CS-341 Lecture 8

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Administrivia

- Exam March 9
  - Will cover material "to date"
    - Lectures, readings, and homeworks
  - Short answer
  - Bring a calculator
- Slides available in PDF format

Floating-Point

- Normalized Fractions
  - 1.xxx …
  - This makes the leading 1 redundant, so it is not stored in the encoded value.
  - Doubles the precision!
- Special values: ±∞. NaN

Bandwidth

- The *rate* (speed) at which information can be transmitted through a *channel*.
  - *Bits per second.*
- HDTV
  - 30 frames per second
  - 800 x 600 pixels per frame
  - 256 red, green, and blue intensities per pixel
  - 43.2 MB per second
    - Broadcast bandwidth
- Computer monitor
  - 60 frames per second, 1024 x768 pixels, 2^{24} colors
    - 1.132 Gbps
    - Framebuffer bandwidth

Error Detection and Correction

- Section 2.2.4 of the textbook.
- Used when transmitting binary data over a "noisy channel."
- Basic principle is to add redundant information (reducing effective bandwidth).
  - Transmitter adds the extra bits.
  - Receiver uses the extra bits to check the integrity of the data received.
- Detection: Receiver can recognize invalid codewords when they are received.
  - Signal an error or request transmitter to send data again.
- Correction: Enough redundant information is sent so the receiver can determine which bit(s) are in error.
  - Correct by inverting the error bits.

Parity: Single Bit Detection

- Each transmitted codeword consists of a packet of data bits and one additional bit whose value is set so that the code word will have an even number of 1's.
  - Parity bit is the exclusive OR of the data bits.
  - Receiver detects an error if the exclusive OR of the codeword bits is 1.
- Odd parity: Each code word has an odd number of 1's.
  - Parity bit is the exclusive NOR of the data bits.
  - Receiver detects an error if the exclusive OR of the codeword bits is 0.

Exclusive OR and Exclusive NOR

a	b	XOR	XNOR
0	0	0	1
0	1	1	0
1	0	1	0
1	1	0	1

a	b	c	XOR	XNOR
0	0	0	0	1
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	0

a xor b xor c = (a xor b) xor c

Hamming Codes

- Codewords have multiple parity bits.
- $P_0\ P_1\ P_2\ D_3\ P_4\ D_5\ D_6\ D_7\ P_8\ D_9\ D_{10}\ D_{11}\ D_{12}\ D_{13}\ D_{14}\ D_{15}$ …
  - Parity bits are in positions that are numbered with powers of two.
  - Data bits fill in other places.
  - Each parity bit produces even parity for all codeword bits that have the parity bit's power of two in their subscripts.
  - P_0 is even parity across the entire codeword.
    - Omitted in the textbook, but needed for double error detection.
- Checking: Pattern of parity errors tells position in which error occurred. Correct it by inverting the value.
  - But if overall parity is correct when there are other errors, a double error was detected and cannot be corrected.