

Today:

- * Administrivia
 - * CS in general
 - * CS1800 in specific
 - * Magic trick
 - * Decimal and binary representations
 - * Conversions: dec to bin; bin to dec
 - * Counting in binary; powers of 2
 - * Hexadecimal
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- * Addition and subtraction in binary

Decimal

$$\overset{10^3}{8}\overset{10^2}{7}\overset{10^1}{9}\overset{10^0}{2}_{10} = 8 \times 10^3 + 7 \times 10^2 + 9 \times 10^1 + 2 \times 10^0 \quad (\text{X})$$

$$= 879 \cdot 10 + 2$$

$$= (87 \cdot 10 + 9) \cdot 10 + 2$$

$$= ((8 \cdot 10 + 7) \cdot 10 + 9) \cdot 10 + 2 \quad (\text{X})$$

$$\begin{array}{ccccccc} 2^5 & 2^4 & 2^3 & 2^2 & 2^1 & 2^0 \\ \dots & 32 & 16 & 8 & 4 & 2 & 1 \end{array}$$

$$= 1 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 \quad (\text{X})$$

$$1 \ 0 \ 1 \ 1 \ 0_2$$

$$= ((\dots + 1) \cdot 2 + 1) \cdot 2 + 0 \quad (\text{X})$$

$$\downarrow \quad \downarrow \quad \downarrow$$

$$16 + 4 + 2 = 22_{10}$$

MSB $\rightarrow$ LSBDecimal $\rightarrow$ BinaryLSB $\rightarrow$ MSB

41₁₀ 64 32 16 8 4 2 1
 1 0 1 0 0 1

$$41 - 32 = 9$$

$$9 - 8 = 1$$

27₁₀ 32 16 8 4 2 1
 1 1 0 1 1

$$27 - 16 = 11$$

$$11 - 8 = 3$$

$$3 - 2 = 1$$

24₁₀ 32 16 8 4 2 1
 1 1 0 0 0

$$24 - 16 = 8$$

41 $\rightarrow$ 1 LSB
 $(41-1) \div 2 = 20 \rightarrow 0$
 $(20-0) \div 2 = 10 \rightarrow 0$
 $(10-0) \div 2 = 5 \rightarrow 1$
 $(5-1) \div 2 = 2 \rightarrow 0$
 $(2-0) \div 2 = 1 \rightarrow 1$ MSB

27 $\rightarrow$ 1
 13 $\rightarrow$ 1
 6 $\rightarrow$ 0
 3 $\rightarrow$ 1
 1 $\rightarrow$ 1

24 $\rightarrow$ 0
 12 $\rightarrow$ 0
 6 $\rightarrow$ 0
 3 $\rightarrow$ 1
 1 $\rightarrow$ 1

Binary → Decimal

16 8 4 2 1

1 0 1 1 0₂

16 + 4 + 2 = 22₁₀

64 32 16 8 4 2 1

1 1 0 1 0 0 1₂

64 + 32 + 8 + 1 = 105₁₀

64 32 16 8 4 2 1

1 0 1 0 0 1 1₂

64 + 16 + 2 + 1 = 83₁₀

MSB

1

0

1

1

LSB

0

1

1 × 2 + 0 = 2

2 × 2 + 1 = 5

5 × 2 + 1 = 11

11 × 2 + 0 = 22

1

10

101

1011

1

1

0

1

0

0

1

1

3

6

13

26

52

105

1

0

1

0

0

1

1

1

2

5

10

20

41

83

→ 8 4 2 1

0	0 0 0 0
①	0 0 0 ①
②	0 0 ① 0
3	0 0 1 1
④	0 ① 0 0
⑤	0 ① 0 ①
6	0 1 1 0
7	0 1 1 1
8	1 0 0 0
9	1 0 0 1
10	1 0 1 0
11	1 0 1 1
12	1 1 0 0
13	1 1 0 1
14	1 1 1 0
15	1 1 1 1

$$2^0 = 1$$

$$2^1 = 2$$

$$2^2 = 4$$

$$2^3 = 8$$

$$2^4 = 16$$

$$2^5 = 32$$

$$2^6 = 64$$

$$2^7 = 128$$

$$2^8 = 256$$

$$2^9 = 512$$

$$2^{10} = 1024$$

$$2^{10} = \text{"kilo"} = K \quad 1024 \approx 1000$$

$$2^{20} = \text{"mega"} = M \quad 1,048,576 \approx 1,000,000$$

$$2^{30} = \text{"giga"} = G \quad \sim 1,000,000,000$$

$$2^{40} = \text{"tera"} = T \quad \sim 1,000,000,000,000$$

$$2^{38} = 2^8 \cdot 2^{30}$$

$\downarrow \quad \downarrow$
 256 billions