Exercise Sensor Networks

Lecture 2: Communication (MAC and error handling)

Exercise 2.1:

In a Hamming code word a check bit and not a data bit toggles. Can the mistake be detected and corrected and if yes, how?

Exercise 2.2:

The following Hamming code word is given: 01111001111. Create an error with as few changes as possible that can not be detected.

Exercise 2.3:

A number of d bit error should be corrected. Explain why a distance of 2d is not sufficient for the code?

Exercise 2.4:

In the last lecture we have seen an estimation of how many redundant bits are necessary to detect and correct 1 bit errors. Now do the same estimation for 2 bit errors. It is not necessary to find a particular code, only a lower bound for the number of check bits is of interest.

How many bits are necessary to protect a 7 bits ASCII code against at most 2 toggled bits?

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Exercise 2.5: Costs for error correction vs. retransmission

a)

For a given transmission channel there is an average of 1 error in 4000 bits. These single bit errors are statistically independent. A single packet consists of 128 bytes. It is either transmitted fully and correctly or not at all. The receiver can detect whether a packet was transmitted free of errors without any additional costs. If an error occurred, the receiver asks the sender only once for retransmission. The request for retransmission is considered to be an ordinary packet of 128 bytes. If an error occurs in such a request it is treated as if no request was ever sent.

How high is the overall data rate in this scenario (in percent of the data rate that could theoretically be achieved if no error occurred)?

b)

To make things easier we assume that a bit error occurs only once per packet. Rather than asking the sender for retransmission, we choose to employ forward error correction, using the Hamming code from the lecture (the code itself is not of importance here).

How high is the actual data rate (in percent) compared to the one that would theoretically be possible without forward error correction and if no errors occurred.

Exercise 2.6: (opt) Explain why protecting n bits of data against single bit errors with forward error correction requires only O(log(n)) check bits while protecting a fixed number of c bits against a number of n toggled bits requires an exponential number of check bits. Hint: Think of the table consisting of valid and invalid code words and of the method in which bits are checked in the Hamming code.