CMSC 10 11-5-09

|#of bit strings of length n|

$= 2^n$

2 ways 2 2 2

0 or 1 — — . . . . — (n slots to fill)

$\#\text{strings} = \underbrace{2 \cdot 2 \cdot 2 \cdots 2}_{n} = 2^n$.

SIGNED Integers : + or −

- SIGN-MAGNITUDE REPRESENTATION

leftmost bit stores SIGN:

$$\begin{cases} + = 0 \\ - = 1 \end{cases}$$

Remaining bits Represent magnitude

EX 8-Bit SIGN-MAGNITUDE REP.

−27 1 0011011

+27 0 0011011

0 ← sign bit

0011011 ← magnitude bits

27 = 16 + 8 + 2 + 1 = 11011

min such number

$$1\ 1111111 = -(2^7 - 1)$$
$$= -127$$

max such number

$$0\ 1111111 = +(2^7 - 1)$$
$$= +127$$

Range : -127 to $+127$

of #s $= 127 + 127 + 1 = 255$

But

(# of bit strings of len. 8) $= 2^8 = 256$

- Two's Complement Representation

again leftmost bit is sign:

0 = +, 1 = −.

Ex. 4-Bit Two's comp. rep.

Dec	Bit Strings
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
−8	1000
−7	1001
−6	1010
−5	1011
−4	1100
−3	1101
−2	1110
−1	1111

Arithmetic Ex:

$$\begin{array}{rcl} & & {\scriptstyle 1} \\ 2 & = & 0010 \\ +(-6) & = & 1010 \\ \hline -4 & = & 1100 \end{array}$$

Rational Numbers i.e. Fractions

- Floating Point Representation

e.g. $+ 12.75$

or $- 0.2109375$

first: Convert to (binary) scientific notation

$$\pm M \cdot 2^{\pm E}$$

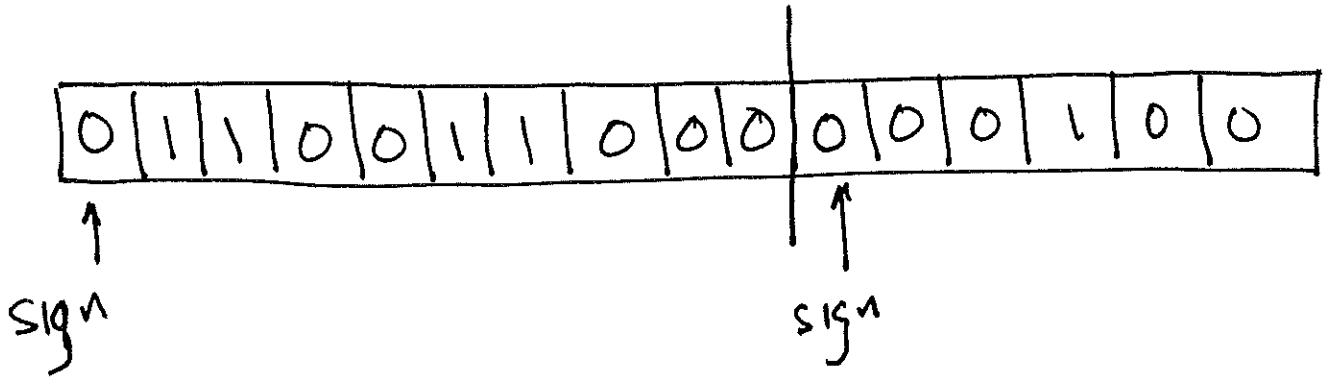
M: mantissa

E: exponent

Ex. Assume 16 Bits Total

$\pm M$: 10-Bit sign-magnitude Rep.

$\pm E$: 6-Bit sign-magnitude Rep.



$12.75 = [1100.11]_2$

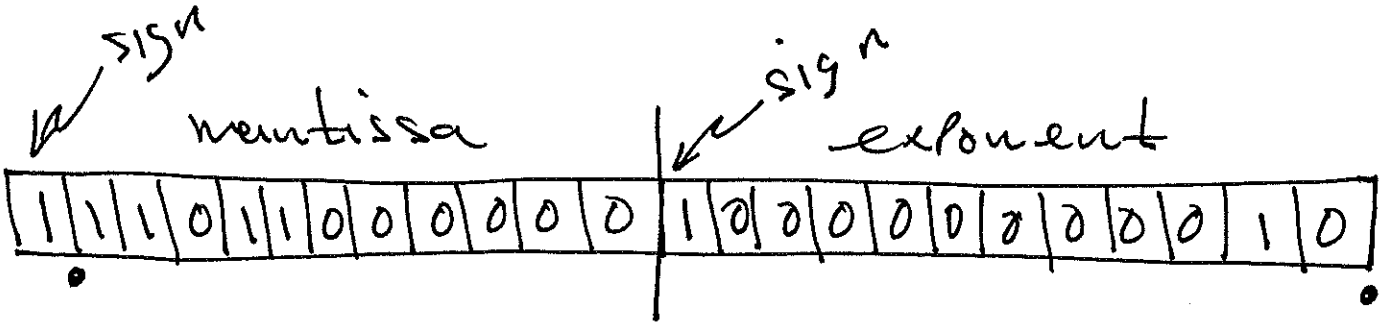
$= [.1100110]_2 \cdot 2^4$

$= +[.1100110]_2 \cdot 2^{+[100]_2}$

Ex. 24-Bit Floating Point Rep.

$\pm M$: 12-Bit S.M.

$\pm E$: 12-Bit S.M.



$$-.2109375 = -\left(\frac{1}{8} + \frac{1}{16} + \frac{1}{64} + \frac{1}{128}\right)$$

$$= -[.0011011]_2$$

$$= -[.11011]_2 \cdot 2^{-2}$$

$$= -[.11011]_2 \cdot 2^{-[10]_2}$$

Text Data

Assign a character code to each text character

- ASCii : older, 8-Bit Per char

$$\left(\begin{matrix}\#\text{char} \\ \text{codes}\end{matrix}\right) = 2^8 = 256$$

- Unicode : newer, 16-Bit Per char

$$\left(\begin{matrix}\#\text{char} \\ \text{codes}\end{matrix}\right) = 2^{16} = 65\,536$$

Ex. Text "Hello"

Ascii

	Hex	8-Bit Binary
H	48	0100 1000
e	65	0110 0101
l	6C	0110 1100
l	6C	0110 1100
o	6F	0110 1111

Unicode

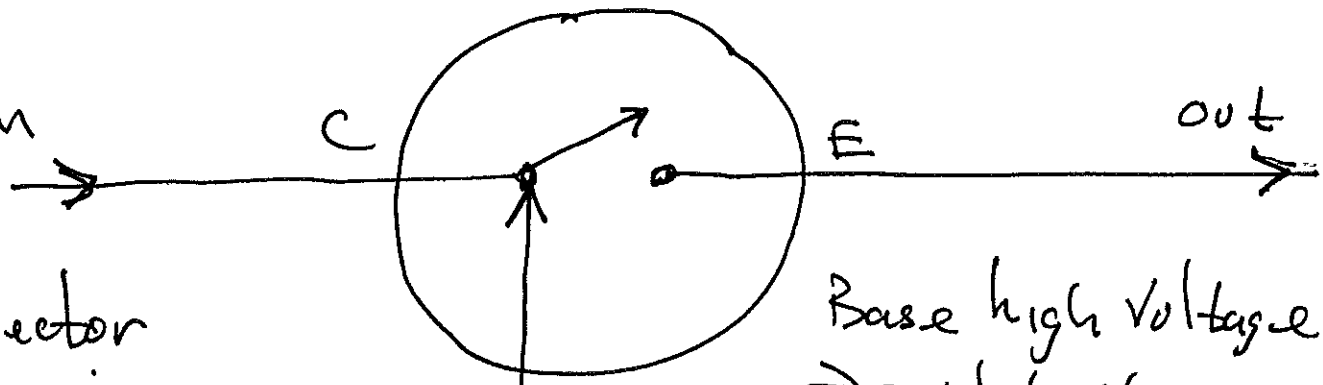
	Hex	16-Bit Binary
H	0048	0000 0000 0100 1000
e	'	
l	'	
l	'	
o	'	

why Binary? Reliability

Bistable Device:

(1) has 2 stable energy states
(2) separated by an 'energy barrier'
(3) can Read state without changing
(4) can change state with energy input

Transistor



C: collector
E: emmitter
B: base

Base high voltage
⇒ switch closes.