**Implementation of Data Structures and Algorithms**

**CS 5V81.001 - Special Topics in Computer Science-S15**

**Assignment 1 :** Recursion

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**Title :** Fibonacci Number

**Description :** Two numbers n(long) and p(int) are given. Aim of project is to perform [Fib(n)mod p].Here Fib(0)=0 and Fib(1) = 1. We calculate Fib(n) = Fib(n-1) + Fib(n-2) .Compare performance of tan straight-forward O(n) algorithm with the divide and conquer algorithm that runs in O(log n) time.

**Solution :**

A>Iterative Approach:

1. At base case we have Fib[0]=0 and Fib[1]=1.Then we obtain value of Fib[2] = Fib[1]+Fib[0].

2.By applying while loop iteratively we obtain the value of Fib[n]=Fib[n-1]+Fib[n-2].

3.When the while loop completes we will return the final result.

B>Used recursive approach along with Divide and Conquer methodology.

I have passed 'n-1' directly to the function as we need to compute for n-1 time.

For divide and Conquer used following concept:

Fib[{n},{n-1}]= (matrix[{1,1},{1,0}] ^ n-1) \* Fib[{1},{0}] = 'X'

1.First we check whether value of 'n' is '1'.If it is true it will just return above matrix and we will display value of Fib[0][0] as it contains value of Fib[n-1].

2.If above condition is not satisfied we will divide the 'n' by 2.Then we will recursively call the function and will divide 'n' by 2.The output is stored in an array 'fibbydac1'.We have two options:

a)If 'n' is Odd we will multiply fibbydac1\*fibbydac1 and then apply mod 'p' on it. The output is stored in another array 'fibbydac2' which will multiply by Fib[..] matrix. We will return this value .As 'n' is odd we will multiply by fibbydac1 with itself and then with base matrix 'X' or Fib[..].

b)If 'n' is Even we will just multiply fibbydac1\*fibbydac1 we get the final output. We will return this value directly.

Used concept of s = X^n % p to obtain the Fibonacci of any number.

Runtime required to execute iterative approach is O(n) while runtime required to execute recursive approach along with divide and conquer is O(log n).

**Output:**

Enter a long number

1234567890

Enter an integer

997

Iterative approach:

241

Time: 21227749270 nsec.

Memory: 2 MB / 128 MB.

Divide and Conquer

241

Time: 119316 nsec.

Memory: 2 MB / 128 MB.

**Note:**

1) Fibonacci series is applied on all positive number n > 1.

2)Displayed the time required to execute the functions in nanosecond.

**References:**

1) Class Notes