CYCLIC CODES

What are cyclic codes?

In coding theory, a cyclic code is a block code, where the circular shifts of each codeword gives another word that belongs to the code. They are error-correcting codes that have algebraic properties that are convenient for efficient error detection and correction.

Definition:

A code C is cyclic if
(i) C is a linear code;
(ii)Any cyclic shift of a codeword is also a codeword, i.e. whenever a0,… an -1 Î C, then also an -1 a0 … an –2 ∈ C.

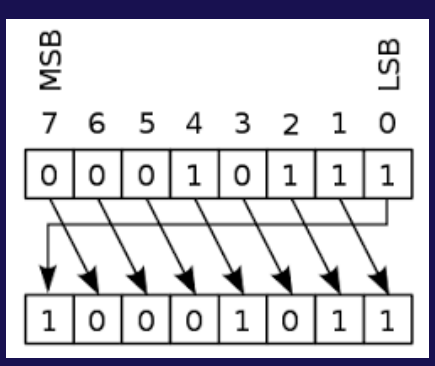


Figure 1: Cyclic code

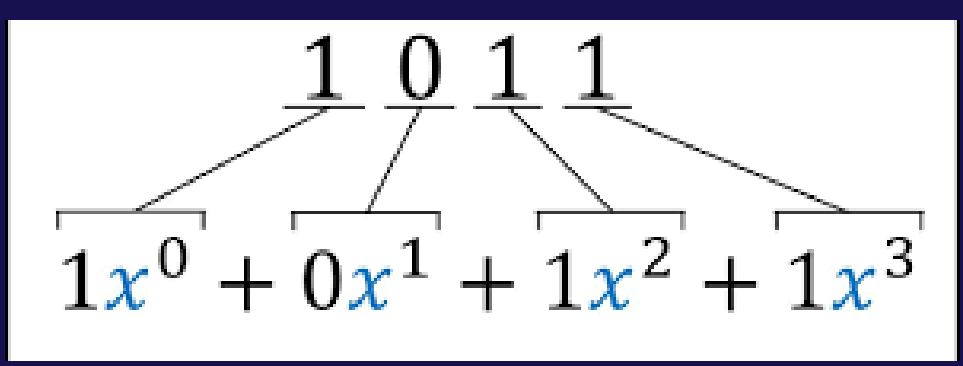
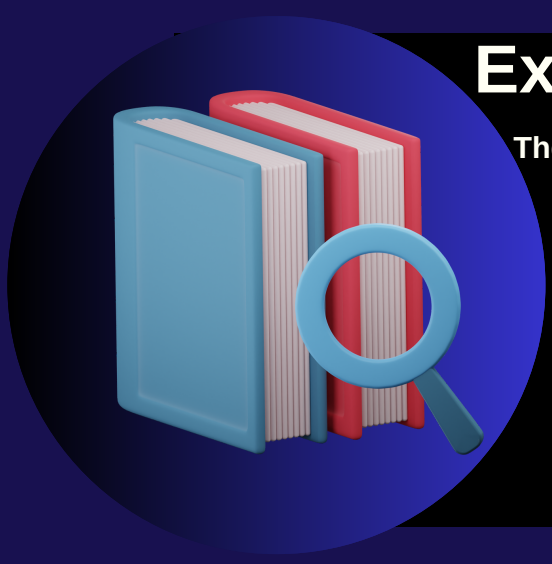


Figure 2: Cyclic codes Polynomial properties

Example:



The code with the generator matrix $\begin{pmatrix} 1 & 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 \end{pmatrix}$ has codewords

c1 = 1011100
c2 = 0101110
c3 =0010111
c1 + c2 = 1110010
c1 + c3 = 1001011
c2 + c3 = 0111001
c1 + c2 + c3 = 1100101

and it is cyclic because the right shifts have the following impacts

c1 → c2,
c1 + c2 → c2 + c3,
c2→c3,
c1 + c3 →c1 + c2 + c3,
c1 + c2 + c3 → c1 + c2
c3→ c1 + c3
c2 + c3 → c1

Advantages:

- Efficient Encoding and Decoding
- Cyclic Structure and Shift Properties
- Robust Error Correction
- Burst-Error Correction
- Low Redundancy Overhead
- Compatibility with Existing Standards

Applications:

- Digital Communications
- Storage Systems
- QR Codes and Barcodes
- Memory Systems
- Cryptographic Applications
- Consumer Electronics
- Satellite Communication
- Network Protocols
- Wireless Sensor Networks
- Automotive Systems

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