

Error Detection and Correction Using Hamming Codes

Hamming codes are a family of error-correcting codes that can detect up to two-bit errors and correct single-bit errors in transmitted data. They use the Hamming distance concept to determine where errors may have occurred.

If we have m number of data bits then let's attach r number of redundant parity bits to it, so the whole bit length will be:

$$n = m + r$$

If two code-words are given, for example : **0101110** and **001111110** and the only difference between them is 1 bit, then the 'Hamming distance' of these code-words will be 1. This is an interesting measure for distance because it does not matter which bit in the row is different or whether it belongs to a binary or decimal system. So for example : **45635263** and **45615263** have the Hamming distance of 1 too. It does not matter that 10 different digits could be in the place of the wrong digit.

The **Hamming-style** correction code supposed to increase the number of parity bits. To correct single bit errors we have to use k number of parity bits using this formula:

$$n + 1 \leq 2^k$$

According to this formula the necessary number of parity bits which are needed to correct single bit errors are stated in the following table (for different word lengths):

word length	number of parity bits	whole bit length	% of added bits
4	3	7	133
8	4	12	50
16	5	21	31
32	6	38	19
64	7	71	11
128	8	136	6
256	9	265	4
512	10	522	2

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