Lecture 2: More binary representation & strings

CSE 29: Systems Programming and Software Tools

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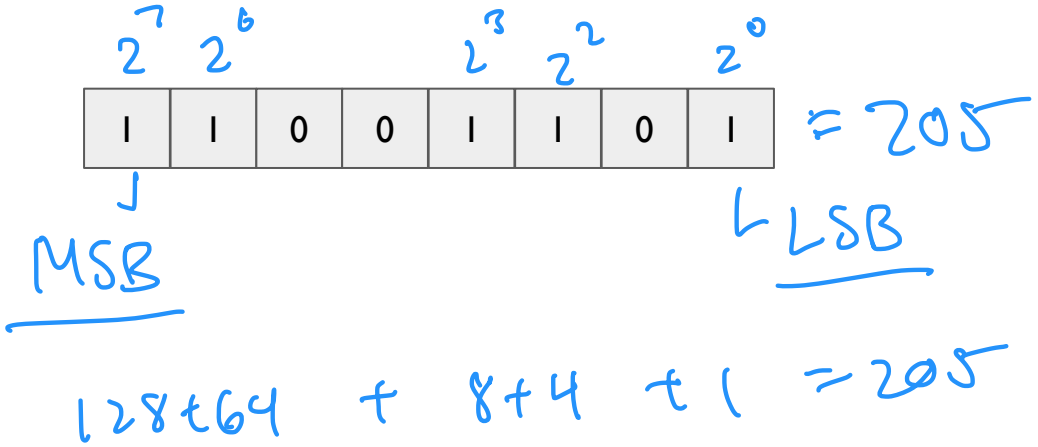
Announcements

- Fill out the welcome survey on the class website
- Attendance/participation credit
- CBTF physical ID

Take attendance

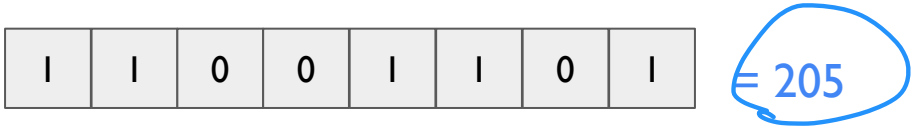
Review: Binary representation

- What number is this?



Review: Binary representation

- What number is this?



Demo 2

- `uint8_t bin8_to_dec(char bin_arr[])`

How do we add two binary numbers together?

Decimal

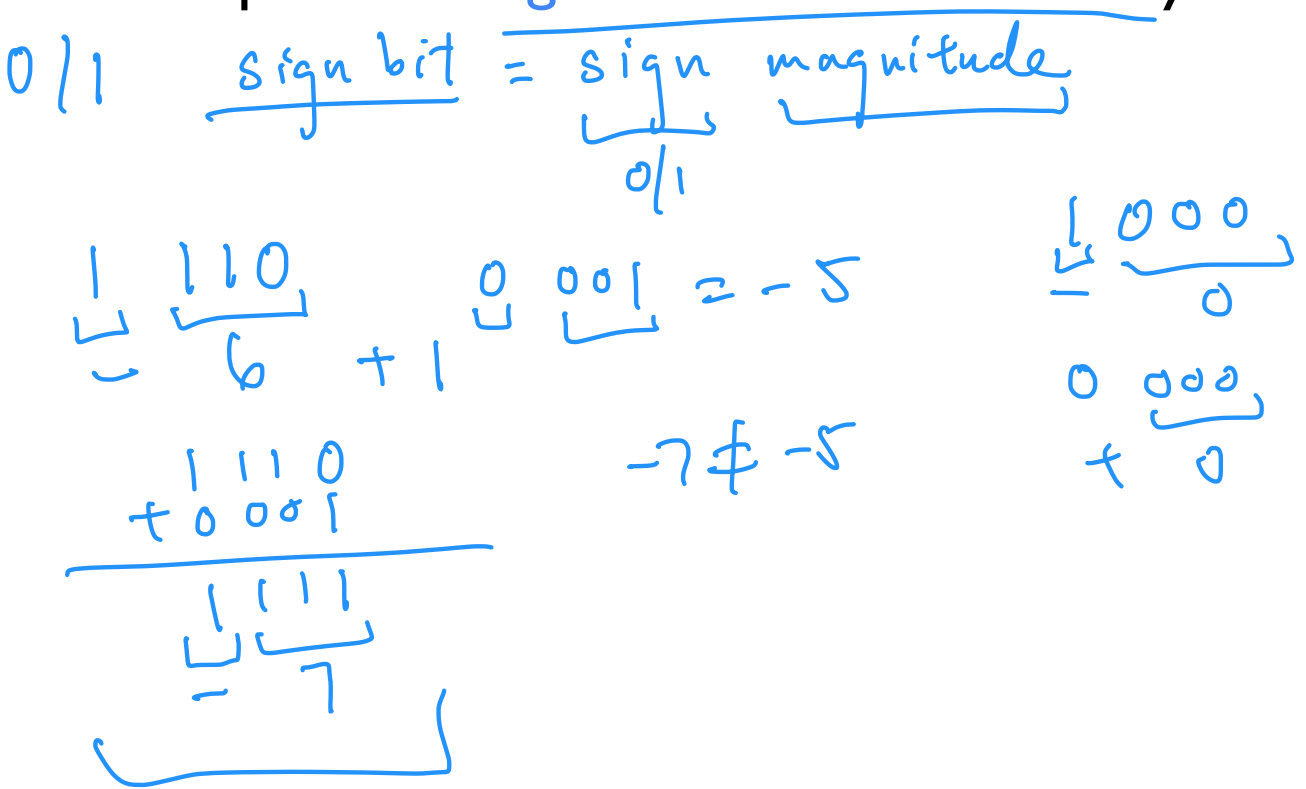
```
  15
+  8
----
  23
```

=

Binary

```
  01111   (15)
+ 00001   (1)
-------
 10000   (16)
```

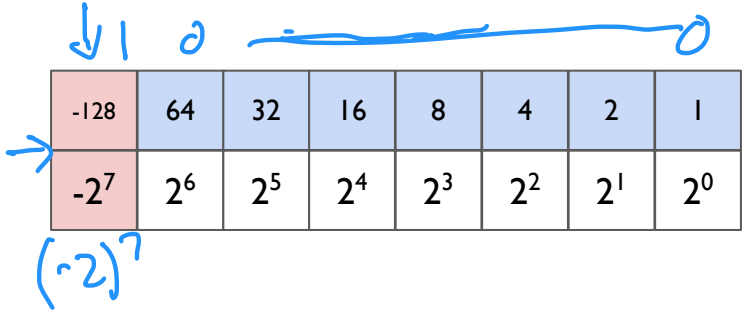
How should we represent negative numbers in binary?



How should we represent negative numbers in binary?

- Two's complement
  - signed values

0 = positive # = unsigned (only + #)
1 = negative



0 0 0 0
-2^3 2^2 2^1 2^0

$(-2)^7$

- Min = -128

b bits = -2^{b-1}

- Max = $2^{b-1} - 1 = 127$

01111111 $2^7 - 1 = 127$

What is the two's complement value?

= 4 bits
8
16

$-2^{5-1} + 2^{5-1} - 1$

min: 10—0
max: 01—1

- 1001 = -7

$-1 \times 2^3 + 1 \times 2^0 = -8 + 1 = -7$

- 1111 = -1

$-1 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 = -1$

$-8 + 7$

- 0101 = 5

$0 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 = 5$

$4 \quad 1$

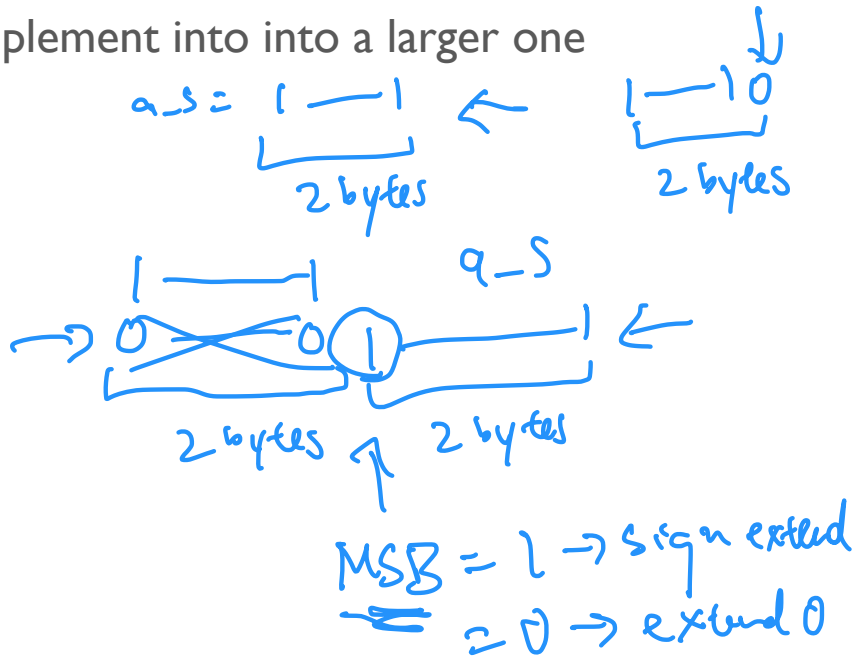
Common data types in C

- Integer data types
  - `char = 'A'; // 1 byte signed`
  - `unsigned char = 255; // 1 byte unsigned`
  - `int/int32_t = -5; // 4 bytes signed`
  - `unsigned int/uint32_t = 5; // 4 bytes unsigned`
  - `long long int/int64_t = -10; // 8 bytes signed`
  - `unsigned long long int/uint64_t = 10; // 8 bytes unsigned`

How to copy a small int into larger sized int?

- Need to handle copying a smaller two's complement into into a larger one

```
short int a_s = -1; // 2 bytes
int a = a_s; // 4 bytes
printf("a = %d a_s = %d\n", a, a_s);
```



Intro to Hexadecimal

- Long binary representations is hard for humans to read
- Hexadecimal helps humans read binary
  - Hexadecimal = base 16
  - Decimal = base 10
  - Binary = base 2

Intro to Hexadecimal

$2^{4 \text{ bits}} = 16$ values

- Hexadecimal = 16 values

Decimal	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Hex	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Binary	0000	0001	0010	0011	0100	0101	0110	0111	1000	1001	1010	1011	1100	1101	1110	1111

00000001

hex = 0x 0 1

What is this hexadecimal number in binary?

0x prefix
I am in hex

- 0xFF ?

1111 1111
F F

- 0x18 ?

0001 1000
1 8