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# Binary Numbers

↳ 0s and 1s

1) our machine understands and interact with 0's and 1's.

## # Decimal to Binary

11 →

2	17
2	8, 1
2	4, 0
2	2, 0
2	1, 0
	<u>0, 1</u>

10001

4 3 2 1 0

1 0 0 0 1

↓ ↓ ↓ ↓ ↓  
 $2^4 + 0 + 0 + 0 + 2^0$

$16 + 0 + 0 + 0 + 1 \Rightarrow 17$

## # Binary to Decimal

1011

3 2 1 0  
1 0 1 1  
↓ ↓ ↓ ↓  
 $2^3 + 0 + 2^1 + 2^0$   
↓ ↓ ↓  
 $8 + 0 + 2 + 1$

11

binary number

base 2 numbers

base 5 numbers

0, 1, 2, 3, 4

2	23
2	1, 0, 1
2	5, 1
2	2, 1
2	1, 0
	0, 1

$$\begin{aligned}
 & 2^4 + 0 \cdot 2^3 + 2^2 + 2^1 + 2^0 \\
 & 16 + 0 + 4 + 2 + 1 \\
 & \Rightarrow 23
 \end{aligned}$$

47  $\rightarrow$  base 5

(2)

(2, 2<sup>-1</sup>)

5	47
5	9, 2
5	1, 4
	0, 1

(142)<sub>5</sub>

$$\frac{1}{5} + \frac{1}{5} + \frac{1}{5} + \frac{1}{5} \rightarrow 2^4 - 1$$

$$\frac{1}{7} + \frac{1}{7} + \frac{1}{7} \rightarrow 2^3 - 1$$

$$7 \rightarrow 2^3 - 1$$

$$\frac{1}{31} + \frac{1}{31} + \frac{1}{31} + \frac{1}{31} + \frac{1}{31} \rightarrow 31$$

$$\frac{1}{31} + \frac{1}{31} + \frac{1}{31} + \frac{1}{31} + \frac{1}{31} \rightarrow 31$$

$$\frac{1}{31} + \frac{1}{31} + \frac{1}{31} + \frac{1}{31} + \frac{1}{31} \rightarrow 31$$

2	23
2	11, 1

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2<sup>5</sup> - 1

x bits

$$\underline{0} \rightarrow \underline{0} \quad \underline{0} \quad \underline{0} \quad \underline{0} \rightarrow 2^0$$

$$1 \rightarrow \underline{0} \quad \underline{0} \quad \underline{1} \quad \underline{0}$$

$$2 \rightarrow \underline{0} \quad \underline{0} \quad \underline{1} \quad \underline{0} \rightarrow 2^1$$

$$3 \rightarrow \underline{0} \quad \underline{0} \quad \underline{1} \quad \underline{1}$$

$$4 \rightarrow \underline{0} \quad \underline{1} \quad \underline{0} \quad \underline{0} \rightarrow 2^2$$

$$5 \rightarrow \underline{0} \quad \underline{1} \quad \underline{0} \quad \underline{1}$$

$$6 \rightarrow \underline{0} \quad \underline{1} \quad \underline{1} \quad \underline{0}$$

$$7 \rightarrow \underline{0} \quad \underline{1} \quad \underline{1} \quad \underline{1}$$

$$8 \rightarrow \underline{1} \quad \underline{0} \quad \underline{0} \quad \underline{0} \rightarrow 2^3$$

$$9 \rightarrow \underline{1} \quad \underline{0} \quad \underline{0} \quad \underline{1}$$

$$10 \rightarrow \underline{1} \quad \underline{0} \quad \underline{1} \quad \underline{0}$$

$$11 \rightarrow \underline{1} \quad \underline{0} \quad \underline{1} \quad \underline{1}$$

$$12 \rightarrow \underline{1} \quad \underline{1} \quad \underline{0} \quad \underline{0}$$

$$13 \rightarrow \underline{1} \quad \underline{1} \quad \underline{0} \quad \underline{1}$$

$$14 \rightarrow \underline{1} \quad \underline{1} \quad \underline{1} \quad \underline{0}$$

$$15 \rightarrow \underline{1} \quad \underline{1} \quad \underline{1} \quad \underline{1}$$

$$16 \rightarrow \underline{1} \quad \underline{0} \quad \underline{0} \quad \underline{0} \rightarrow 2^4$$

Ques

Convert a decimal number to binary

$$17 \div 2$$

↓

$$n=17$$

$$n = n/2$$

$$\begin{array}{r|l} 2 & 17 \rightarrow 1 \\ \hline 2 & 8 \checkmark \quad 1 \\ \hline 2 & 4 \quad 0 \\ \hline 2 & 2 \quad 0 \\ \hline 2 & 1 \quad 0 \\ \hline & 0 \quad 1 \end{array}$$

$$\text{Storing binary} = 1$$

$$\text{binary} = 2^0 + \text{binary} \Rightarrow 01$$

$$\Rightarrow \underline{001}$$

$$\underline{0001}$$

$$\underline{10001}$$

$$n = 23 / 115210 / \text{binary} = 1110111$$

$$\text{rem} = 1 \cdot 2 = 2$$

$$\begin{array}{r} 2 \overline{) 23} \\ \underline{2} \phantom{0} \\ 11 \\ \underline{10} \\ 1 \end{array}$$

5, 1

```
public static String decimalToBinary(int n){
    String binary="";

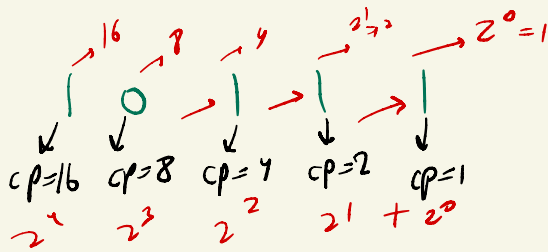
    while(n>0){
        int rem=n%2;

        binary= rem + binary;

        n=n/2;
    }

    return binary;
}
```

Ques Given a binary string, change it to decimal number.



$$2^0 + 2^1 + 2^2 + 2^3 + 2^4 = 1 + 2 + 4 + 8 + 16 = 23$$

$$\text{cp} = 16, 8, 4, 2, 1$$

$$\text{Ans} = 16 + 8 + 4 + 2 + 1 = 23$$

```
public static int binaryToDecimal(String binary){
    int n=binary.length();

    int curr_pow=1;
    int ans=0;

    for(int i=n-1; i>=0; i--){
        char ch=binary.charAt(i);

        if(ch=='1'){
            ans=ans+curr_pow;
        }

        curr_pow=curr_pow*2;
    }

    return ans;
}
```

aaabbcadeeffgggggg

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

$a \rightarrow 4$   
 $b \rightarrow 2$   
 $c \rightarrow 1$   
 $d \rightarrow 1$   
 $e \rightarrow 2$   
 $f \rightarrow 1$   
 $g \rightarrow 6$

$c = c + 'a';$

mon = 3

$c = 6 + 'a' \Rightarrow \underline{\underline{9}}$

$j(\text{mon} \rightarrow \text{freq}(i))$

