Sign magnitude Reprsentation

Sign-Magnitude representation

- "+" sign before a number indicates it as a positive number
- "-" sign before a number indicates it as a negative number
- Not very convenient on computers

• Replace "+" sign by "0" and "-" by "1"

$(+1100101)_2 \rightarrow (01100101)_2$

$(+101.001)_2 \rightarrow (0101.001)_2$

$(-10010)_2 \rightarrow (110010)_2$

(-110.101)$_2$ --. (1110.101)$_2$

Complements

1. Simplying subtraction operation
2. Logical manipulation

Types of complements

- Diminished Radix Complement (DRC) or (r-1) - complement
- Radix Complement (RXC) or r-complement

Binary numbers

- DRC is known as “one’s-complement”
- RXC is known as “two’s-complement”

Decimal numbers

- DRC is known as 9’s-complement
- RXC is known as 10’s-complement

(r-1)'s complement (or) diminished radix

Given positive number N in base r having integer part of 'n' digits and fractional part of 'm' digits

Then (r-1)'s Complement of 'N' is

$\boxed{(r^n - r^{-m} - N)}$ $= 10^1 - r^{-0} - 7$

$= 10 - 1 - 7 = (10-1) - 7 \Rightarrow 9 - 7 = 2$

r = 10

r's = 10's

$(7)_{10}$ (r-1)'s = 9's

N = 7 (positive)

r = 10

n = 1

m = 0

9's Complement of 7 = 2

$[(10-1)-7] = 9 - 7 = 2$

$(73)_{10}$ represent it in 9's Complement

$10^2 - 10^{-0} - 73 \Rightarrow (100 - 1) - 73 = 26$

$99 - 73 = 26$

$(853)_{10}$ represent it in 9's Complement

$10^3 - 10^{-0} - 853 \Rightarrow (1000 - 1) - 853 = 146$

$999 - 853 = 146$

9's Complement of number can be obtained by subtracting each digit from 9

octal (Base = 8)

(r-1) 's Complement = 7's Complement

$(26)_8$ in 7's Complement

$r^n - r^{-m} - N \Rightarrow 8^2 - 8^{-0} - (26)_8$

$r^n - r - N \Rightarrow (8) - 8 - (26)_8$

$\Rightarrow (64)_{10} - 1 - (22)_{10}$

$\Rightarrow 64 - 23 \Rightarrow (41)_{10}$

$\downarrow$

$(\ )_8$

$(41)_{10} = (51)_8$

$$\boxed{77 - 26 = (51)_8}$$

$(A)_{16}$ repear in $= (5)_{16}$

$$\begin{array}{r} A \quad 15 \\ 10 \\ \hline 5 \\ \hline \end{array}$$

Binary $(r = 2)$

$(r-1)$'s Complement = 1's Complement

$(100)_2$

$r^n - r^{-m} - N$

$(100)_2 = (4)_{10}$

$(100)_2 = 2^3 - 2^{-0} - (100)_2$

1's $(011)_2$ $= (8)_{10} - 1 - (4)_{10} \Rightarrow 8-5 = (3)_{10}$

$= (3)_{10} \Rightarrow (011)_2$

1's complement of $(100)_2$ as $(011)_2$

(110) in 1's Complement

001_2

$$\boxed{\begin{array}{l} r^n - r^{-m} - N \\ 2^3 - 2^{-0} - (110)_2 \end{array}}$$

$(8)_{10} - 1 - (6) \Rightarrow 8 - 7 = (1)_{10}$

$(1)_{10} = (001)_2$

$(110)_2$ 1's Complement number as $(001)_2$

$(110)_2$ 1's Complement number as $(001)_2$

$(\underbrace{110}_{n=3}.\underbrace{1}_{m=1})_2$ in 1's Complement $= (001.0)_2$

$r^n - r^{-m} - N$

$2^3 - 2^{-1} - (110.1)_2$ ✓ (6.5)

$(8)_{10} - \left(\frac{1}{2}\right)_{10} - (6.5)_{10} \Rightarrow (\_\_\_)_{10}$

$\downarrow$ Binary

$= (001.0)_2$ ✓

$(7A8)_{16}$ in 15's Complement

$16^3 - 16^{-0} - (7A8)_{16}$

$(\ )_{10} - (1)_{10} - (\ )_{10} = (\ )_{10}$

$\downarrow$

Hexadecimal

$(857)_{16}$

Second

15	15	15
7	A	8
8	5	7

$(1101)_2$ binary

$\downarrow\downarrow\downarrow\downarrow$

(0010) 1's

$(1101101)_2$

1's $\rightarrow (0010010)_2$

1's Complement can be obtained by replacing 1's by 0's and 0's by 1's

(2.67) represent it in 9's complement

$(2.67)_{10}$ represent it in 9's complement

$$\begin{array}{r} 9.99 \\ -\ 2.67 \\ \hline \underline{7.32} \end{array}$$

r's Complement (or) Radix complement

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Given positive number N base 'r' having an integer part of 'n' digits is given by $r^n - N$

$(8)^2 - (26)_8$

$(64)_{10} - (26)_8$

$(\ )_8 - (26)_8$

$r = 10$ (Decimal)

10's complement

$(12)_{10}$ represent it in 10's Complement

$10^2 - (12)_{10} \Rightarrow 100 - 12 = (88)_{10}$

$(73)_{10}$ in 10's Complement $\Rightarrow 10^2 - 73 = (27)_{10}$

2nd method

10's = 9's complement + 1

$(12)_{10}$ in 9's $\Rightarrow$ $87 + 1 = 88$

$(73)_{10}$ in 9's $\Rightarrow$ $26 + 1 = 27$

octal ($r = 8$)

8's complement = 7's complement + 1

Binary ($r = 2$)

2's complement = 1's Complement + 1

Hexadecimal ($r = 16$)

16's complement = 15's complement + 1

$(26)_8$ represent it in 8's complement

$(26)_8$ represent it in 8's complement

7's complement of 26 = 51
+ 1
52

$(127)_8$ in 8's Complement

7's Complement $(127)_8$ = 650
+1
651

$(958.12)_{16}$ in 16's Complement

15 15 15 . 15 15
− 958 . 12
6 10 7 . 14 13
6 A 7 . E D

A = 10
B = 11
C = 12
D = 13
E = 14
F = 15

15's Complement of $(958.12)_{16}$ is = 6A7.ED
1
6A7.EE

Binary (r = 2)

2's Complement = 1's Complement + 1

$(1011.101)_2$ represent it in 2's complem

(0100.010) → 1's Complement
+1
0100.011

MSB LSB

$1+1 = (2)_{10} = (10)$

Carry Sum
1 0

2 | 2
2 | 1 → 0
0 − 1

Arithmetic operations(addition)

octal addition

$(533 \cdot 44)_8$ to $(471 \cdot 62)_8$

Addend ↓ Augend ↓

Carry → 1 1 10

$$\begin{array}{r} 533.44 \\ +\ 471.62 \\ \hline (1225.26)_8 \end{array}$$

Carry Sum

$(10)_{10} = (12)_8$

8 | 10
1 — 2

② $(B6)_{16}$ to $(32)_{10}$ Perform octal addition

$(B6)_{16} = (\ \ )_8$

(11)

Hexa decimal to octal

ⓐ each Hexa digit represented by 4 bit binary

0 1 0 1 1 0 1 1 0

ⓑ Convert octal $(266)_8$

$(32)_{10} = (40)_8$

8 | 32
4 → 0

40

Carry → 1 10

$$\begin{array}{r} 266 \\ 40 \\ \hline 326 \end{array}$$

③ $(456.7B)_{16}$ to $(24.A6)_{16}$

Carry → 1 1

$$\begin{array}{r} 456.7B \\ 24.A6 \end{array}$$

(17)

16 | 18 Carry Sum
1 → 2

456.7B
24.A6

47B.21

16 | 18 carry sum
1 → 2

$(18)_{10} = (12)$

16 | 17
Carry 1 → 1 Sum
$(17)_{10} = (11)_{16}$

Binary addition (Rules)

(A) Addend	(B) Augend	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

$1+1 = (2)_{10}$

MSB LSB
$(10)_2$
Carry Sum

Binary Subtraction

① Direct subtraction
② Complement subtraction

Binary Subtraction (Direct subtraction)

A Minuend	B Subtrahend	Difference	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

subtract $(27)_{10} - (21)_{10}$ using binary

(27) - 11011

$$\begin{array}{rcl} (27)_{10} & = & 11011 \\ -\ (21)_{10} & = & -\ 10101 \\ \hline (6)_{10} & & (00110)_2 \end{array}$$

Signed Binary Numbers

Decimal	Signed-2's Complement	Signed-1's Complement	Signed Magnitude
+7	0111	0111	0111
+6	0110	0110	0110
+5	0101	0101	0101
+4	0100	0100	0100
+3	0011	0011	0011
+2	0010	0010	0010
+1	0001	0001	0001
+0	0000	0000	0000
−0	—	1111	1000
−1	1111	1110	1001
−2	1110	1101	1010
−3	1101	1100	1011
−4	1100	1011	1100
−5	1011	1010	1101
−6	1010	1001	1110
−7	1001	1000	1111
−8	1000	—	—

The subtraction of two n-digit unsigned numbers $M - N$ in base r can be done as follows:

1. Add the minuend M to the r's complement of the subtrahend N. This performs $M + (r^n - N) = M - N + r^n$.
2. If $M \geq N$, the sum will produce an end carry, r^n, which is discarded; what is left is the result $M - N$.
3. If $M < N$, the sum does not produce an end carry and is equal to $r^n - (N - M)$, which is the r's complement of $(N - M)$. To obtain the answer in a familiar form, take the r's complement of the sum and place a negative sign in front.

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