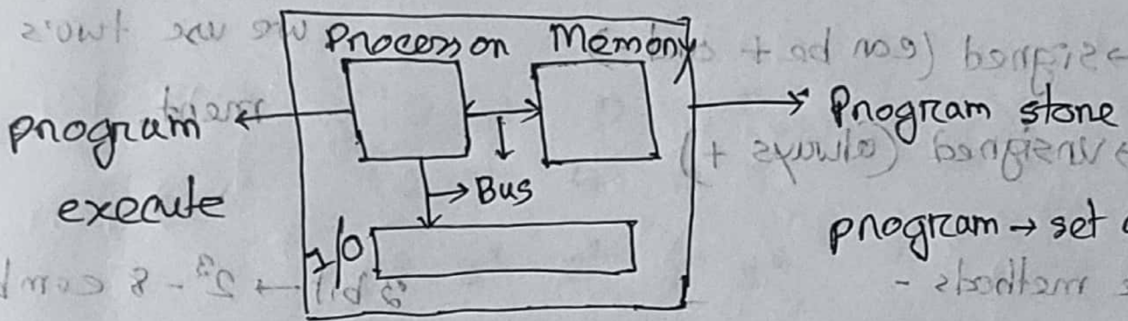
Lecture-1

Computer Antichitecture

12.03.2022



program → set of instructions

compiler converts the high level program into machine language and store in memory

Processor has two parts -

i) Control unit → fetch & decode

ii) Execution unit → Execute

Decode: Decode understand the binary pattern by control unit of processor.

Assembler: Assembler converts assembly and high level language into machine/binary language.

Execution → ALU - Arithmatic Logic Unit

Memory types -

1. primary → ram, Rom
2. Secondary → Hard disk

How to represent number.

→ signed (can be + and -)

→ unsigned (always +)

To get negative number we use two's compliment.

3 bit → $2^3 = 8$ combinations

Three methods -

1. sign magnitude		2. 1's complement	3. 2's compliment
+3	011	011	011
+2	010	010	010
+1	001	001	001
0	000	000	000
-1	101	110	111
-2	110	101	110
-3	111	100	101

Another combination (-0 / 100) not valid

111 (-0) missing not valid

missing 100 which is not -0

Short-cut:

From the right hand side, copy the number as it is, till you get first 1, then invert everything.

* 2's compliment does not give negative 0, that's why we use it.

Convent to binary :

$(0\ 1\ 0\ 1\ 0)_2$

16 8 4 2 1

2^4 2^3 2^2 2^1 2^0

3 bit

$2^3(8)$

$-$ / \ $+$

$(-4,-1)$ $(0,3)$

4 bit

$2^4\ (16)$

$-$ / \ $+$

$(-8,-1)$ $(0,\cancel{8}7)$

8 bit

$2^8(256)$

$-$ / \ $+$

$(-128,-1)$ $\cancel{(0,127)}$

$(0,127)$

$101 \longrightarrow -3$

After $\rightarrow 011 \longrightarrow 3$

2's compliment

$0101 \longrightarrow$

1010

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14.03.2022

64 32 16 8 4 2 1

2^6 2^5 2^4 2^3 2^2 2^1 2^0

3 bit

$2^3 = 8$

$-$ / \ $+$

$(-4,-1)$ $(0,3)$

4 bit

$2^4 = 16$

$-$ / \ $+$

$(-8,-1)$ $(0,7)$

5 — +5 0101, −5 1011

7 — +7 0111, −7 1001

9 — +9 01001, −9 10111

67 — +67 01000011, −67 10111101

85 — +85 01010101, −85 10101011

Floating Point Number

567	0.0158
782	1.275
125	23.5
↓	↓
Fixed point number	Floating point number

Any number where the position of number is not fixed is called floating point number

Floating point number representation:

$73.2 - 7.32 \times 10^2$

$649 - 6.49 \times 10^2$

$.847 - 8.47 \times 10^{-1}$

$5.63 - 5.63 \times 10^0$

Convert the floating point into fixed point. This process is known as normalization.

Normalization

$73.2 \longrightarrow 7.32 \times 10^1$

$649 \longrightarrow 6.49 \times 10^2$

$.847 \longrightarrow 8.47 \times 10^{-1}$

$5.63 \longrightarrow 5.63 \times 10^0$

| M | E |

Biased Ex

E positi

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Date: 16.03.2022

$73.2 \longrightarrow 7.32 \times 10^1$

$649 \longrightarrow 6.49 \times 10^2$

$.847 \longrightarrow 8.47 \times 10^{-1}$

$5.63 \longrightarrow 5.63 \times 10^0$

Non Normalized

Normalization:

There should be only one non zero digit to the left of the point.

Exponent — $\boxed{E \mid M}$ — Mantissa

0 → position representation

563 → represent all digits

$\longrightarrow 5.63 \times 10^0$

$0101.001 \rightarrow 1.01001 \times 2^2 \times (-1)^0$

$11111.01 \rightarrow 1.111101 \times 2^4 \times (-1)^0$

$0.00101 \longrightarrow 1.01 \times 2^{-3} \times (-1)^0$

$-10.01 \longrightarrow -1.001 \times 2^1 \times (-1)^1 \longrightarrow \boxed{E \mid M}$

1 ~~1001~~/001

to utilize space we can write

To represent negative number

$(-1)^S \boxed{E \mid M}$

* S represent → if S = 0 positive

if S = 1 negative

S E M (digit of the number without 1 and .)

$(-1)^S \times 1.M \times 2^E$ $\longrightarrow$ Normalization form

$S=0$, $M=1101$, $E=3$ $\longrightarrow$ $1.1101 \times 2^3 \longrightarrow 1110.1$

IEEE - 754 - 32 bit format / single precession

S	E	M
1	8	23

E - Biased exponent positive
to make the exponent biased by adding

Bias - 127

IEEE - 754 - 64 bit format / double precession

S	E	M
1	11	52

$\therefore$ Bias $= \frac{2^{11}}{2} = \frac{2048}{2} = 1024 = 1023$

including 0

Biased E = True E + Bias

BE = TE + Bias

condition for bias - support equal number of positive and negative

Q. Convert $(14.125) \rightarrow$ single precission

Steps:

1. Convert into binary
2. Normalization
3. Take the bias
4. Convert bias exponent into binary
5. Substitute into required format.

Step-1: $14.125 \longrightarrow 1110.001$

$0.125 \times 2 = 0.25 \quad 0$

$0.25 \times 2 = 0.5 \quad 0$

$0.5 \times 2 = 1 \quad 1$

Step-2: $1.110001 \times 2^3 \times (-1)^0$

Step-3: for single precision $\rightarrow 127$

$\therefore$ Biased exponent $\rightarrow 127+3 = 130$

~~In bit~~

Step-4: $130 \rightarrow 10000010$

Step-5: $(-1)^S \times 1.M \times 2^E \longrightarrow$

S	E	M
0	10000010	110001.....

extend upto 23 bit

If the number be -14.125, s value 1

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S	E	M
1	2	563

$-5.63 \times 10^2 = -563$

S	E	M
1	1	001

Binary

-1.001×2^1

* Why we use bias?

→ To make the calculation faster.

Bias value - single pression : 127 and double pression - 1023

For single pression exponent - 8 bit

$\therefore$ Ep : 8 → 2^8 → 256 → 0 - 255 → $\frac{255}{2}$ → 127.5

127

By avoiding .5 we use

so that it can support equal number of positive and negative

Floating point number → 0.00101 double pression.

single pression

S	E	M
0	1111100	00101

(1) 0.00101

(2) $1.01 \times 2^{-3} \times (-1)^0$

(3) 127 - 3 = 124

(4) 124 → 1111100

double precission

1. 0.00101

2. 1.01×2^{-3}

3. $1023 - 3 = 1020$

4. 1111111100

5. | S | E | m |
   |---|---|---|
   | 0 | 1111111100 | 01000 → 0 upto 52 |

$(-1)^0 \times 1.01 \times 2^{1111111100}$

Q. 0101.001 → single pression

1. 0101.001

2. $1.01001 \times 2^2 \times (-1)^0$

3. $127 + 2 = 129$

4. 10000001

5. | S | E | m |
   |---|---|---|
   | 0 | 10000001 | 01001 → 0 |

Book reference -

Writen - William Stalling

Q. $(2A3B)_{16} \rightarrow$

2A3B

0010 1010 0011 1011

① 0010101000111011

② $1.0101000111011 \times 2^{13} \times (-1)^{0}$

③ $127 + 13 = 140$

④ 10001100

⑤

S	E	M
0	10001100	0101000111011