Hamming Code

Hamming Code

- Detect and correct the 1 bit error.
- Uses extra parity bits of a single error.

1. Mark all bit positions that are powers of two as parity bits. (positions 1, 2, 4, 8, 16, 32, 64, etc.)

2. All other bit positions are for the data to be encoded. (positions 3, 5, 6, 7, 9, 10, 11, 12, 13, 14, 15, 17, etc.)

3. Each parity bit calculates the parity for some of the bits in the code word. The position of the parity bit determines the sequence of bits that it alternately checks and skips.

- **Position 1:** check 1 bit, skip 1 bit, check 1 bit, skip 1 bit, etc. (1,3,5,7,9,11,13,15,...)
  Position 2: check 2 bits, skip 2 bits, check 2 bits, skip 2 bits, etc. (2,3,6,7,10,11,14,15,...)
  Position 4: check 4 bits, skip 4 bits, check 4 bits, skip 4 bits, etc. (4,5,6,7,12,13,14,15,20,21,22,23,...)
  Position 8: check 8 bits, skip 8 bits, check 8 bits, skip 8 bits, etc. (8-15,24-31,40-47,...)
  Position 16: check 16 bits, skip 16 bits, check 16 bits, skip 16 bits, etc. (16-31,48-63,80-95,...)
  Position 32: check 32 bits, skip 32 bits, check 32 bits, skip 32 bits, etc. (32-63,96-127,160-191,...)
  etc.

4. Set a parity bit to 1 if the total number of ones in the positions it checks is odd. Set a parity bit to 0 if the total number of ones in the positions it checks is even.

- Here is an example:
- A byte of data: 10011010
  Create the data word, leaving spaces for the parity bits: _ _ 1 _ 0 0 1 _ 1 0 1 0
  Calculate the parity for each parity bit (a ? represents the bit position being set):
- Position 1 checks bits 1,3,5,7,9,11:
  ? _ **1** _ **0** 0 **1** _ **1** 0 **1** 0. Even parity so set position 1 to a 0: **0** _ **1** _ **0** 0 **1** _ **1** 0 **1** 0
- Position 2 checks bits 2,3,6,7,10,11:
  0 **? 1** _ 0 **0 1** _ 1 **0 1** 0. Odd parity so set position 2 to a 1: 0 **1 1** _ 0 **0 1** _ 1 **0 1** 0
- Position 4 checks bits 4,5,6,7,12:
  0 1 1 **? 0 0 1** _ 1 0 1 **0**. Odd parity so set position 4 to a 1: 0 1 1 **1 0 0 1** _ 1 0 1 **0**
- Position 8 checks bits 8,9,10,11,12:
  0 1 1 1 0 0 1 **? 1 0 1 0**. Even parity so set position 8 to a 0: 0 1 1 1 0 0 1 **0 1 0 1 0**
- Code word: 011100101010.

Try one yourself

- 010101100011
- 111110001100
- 000010001010