

Participation

Lab 03 Questions / markfiles

marktest - raspberry Pi only

Lab 03 requirements

Big Picture: How do computers represent information?

Project 02 ntlang working with different number representations

decimal hexadecimal binary
bit manipulation

subset of the C language

Data is all binary

01010111 0

Decimal 0, 1, 2 ..., 9

Binary 0, 1

Hexadecimal 0, 1, 2 ..., 9, A, ..., F

Project 02

1 + 2 dec \rightarrow 3

$0 \times 1 + 0 \times 2$ hex \rightarrow 0x3

0b1 + 0b10 bin \rightarrow 0b11

Number Systems

decimal base 10
412
 $0, 1, \dots, 9$

$$400 + 10 + 2 = 412$$

$$(4 \times 10^2) + (1 \times 10^1) + (2 \times 10^0) = 412$$
$$10^2 = 100 \quad 10^1 = 10 \quad 10^0 = 1$$

Binary base 2 0, 1

Dec	Bin
0	000
1	001
2	010
3	011
4	100
5	101
6	110
→ 7	111

$$\begin{array}{r} 000 \\ + 1 \\ \hline 001 \end{array} \quad \begin{array}{r} 001 \\ + 1 \\ \hline 010 \end{array}$$

Binary
 $\begin{array}{r} 1 \\ 0 \\ 1 \end{array}$

$$\left[(1 \times 2^3) + (0 \times 2^2) + (1 \times 2^1) + (1 \times 2^0) \right]$$

$$(1 \times 8) + (0 \times 4) + (1 \times 2) + (1 \times 1)$$
$$8 + 0 + 2 + 1 = \boxed{11}_{10}$$

$$2^0 = 1$$

$$2^1 = 2$$

$$8 \quad 2^1$$

$$2^2 = 4$$

$$10 \quad 11 = 11$$

$$2^3 = 8$$

$$10 \quad 42$$

$$2^4 = 16$$

$$10110 = 22$$

$$2^5 = 32$$

$$\text{int } x = \boxed{061011}$$

$$2^6 = 64$$

$$2^7 = 128$$

$$\underline{2^8 = 256}$$

$$2^9 = 512$$

word size 32 bits

$$2^{10} = 1024$$

4 bytes

$$2^{11} = 2048$$

$$2^{12} = 4096$$

$$0b\underbrace{0000 \dots}_{32} 1101$$

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$061101 =$

$06\ 0000|0000|0\ 000|0000|0000|0000|1101$

0012 = 12 * means octal in C

Hexadecimal base 16

Dec Hex Bin

0	0	0000	
1	1	0001	
2	2	0010	0x1B3
3	3	0011	
4	4	0100	
5	5	0101	$(\underline{1} \times 16^2) + (\underline{B} \times 16^1) + (\underline{3} \times 16^0)$
6	6	0110	
7	7	0111	$(1 \times 256) + (11 \times 16) + (3 \times 1)$
8	8	1000	$256 + 176 + 3$
9	9	1001	$256 + 179$
10	A	1010	$= 435$
11	B	1011	
12	C	1100	
13	D	1101	
14	E	1110	Octal base 8
15	F	1111	$0, 1, \dots 7$

Base conversion -_{bin} 2, _{dec} 10, _{hex} 16

\downarrow bin \rightarrow dec dec \rightarrow hex

\downarrow hex \rightarrow dec dec \rightarrow bin

easy $\begin{cases} \text{hex} \rightarrow \text{bin} \\ \text{bin} \rightarrow \text{hex} \end{cases}$

hex \rightarrow bin

$$\begin{array}{rcl} 0xA7 & \stackrel{\swarrow}{\downarrow} & \stackrel{\searrow}{\downarrow} \\ & \Rightarrow (A \times 16^1) + (7 \times 16^0) \\ & & (10 \times 16) + (7 \times 1) \\ & & = \boxed{167} \end{array}$$

$$\begin{array}{rcl} 0b\ 1010\ 0111 & \stackrel{\swarrow}{\downarrow} & \stackrel{\searrow}{\downarrow} \\ & \Rightarrow (1 \times 2^7) + (1 \times 2^5) + (1 \times 2^2) + (1 \times 2^1) \\ & & + (1 \times 2^0) \end{array}$$

$$128 + 32 + 4 + 2 + 1$$

$$= \boxed{167}$$

0xa7

0xA7
bin \rightarrow Hex

0b 10011000

\downarrow

0x 98

0x98

0b 101101100
 \downarrow

\downarrow

$0 \times \boxed{F2}$
 \uparrow
8 bits | byte

Dec \rightarrow Bin

$$100_{10} = 2^7 + 2^5 + 2^3 + 2^2 + 2^1 + 2^0$$

$$\begin{array}{r} 128 \quad (64) \quad (32) \quad (1) \\ \diagdown \\ 64 \end{array}$$

$$\begin{array}{r} 1100100 \\ 64 \quad 32 \quad 4 \quad = \quad 100 \end{array}$$

Dec \rightarrow Bin Conversion

Remainder

$$100 \quad \underline{/2} \quad = 50 \quad 166 \quad 0$$

$$50 \quad /2 \quad = 25 \quad 0$$

$$25 \quad /2 \quad = 12 \quad 1$$

$$12 \quad /2 \quad = 6 \quad 0$$

$$6 \quad /2 \quad = 3 \quad 0$$

$$3 \quad /2 \quad = 1 \quad 1$$

$$1 \quad /2 \quad = 0 \quad \text{msb} \quad \underline{1}$$

64 32 u
1100100

$$25/2 = 12$$
$$25 \% 2 = 1$$

Dec \rightarrow Hex

Bitwise operations

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