Maths Concepts & Qns

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Motivation :-

If you have the patience to do what others can't, you are already ahead of them.

MIK...

Binary Exponentiation

OR,

Fast Exponentiation

What is it ??

It is one of the most efficient ways to calculate large powers a^b

a^b in $O(\log b)$ time

What's wrong with Naive Exponentiation ???

a^b

$2^{10} \rightarrow 2 * 2 * 2 * \ldots\ldots$ 10 times

$$\boxed{\text{Time} = O(b)}$$

Using fast exponentiation

Example:- $2^{10} = 2^5 * 2^5$

$$\boxed{\text{Time} = O(\log(b))}$$

Key Concept :-

$$a^b = \begin{cases} (a^{b/2})^2 & \text{, if } b \text{ is even} \\ a * (a^{b/2})^2 & \text{, if } b \text{ is odd} \end{cases}$$

Example :-

3^{12} : $a = 3$, $b = 12$ (even)

↳ $val = 3^{12/2}$ i.e 3^6

result = val * val ;

3^{13} : $a = 3$, $b = 13$ (odd)

$(3 * 3^{12})$

↳ $val = 3^{13/2}$ i.e 3^6

result = val * val ; $3^6 * 3^6 = 3^{12}$

result = 3 * result;

Recursive code

```
int findPower ( int a, int b) {
    if (b == 0)
        return 1 ;
    int half = findPower (a, b/2) ;
    int result = ((half * half)) % M ;
```

```
if ( b % 2 == 1) {
    result = (result * a) % M ;
}

return result;
}
```

T.C = a^b

$\downarrow$

$a^{b/2}$

$\downarrow$

$a^{(b/2)/2}$

$\downarrow$

$a^{(b/2/2)/2}$

$\vdots$

a^0

S.C = $(\log_2 b)$

$\log(_2 b)$

$O(\log_2 b)$

$\log_2(b)$

Iterative Code

Note : Iterative code is faster than Recursive code ...

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