Lecture 2:
Binary and Strings

CSE 29: Systems Programming and Software Tools

Aaron Schulman (Shalev)

UCSDCSE
Computer Science and Engineering

Lecture 1 Overview

- How to access strings and arrays in C
- How does binary number representation work
- String functions and how things can go wrong

Course Website / Syllabus

https://ucsd-cse29.github.io/fa24/

Demo: Accessing Binary Data in C

- **Big Lesson:**
  - Programs can interpret and present bits (in arrays) **in many ways:**
    - » They can be **Integers** printf("%d", arr[i])
    - » They can be **Characters** printf("%c",arr[i])
    - » They can be **Strings** of Characters printf("%s",arr)
    - » There are many other ways too!
  - **C gives us direct access to the bit representations of data in memory!**

Why is 'H' or 72 = bin 10010000 ?

$$\mathbf{1\ 0\ 0\ 1\ 0\ 0\ 0} = 1x2^6 + 1x2^4$$
$$= 64 + 8 = 72$$

Binary (Base 2) is *similar* to Decimal (Base 10) representation:

$$\mathbf{7\ 2} = 7x10^2 + 2x10^1$$
$$= 70 + 2 = 72$$

Converting integers to/from binary arrays

1 bit

0 =0

1 =1

2 values: 2^1

2 bits

0	**0**	**=0**
0	1	**=1**
1	0	**=2**
1	1	**=3**

4 values: 2^2

3 bits

0	**0**	**0**	**=0**
0	0	1	**=1**
0	1	0	**=2**
0	1	1	**=3**
1	0	0	**=4**
1	0	1	**=5**
1	1	0	**=6**
1	1	1	**=7**

8 values: 2^3

What does each index of a bit array mean?

1 byte

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

MSB **LSB**

Bit array -> Integer conversions

$$\mathbf{1\ 0\ 1\ 0} = 1x2^3 + 0x2^2 + 1x2^1 + 0x2^0$$
$$= 8 + 0 + 2 + 0 = 10$$

$$\mathbf{1\ 1\ 1\ 0} = 1x2^3 + 1x2^2 + 1x2^1 + 0x2^0$$
$$= 8 + 4 + 2 + 0 = 14$$

Demo: How do strings work in C?

- Big Idea:
  - Strings are just arrays of characters
  - The string is terminated when there is a null character at the end

What is a string, an array of characters!

char sup[7] = “Hello”;

0	1	2	3	4	5	6
‘H’	**‘e’**	**‘l’**	**’l’**	**’o’**	**‘ ’**	**‘\0’**

Special char.
NUL Character
End of string = **0**

Demo: What if we forget the NULL Char?

- Big Idea:
  - There are no training wheels anymore in C, this is not Java
  - If you tell the computer to do something, it will do exactly what you say.

What happens if the null is not there?

char sup[7] = “Hello”;
char hi[2] = {‘H’, ‘i};

0	1	0	1	2	3	4	5	6
‘H’	**‘i’**	**‘H’**	**‘e’**	**‘l’**	**’l’**	**’o’**	**‘ ’**	**‘\0’**

hi **sup**

Week 1 Announcements

- **Announcements**:
  - Lab attendance is **required** and a lot happens there, make sure to go to lab
  - Submit the welcome survey before lab on Tuesday of week 1