# CS-341 Lecture 5

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## Compression Concepts

- Saves disk space
- Reduces demands on *bandwith*.
  - Capacity of a channel, such as a network connection.
  - Measured in bits per second. (Transmission rate)
- Lossless (Zip)
  - Eliminate redundant information.
    - Sequence of identical values replaced by the value and a repeat count.
    - Record differences between successive frames instead of entire frames.
- Lossy (MP3)
  - Reduce bits per sample, and/or sampling rate.

## Encoding Numbers

- Fixed Point
  - Integers
    - Unsigned
    - Signed
  - Fractions
- Floating Point
  - IEEE-754

## Fixed Point

- Integer is a special case, where the binary point is at the right end. But there can be fractions.

$$\ldots + 2^{3}b_3 + 2^{2}b_2 + 2^{1}b_1 + 2^{0}b_0 + 2^{-1}b_{-1} + 2^{-2}b_{-2} + 2^{-3}b_{-3} + \ldots$$

  - $0101.1010 = 2^{2} + 2^{0} + 2^{-1} + 2^{-3}$
  - Equals $4 + 1 + 0.5 + 0.125$
  - Equals $5 + 5/8$
  - Equals $5 + 10/16$

## Integers

- Unsigned – piece of cake
  - Values from 0 to $2^{n}$-1 for *n*-bit numbers.
- Four Ways to Encode Signed Values
  1. Sign-magnitude
     - Easy for people, rotten for logic circuits
  2. Biased
     - Good for comparing values
     - Used for floating-point exponents
  3. One's Complement
     - Two zeros
     - Requires end-around carry step for addition
     - Stepping stone to two's complement
  4. Two's Complement …

Assigning Numeric Values to 4-bit Numbers

| Binary | Unsigned | Sign-Magnitude | Biased (8) | One's Complement | Two's Complement |
|---|---|---|---|---|---|
| 0000 | 0 | +0 | -8 | +0 | 0 |
| 0001 | 1 | +1 | -7 | +1 | +1 |
| 0010 | 2 | +2 | -6 | +2 | +2 |
| 0011 | 3 | +3 | -5 | +3 | +3 |
| 0100 | 4 | +4 | -4 | +4 | +4 |
| 0101 | 5 | +5 | -3 | +5 | +5 |
| 0110 | 6 | +6 | -2 | +6 | +6 |
| 0111 | 7 | +7 | -1 | +7 | +7 |
| 1000 | 8 | -0 | 0 | -7 | -8 |
| 1001 | 9 | -1 | +1 | -6 | -7 |
| 1010 | 10 | -2 | +2 | -5 | -6 |
| 1011 | 11 | -3 | +3 | -4 | -5 |
| 1100 | 12 | -4 | +4 | -3 | -4 |
| 1101 | 13 | -5 | +5 | -2 | -3 |
| 1110 | 14 | -6 | +6 | -1 | -2 |
| 1111 | 15 | -7 | +7 | -0 | -1 |

## Homework Due Feb. 23

- Exercises 1 -14 at the end of Appendix A