

Decimal Number System (Base = 10)

Digits allowed - 0 1 2 3 4 5 6 7 8 9

No. of Digits 10
 first → second pos. →
 Decimal Number System.

0	1 0	2^0
1	1 1	2^1

2	1 2	2^2
---	-----	-------

3	1 3	2^3
---	-----	-------

4	1 4	2^4
---	-----	-------

5	1 5	2^5
---	-----	-------

6	1 6	2^6
---	-----	-------

7	1 7	2^7
---	-----	-------

8	1 8	2^8
---	-----	-------

9	1 9	2^9
---	-----	-------

Binary System (Base - 2)

No. of Digit = 2 , 0 , 1

Dec Bin.
 0 → 0 2 → 1 0 4 → 1 0 0 8 → 1 0 0 0

1 → 1 2 → 1 1 5 → 1 0 1 9 → 1 0 0 1

6 → 1 1 0 10 → 1 0 1 0

7 → 1 1 1 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

Octal Number (Base = 8)

0, 1, 2, 3, 4, 5, 6, 7 } → No. of Digits = 8

Octal	Binary	Octal	Binary	Octal
0	000	1	001	100
1	001	2	010	101
2	010	3	011	102
3	011	4	100	103
4	100	5	101	104
5	101	6	110	105
6	110	7	111	106
7	111			107

Hexadecimal → Base - 16

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F } 16 digits

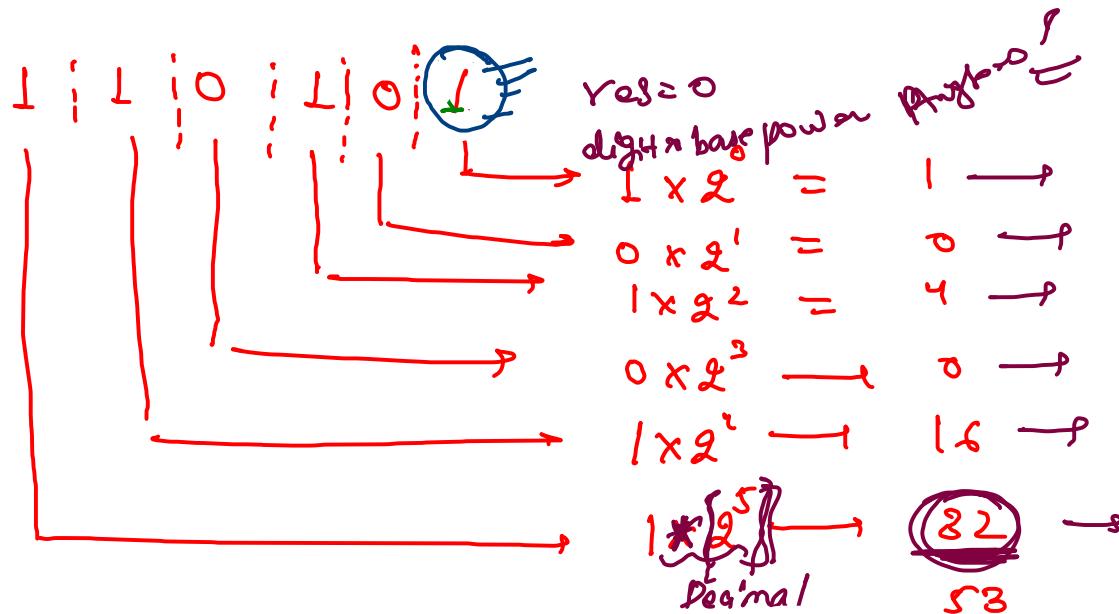
Binary to Decimal

number =

$$\begin{array}{r}
 (1 \ 1 \ 1) \\
 \downarrow \quad \downarrow \quad \downarrow \\
 2^2 \times 1 \quad 2^1 \times 1 \quad 2^0 \times 1 \\
 4 + 2 + 1 = 7
 \end{array}$$

$$\begin{array}{r}
 (1 \ 1 \ 1) \\
 \downarrow \quad \downarrow \quad \downarrow \\
 base^2 \times 1 \quad base^1 \times 1 \quad base^0 \times 1 \\
 1 \times base^2 + 1 \times base^1 + 1 \times base^0
 \end{array}$$

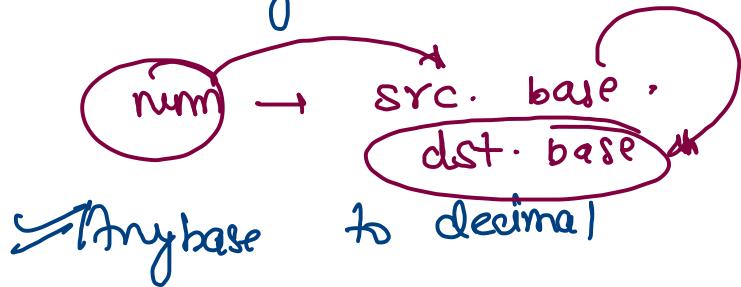
$$\begin{array}{r}
 (9 \ 8) \\
 \downarrow \quad \downarrow \\
 1 \times base^2 + 9 \times base^1 + 8 \times base^0
 \end{array}$$



Any base?

$$\begin{aligned}
 & 1 \times \text{base}^0 \\
 & 0 \times \text{base}^1 \\
 & 1 \times \text{base}^2 \\
 & 0 \times \text{base}^3 \\
 & 1 \times \text{base}^4 \\
 & 1 \times \text{base}^5
 \end{aligned}$$

Any base to Any base



= Decimal to Anybase

Decimal to Anybase

The diagram illustrates the conversion of the decimal number 57 to its binary equivalent. It features a vertical division tree on the left, where 57 is divided by 2 to get 28, then 28 by 2 to get 14, 14 by 2 to get 7, 7 by 2 to get 3, and finally 3 by 2 to get 1 with a remainder of 1. The remainders (1, 1, 0, 1, 1) are circled in red and labeled as 'rem'. To the right of the tree is a horizontal number line with arrows at both ends, labeled with 'neg' above it. Below the number line, the remainders are arranged in a sequence: 1, 1, 0, 1, 1. To the right of this sequence is a binary number '111001' with a bar over it. Above the binary number is another row of digits: 1, 1, 1, 0, 0, 1. To the right of the binary number, the remainders are shown as powers of 10: 1×10^0 , 0×10^1 , 1×10^2 , 1×10^3 , 0×10^4 , and 1×10^5 . A bracket groups the first two terms as 'rem & power'. Red annotations include 'base 2' with a circled 2, 'rem' with a circled 1, 'power' with a circled 10⁰, and 'rem & power.'.

Subset / Subsequence

Subset → Array

Subsequence - String No. of arr.

→ order maintain = 2^n

→ but it is not necessary that it will be continuous, $n=3$, $\{2, 3\}$

String - abc, array = $\{10, 20, 30\}$

<u>Binary No.</u>	<u>0 → char - Reject</u>	<u>1 → char - Accept</u>	<u>Subsets</u>
① 0 0 0			$\{\}, \{10\}, \{20\}, \{30\}$
② 0 0 1			$\{\}, \{10\}, \{20\}, \{30\}$
③ 0 1 0	- b -	b → $\{\}, \{10\}, \{20\}, \{30\}$	
④ 0 1 1	- bc	bc → $\{\}, \{10\}, \{20\}, \{30\}$	
⑤ 1 0 0	a --	a → $\{\}, \{10\}, \{20\}, \{30\}$	
⑥ 1 0 1	a - c	ac → $\{\}, \{10\}, \{20\}, \{30\}$	
⑦ 1 1 0	a b -	ab → $\{\}, \{10\}, \{20\}, \{30\}$	
⑧ 1 1 1	a b c	abc → $\{\}, \{10\}, \{20\}, \{30\}$	

Subarray / substring.

Subarray - array

substring - string.

→ order maintain

→ = Continuous Total Count: $1+2+3+\dots+n$
 $\frac{n(n+1)}{2} = n(n+1)$

String: 'a b c d' : $n=4$

Substring:

① a	⑤ b
② ab	⑥ bc
③ abc	⑦ bcd

Subarray → ④ abcd

$\{10, 20, 30\}$

$\{10\}$

$\{10, 20\}$

$\{10, 20, 30\}$

$\{20\}$

$\{30\}$

$\{20, 30\}$

Subset of an array -

~~$\{10, 20, 30\}$~~

length = 3

answr.

2^3

leng = 8, $2^1 \cdot 3$

0 → 0 0 0

10, 20, 30

0

1 → 0 0 1

10, 20, 30

1

2 → 0 1 0

20, -

2

3 → 0 1 1

20, 30

3

4 → 1 0 0

10, -, -

4

5 → 1 0 1

10, -, 30

5

6 → 1 1 0

10, 20, -

6

7 → 1 1 1

10, 20, 30

7

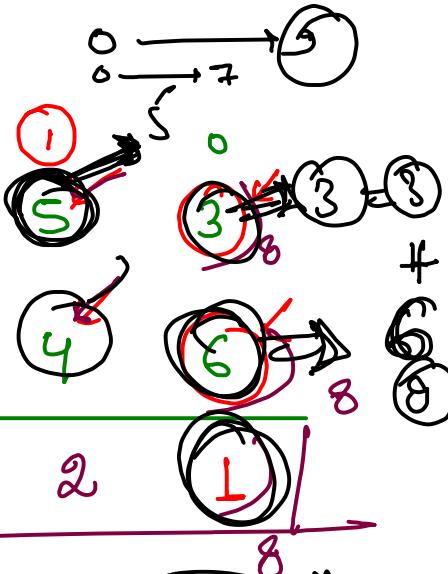
-	-	30
-	20	-
-	20	30
10	-	-
10	-	30
10	20	-
10	20	30

binary = (0 1)

digit = binary % 10;

Any base Addition

$$\begin{array}{r} \text{Base} = 8 \\ \text{num1} \rightarrow (2 \quad 1) \quad 7 \leftarrow \\ \text{num2} \rightarrow 0 \quad 7 \leftarrow \\ \hline \cancel{1} \quad 7 \quad 2 \end{array}$$



Carry = 0

$$\text{val1} = \text{num1 \% 10}, \text{num1 / = 10};$$

$$\text{val2} = \text{num2 \% 10}, \text{num2 / = 10};$$

$$\text{sum} = \text{val1} + \text{val2} + \text{carry}.$$

$$\text{val} = \text{sum \% base}$$

$$\text{carry} = \text{sum / base} -$$

$$\begin{array}{l} \text{carry} = 0 \neq 0 \\ \text{val1} = 8 \neq 2 \\ \text{val2} = 4 \neq 0 \\ \text{sum} = \text{val1} + \text{val2} + \text{carry} : 18 \neq 3 \\ \text{val} = \text{sum \% b} : 2 \neq 3 \\ \text{carry} = \text{sum / b} : 1 \neq 0 \end{array}$$



Decimal Additions

decimal Number System.

$$\begin{array}{r} 0 \quad 1 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7 \quad 8 \quad 9 \\ 9 \quad 9 \\ \hline 1 \quad 0 \quad 2 \quad 3 \quad 4 \quad 5 \quad 6 \quad 7 \quad 8 \quad 9 \end{array}$$

Carry:

$12 \% 10$

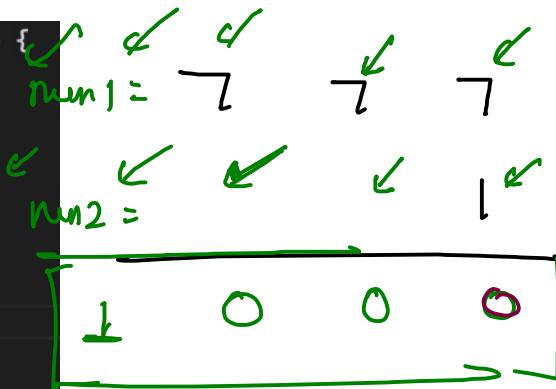
$12 / 10$

```

public static int anybaseAddition(int num1, int num2, int b) {
    int carry = 0;
    int power = 1; //  $10^0$ 
    int res = 0;
    while(num1 != 0 || num2 != 0 || carry != 0) {
        int val1 = num1 % 10;
        num1 /= 10;
        int val2 = num2 % 10;
        num2 /= 10;
        int sum = val1 + val2 + carry;
        int val = sum % b;
        carry = sum / b;

        res += val * power;
        power *= 10;
    }
    return res;
}

```



$$\textcircled{2} \quad 277.2 = 0$$

$$\begin{array}{r}
 \text{res} = \\
 \begin{array}{r}
 \text{val } 0 \times 10^0 \rightarrow 0 \\
 \text{val } 0 \times 10^1 \rightarrow 0 \\
 0 \quad 0 \times 10^2 \rightarrow 0 \\
 0 \quad 1 \times 10^3 \rightarrow 1 \times 10^3 \\
 \hline
 1 \quad 0 \quad 0 \quad 0 \\
 \hline
 1 \quad 0 \quad 0 \quad 0
 \end{array}
 \end{array}$$

Carry	0	1	1	1	0
$\text{val1} =$	2	7	7	0	
$\text{val2} =$	1	0	0	0	
$\text{sum} =$	3	8	8	1	
$\text{val} =$	0	0	0	1	

$$\text{res} \neq \text{val} + \text{power};$$

Any base Subtraction

base: 8

$$\begin{array}{r}
 n_2 \quad 2 \leftarrow \quad 7 \leftarrow \quad 5 \leftarrow \quad 3 \leftarrow \\
 \swarrow \quad \swarrow \quad \swarrow \quad \swarrow \quad \swarrow \\
 n_1 \quad 7 \quad 4 \quad 6
 \end{array}$$

$$\begin{array}{r}
 \text{res} = \quad 2 \quad 0 \quad 0 \quad 5
 \end{array}$$

$$\text{carry} = \cancel{x} \cancel{x} \cancel{x} \cancel{x} \quad 0$$

$$\text{val2} = \cancel{3} \cancel{9} \cancel{7} \quad 2$$

$$\text{val1} = \cancel{6} \cancel{4} \cancel{2} \quad 0$$

$$\text{val} = \cancel{-3} \cancel{5} \cancel{6} \quad 2$$

subtraction is depend on
 n_2 , in case
 carry = 0 $\underline{\underline{n_2 - n_1}}$

$$\text{val2} = \text{num2} \% 10$$

$$\text{num2} /= 10;$$

$$\text{val1} = \text{num1} \% 10$$

$$\text{num1} /= 10;$$

$$\text{val} = (\text{val2} + \text{carry}) - \text{val1}$$

if (Subtract < 0) {

 subtract += base;

 carry = -1;

} else {

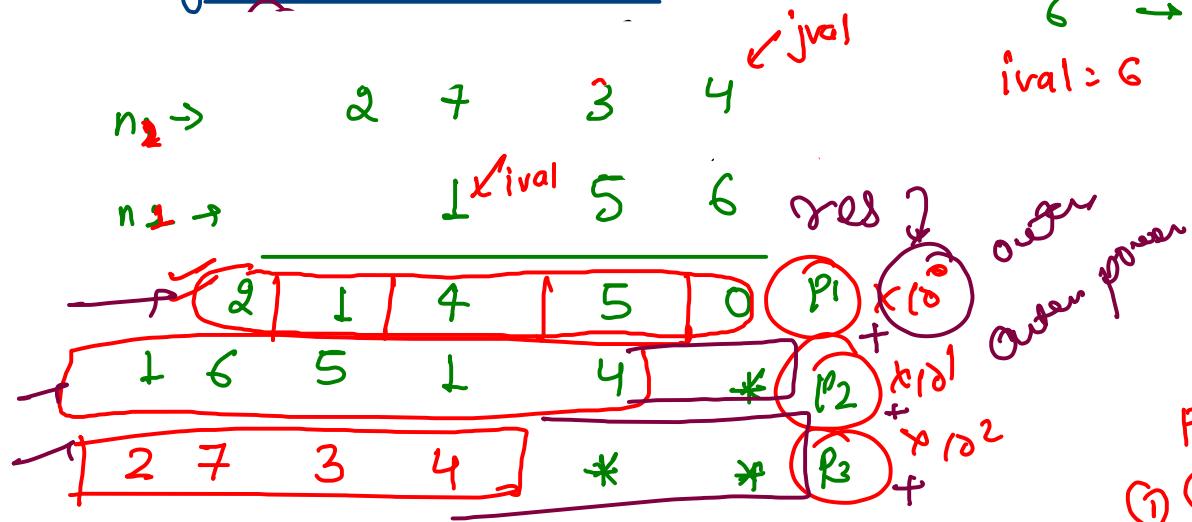
 carry = 0;

}

$$\begin{array}{r}
 n_2 \quad 1 \quad \cancel{9} \quad \cancel{3} \quad \cancel{8} \\
 \swarrow \quad \swarrow \quad \swarrow \quad \swarrow \\
 n_1 \quad 7 \quad 4 \quad 2
 \end{array}$$

$$\begin{array}{r}
 1 \quad 1 \quad 9 \quad 6
 \end{array}$$

Anybase Multiplication



$$\text{carry} = 0$$

$$\text{ival} = 1$$

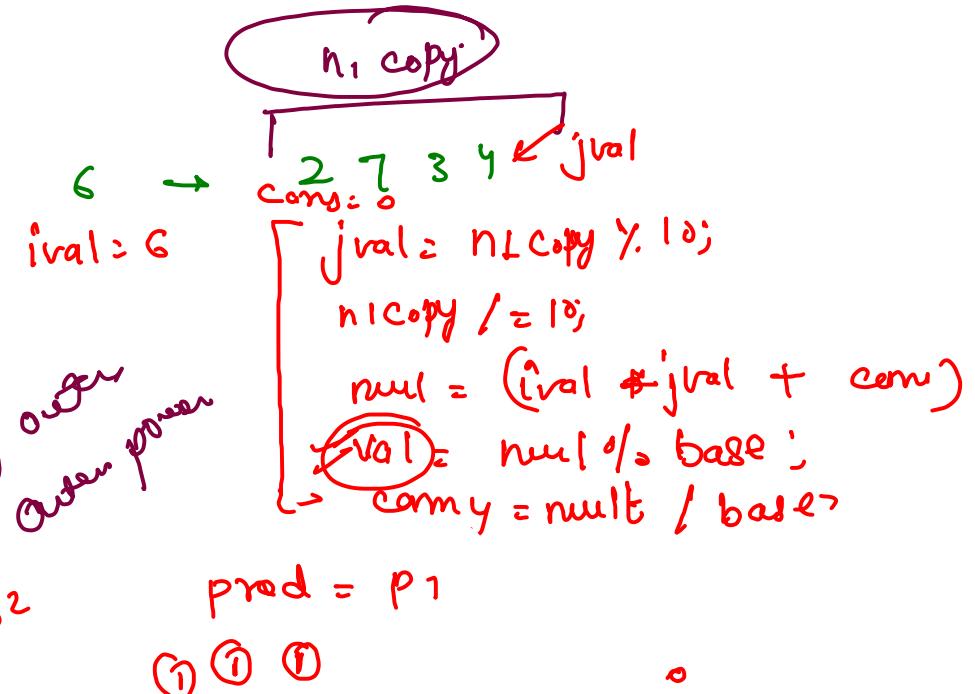
$$\text{jval} = 4$$

$$\text{mult} = 4$$

$$\text{val} = 4$$

$$\boxed{\text{res} += \text{p1} \% 10}$$

carry
base
creation



$$\begin{array}{r} 2735 \\ \times 16404 \\ \hline 10936 \\ 16404 \\ \hline 502210 \end{array}$$

$$\begin{array}{r} 132734 \\ \times 156 \\ \hline 136404 \\ 136700 \\ \hline 153104 \end{array}$$

eval

