**Error correcting using Hamming code**

One of big problems in digital communication, as well as in communication in general is it’s sustainability. For the digital signal this problem is represented by the appearance of distorted bits of data (1 instead of 0 or vice versa) on the receiving side of a connection channel.

Therefore there are lots of solutions for this problem, i.e. algorithms which transform chunks of data into “self-refining” units which contain information overhead required for verification and refining data to it’s initial state. One of most prominent algorithms of such solution is a Hamming codes application.

In telecommunication, Hamming codes are a family of linear error-correcting codes that generalize the Hamming(7,4)-code, and were invented by Richard Hamming in 1950. Hamming codes can detect up to two-bit errors or correct one-bit errors without detection of uncorrected errors. By contrast, the simple parity code cannot correct errors, and can detect only an odd number of bits in error. Hamming codes are perfect codes, that is, they achieve the highest possible rate for codes with their block length and minimum distance of three

Richard Hamming, the inventor of Hamming codes, worked at Bell Labs in the 1940s on the Bell Model V computer, an electromechanical relay-based machine with cycle times in seconds. Input was fed in on punched cards, which would invariably have read errors. During weekdays, special code would find errors and flash lights so the operators could correct the problem. During after-hours periods and on weekends, when there were no operators, the machine simply moved on to the next job.

Due to the limited redundancy that Hamming codes add to the data, they can only detect and correct errors when the error rate is low. This is the case in computer memory (ECC memory), where bit errors are extremely rare and Hamming codes are widely used. In this context, an extended Hamming code having one extra parity bit is often used. Extended Hamming codes achieve a Hamming distance of four, which allows the decoder to distinguish between when at most one one-bit error occurs and when any two-bit errors occur. In this sense, extended Hamming codes are single-error correcting and double-error detecting, abbreviated as SECDED.

Before algorithm processing data should be transformed into 4-bit chunks, also called “nibbles”.

All operations in Hamming code can be represented as a linear matrices multiplication:  
Generator matrix:

“Checker” matrix:

Recovery matrix:

Workflow of a data processing:



