Discussion 01

Number Representation

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Slides available at `teaching.aditbala.com`

About Me

- Grade: Junior
- # Teaching Sem: `4`
  - 61a: `3`
  - 61c: `1`
- Major: `Computer Science`
- Origin: `Maryland`
- Interests:
  - `Reading`, `Gymming`, `Blogging`, `Coffee`

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Announcements 📣

- `Lab 0`
  - Due: `Monday, June 26th`
- `Homework 1`
  - Due: `Wednesday, June 28th`
- `Project 1`
  - Due: `Friday, June 30th`
- Advice :D

Agenda

- Intro
- Unsigned
- Sign-Magnitude
- 2's Complement
- Q & A

Number Representation

- Everything is bits!
- Numbers
  - 19 -> `0b00001011`
- ASCII Characters
  - Even letters and punctuation can be represented with bits
  - `a` -> `0b1100001`
- Computer Instructions
  - `3 + 0` -> `0b00000000000110000000000010010011`

Conversions between Representations

- Base *a* to decimal
  - $\_\_ \_\_ \_\_ \_\_ \_\_ \_\_ \_\_ \_\_$
    $a^7\ a^6\ a^5\ a^4\ a^3\ a^2\ a^1\ a^0$
  - Example: 61
  - Binary: `0b0111101`
  - Octal (Base 8): `75`
  - Hex (Base 16): `3D`
- Binary to Hex
  - Convert groups of 4 bits at a time
  - Example: `0b00111100`
  - What if length is not multiple of `4`?

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Speedy Conversions

- `2^n` -> `n+1` bit is `1`, rest are `0`
  - `64 = 2^6 = 0b01000000`
- `2^n - 1` -> `n-1` bits that are all 1
  - `63 = 2^6 - 1 = 0b00111111`

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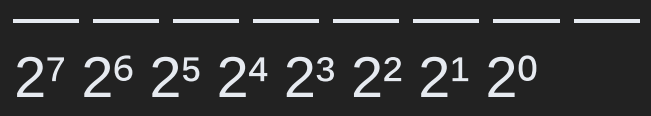
Unsigned

- Range: [`0`, `2^n - 1`]
- 

Sign-Magnitude Notation

- Range: `[-(2^n-1 - 1), 2^n-1-1]`
- ▁▁▁▁ ▁▁ ▁▁ ▁▁ ▁▁ ▁▁ ▁▁ ▁▁
  sign 2^6 2^5 2^4 2^3 2^2 2^1 2^0
- `-1^sign * magnitude` (convert normally)
- Cons
  - `+0` and `-0`

Two's Complement

- Range: `[-2^n-1, 2^n-1-1]`
- ——— — — — — — — —
  $-2^7\ 2^6\ 2^5\ 2^4\ 2^3\ 2^2\ 2^1\ 2^0$
- `-1^sign * magnitude` (convert normally)
- Positive: same as unsigned
- Negative: `~(positive) + 1`

Bias Notation

- Range: `[bias, 255 + bias]`
- Applying a shift to the unsigned interpretation of number
- Bias is typically negative
  - Standard bias: $-(2^{n-1}-1)$
- Converting to bias notation
  - $x + b = n$
  - x = binary in bias notation
  - b = chosen bias
  - n = number want to represent

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Thank you!

Feedback