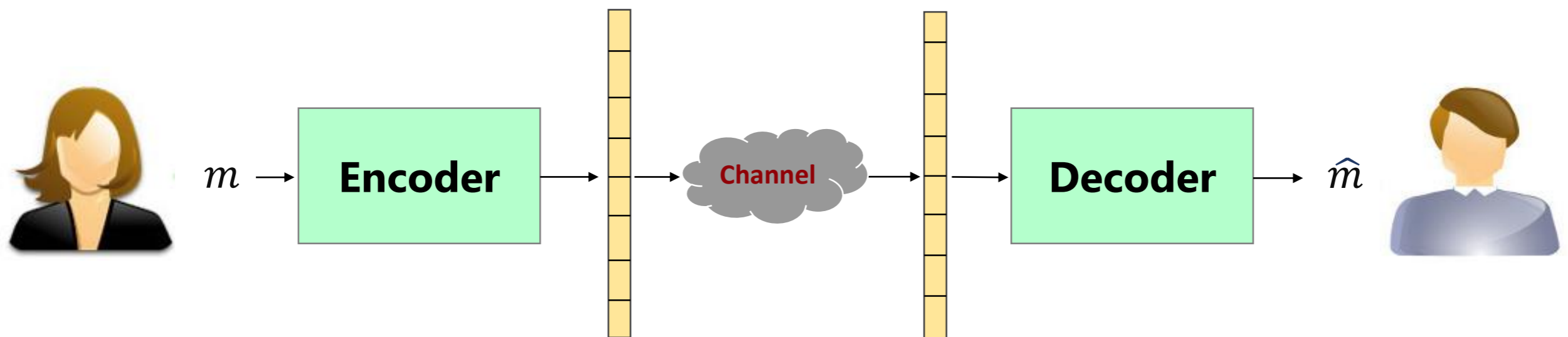
### A Mathematical Theory of Communication

By C. E. SHANNON

#### INTRODUCTION

THE recent development of various methods of modulation such as PCM and PPM which exchange bandwidth for signal-to-noise ratio has intensified the interest in a general theory of communication. A basis for such a theory is contained in the important papers of Nyquist<sup>1</sup> and Hartley<sup>2</sup> on this subject. In the present paper we will extend the theory to include a number of new factors, in particular the effect of noise in the channel, and the savings possible due to the statistical structure of the original message and due to the nature of the final destination of the information.

# Codes: a mathematical lens

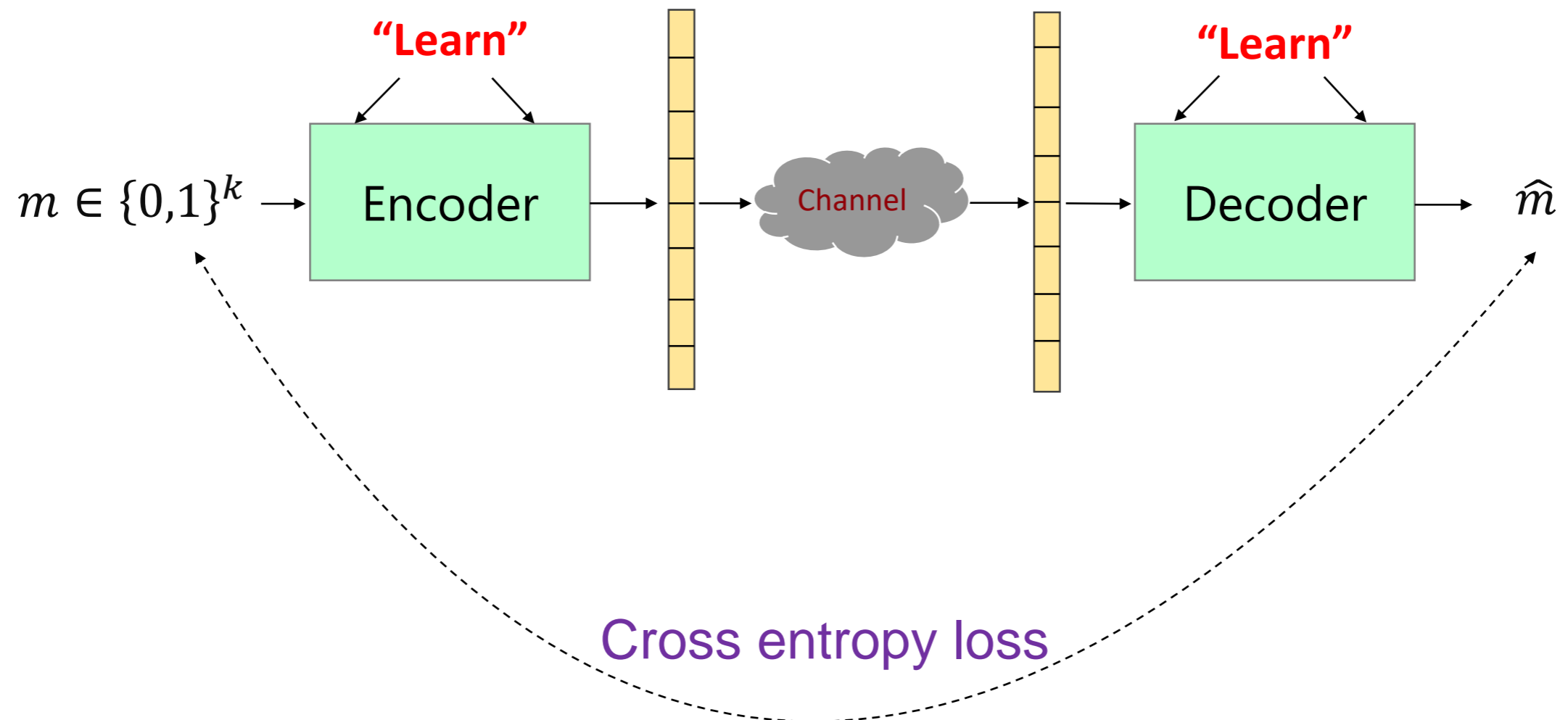


Code = (Encoder, Decoder)

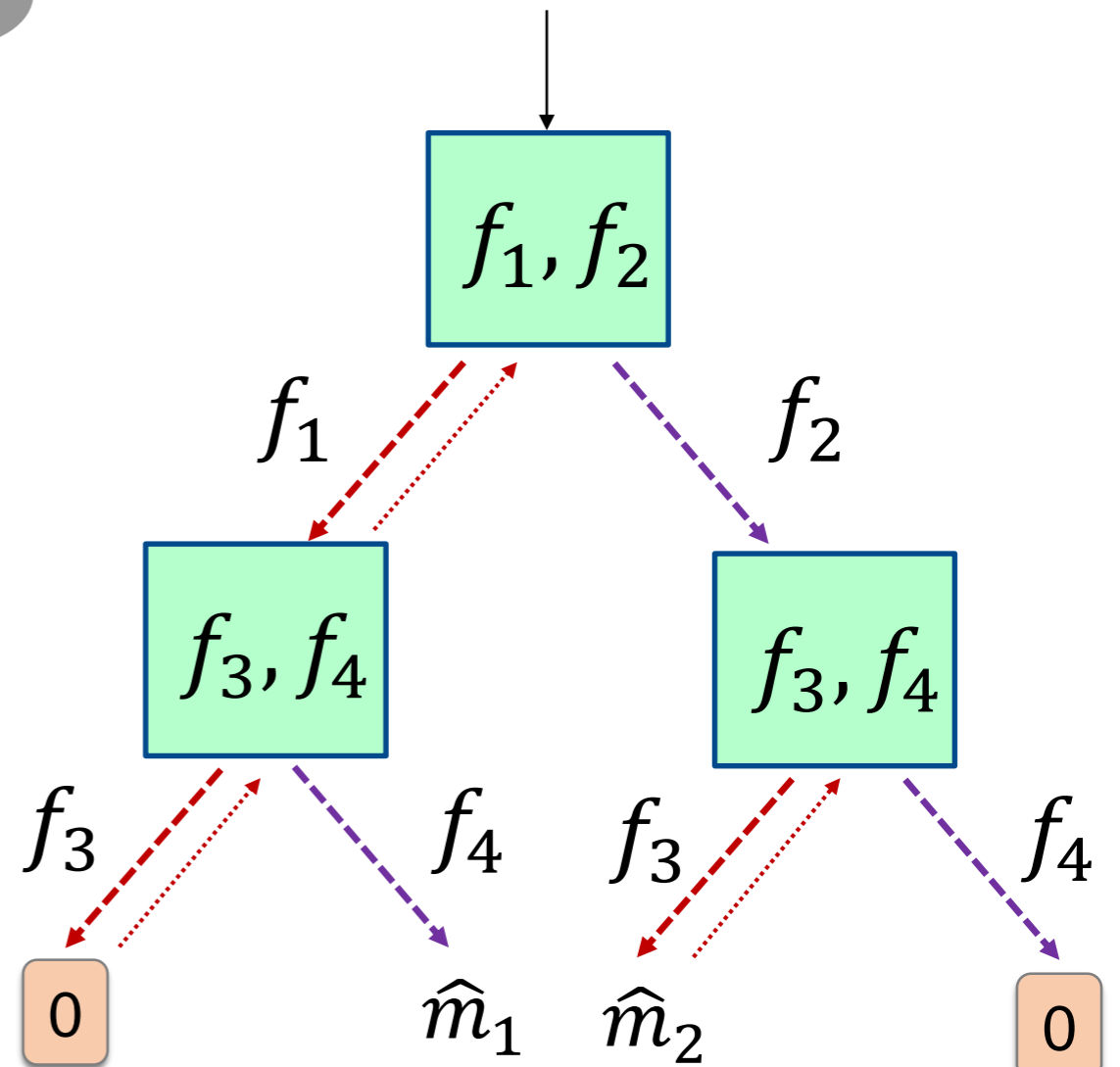
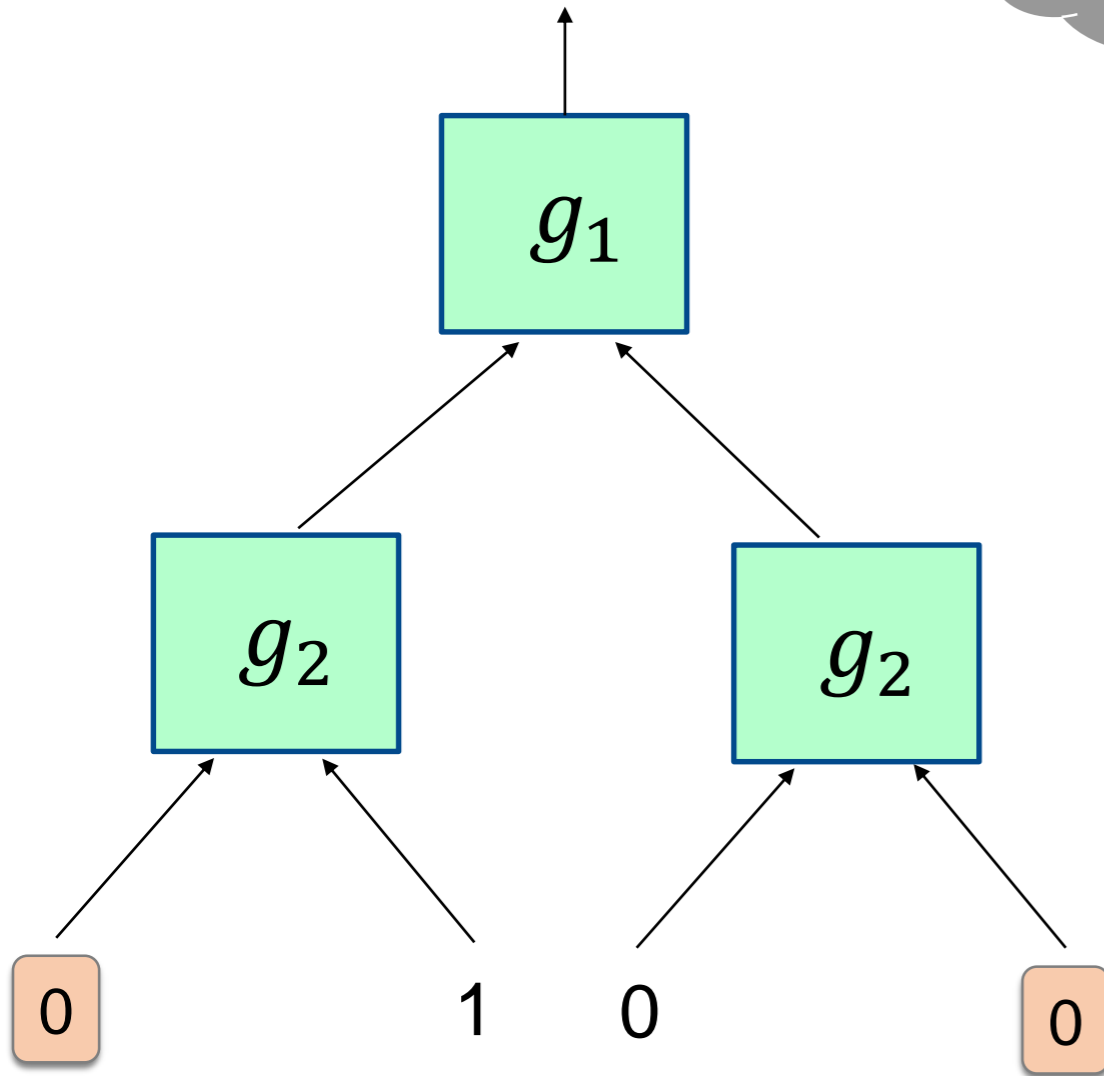
# Technical challenges

- **Challenge:** space of (encoders, decoders) very large
  - Rate =  $\frac{1}{2}$ ,  $k = 100$ :  $2^{100}$  codewords in 200 dimensional space
- **Our approach:** efficient DL-algorithms to learn codes

# Learning a new code

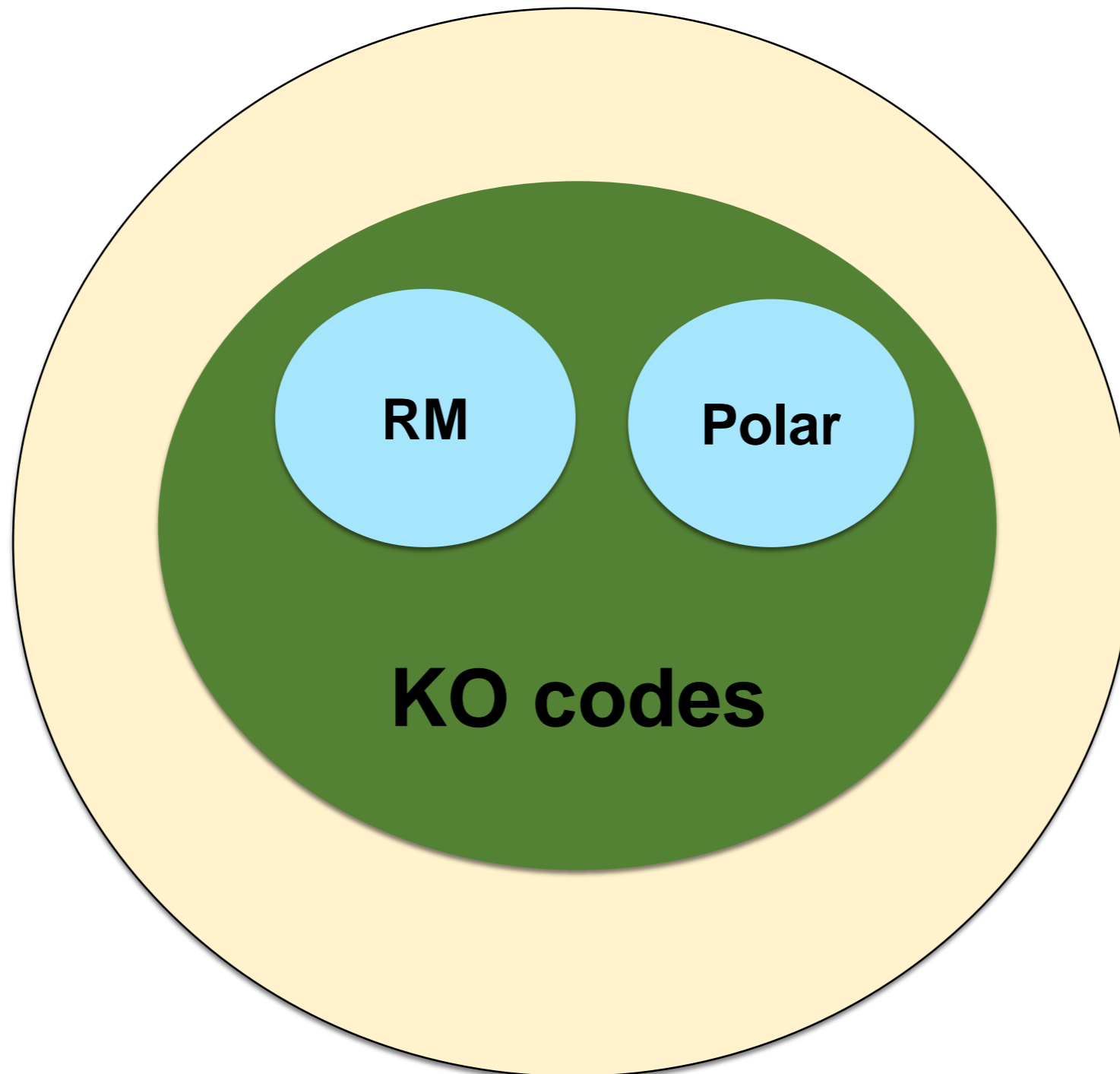


# KO (encoder, decoder)





# KO codes

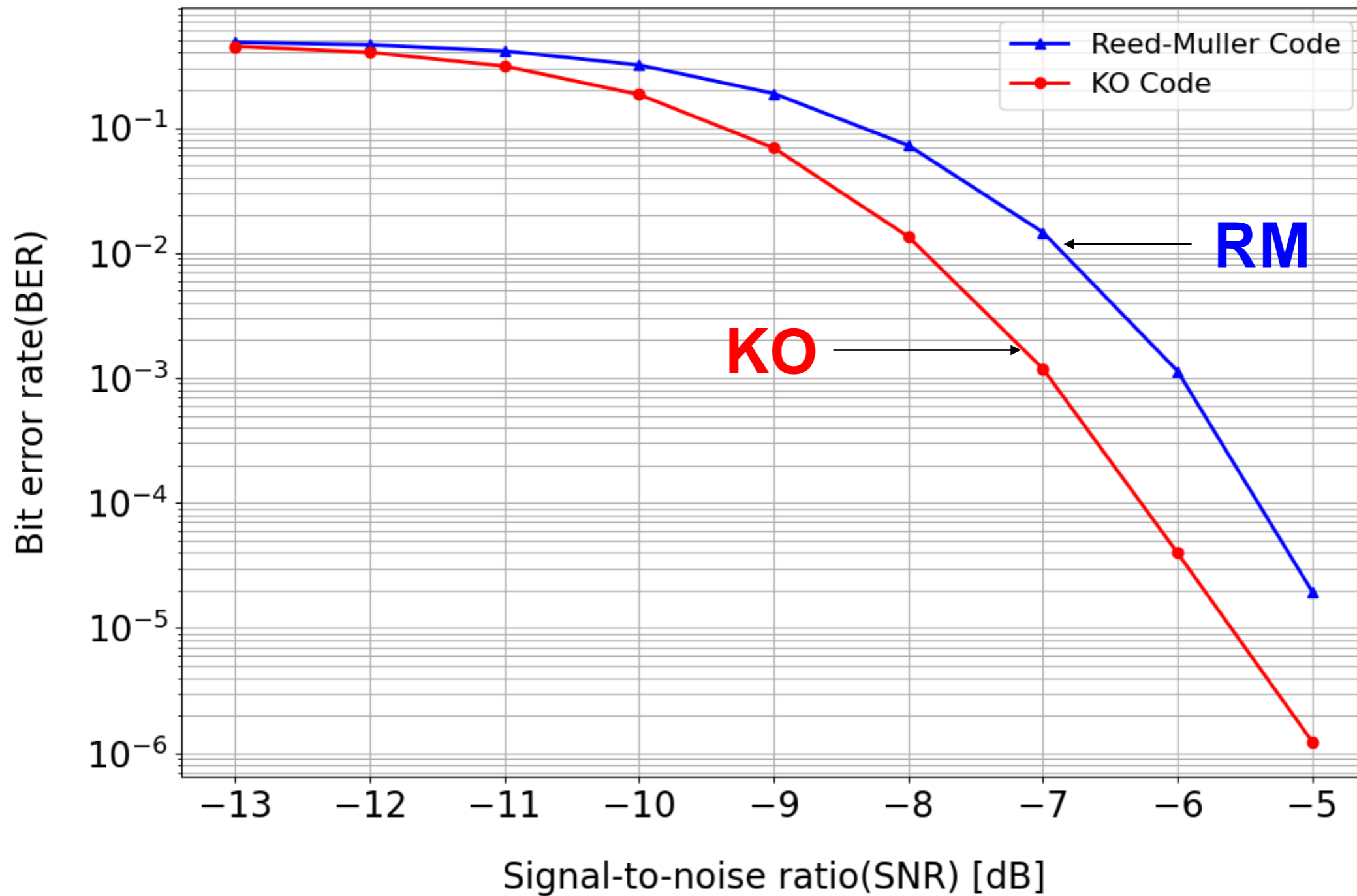


# KO codes: An overview

- Novel family of neural codes
- Outperform both RM and Polar in certain regimes
- Fascinating properties

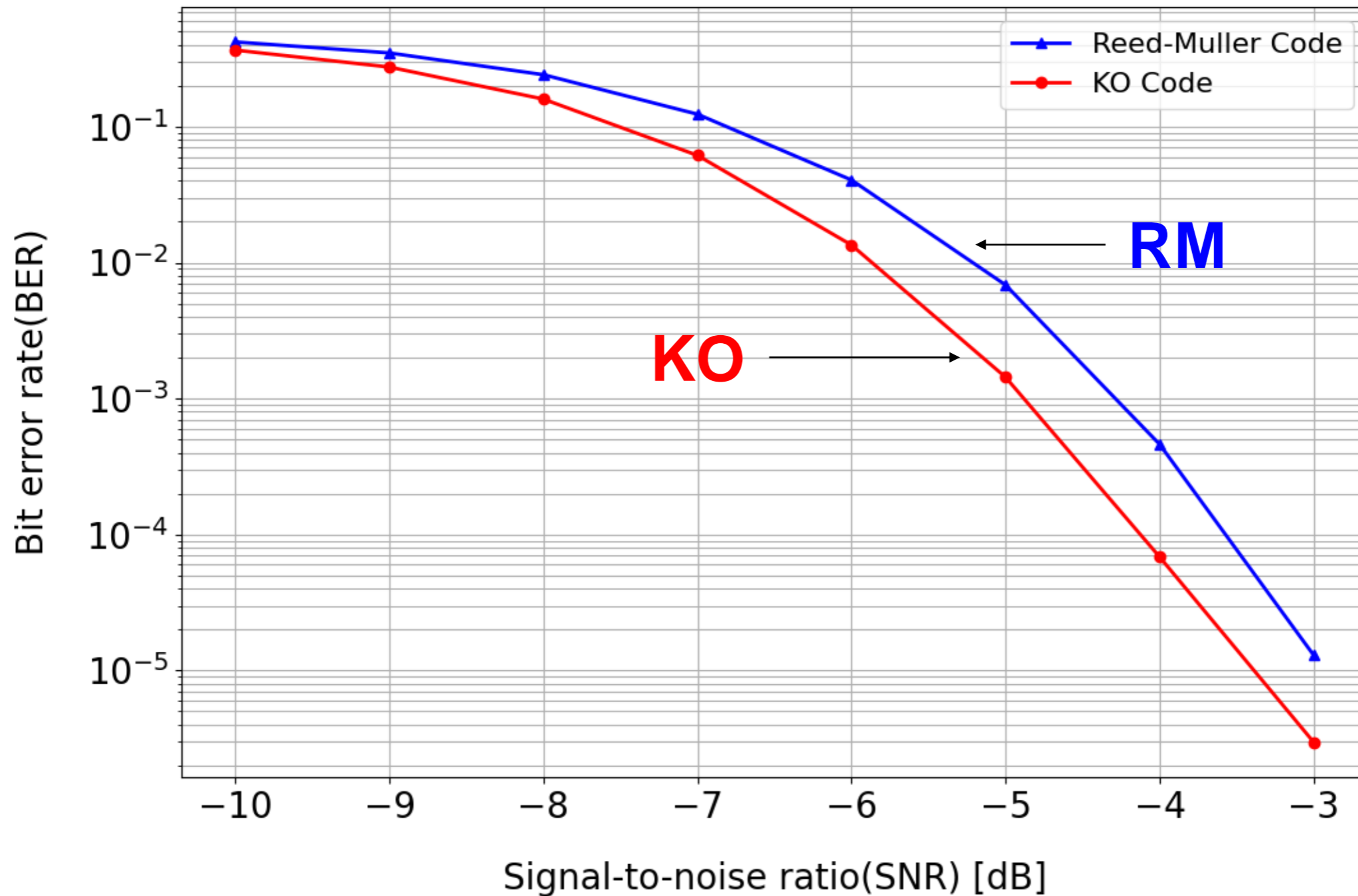
# KO codes beat RM

Code-dimension=46, Block length = 512



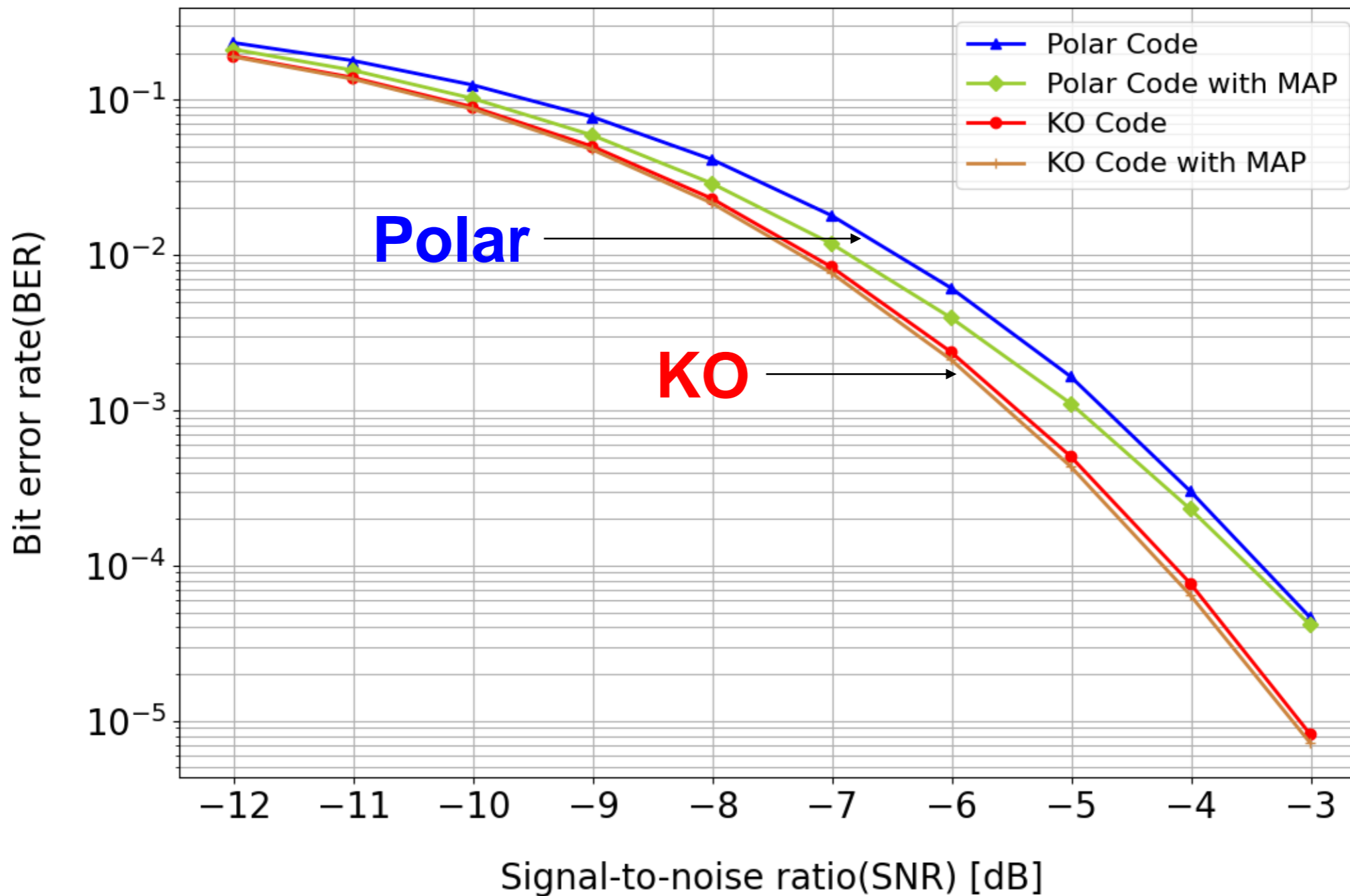
# KO codes beat RM

Code-dimension=37, Block length = 256



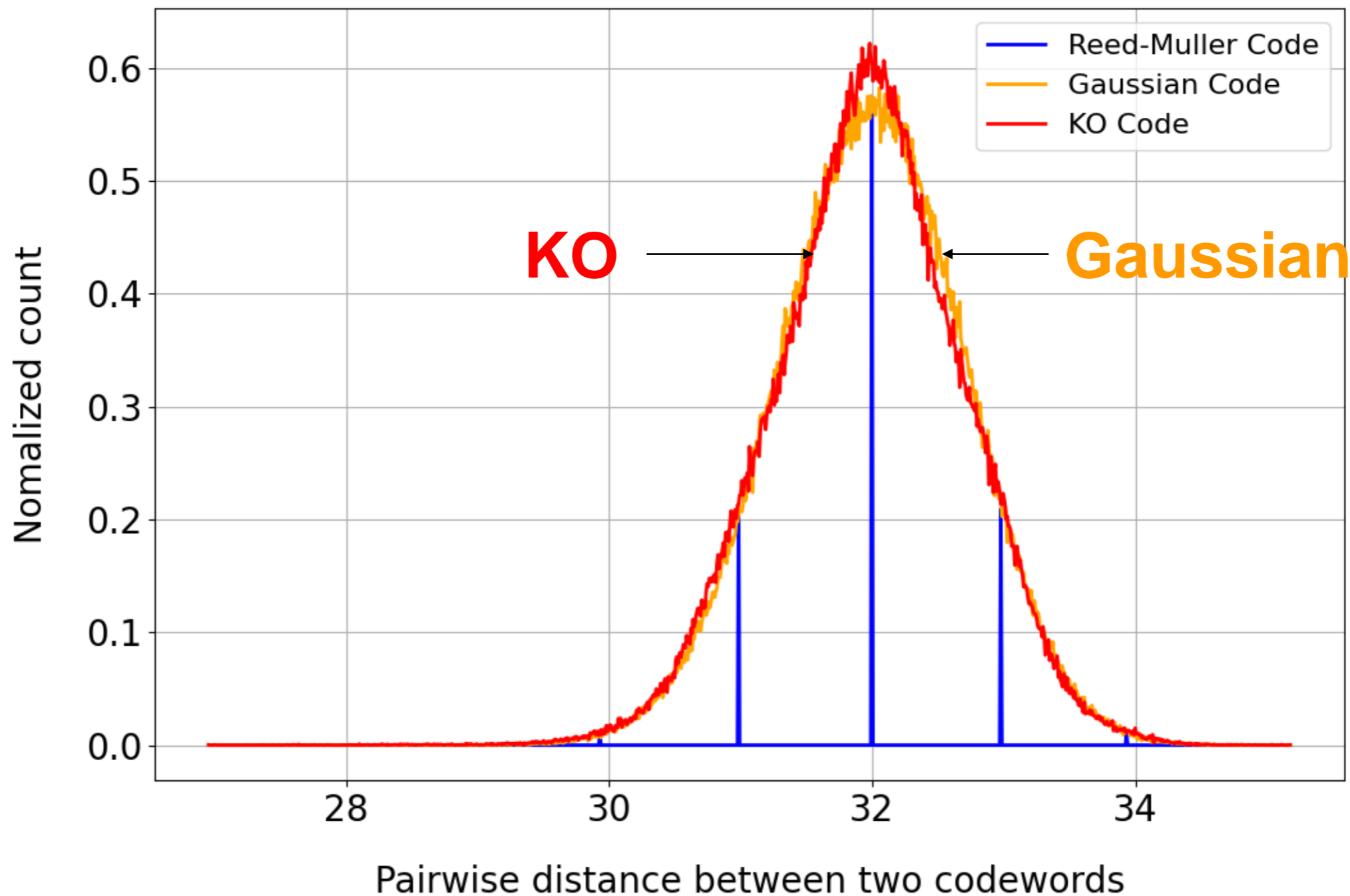
# KO beats Polar

Code-dimension=7, Block length = 64



# Gaussian like!

Code-dimension=46, Block length = 512



# Collaborators



**La Fin**

**Thank you!**