

CS210A: Data Structure and Algorithms

Semester I, 2014-15, CSE, IIT Kanpur

Programming Assignment 1

Fun with Fibonacci

Efficiency of algorithms does matter even for simple problems

Let F_n denote n th Fibonacci number. Each of you would have written a code for Fibonacci numbers during the course ESC101. Consider a related computational problem whose input is an integer n and $m = 10^9 + 7$, and output is $(F_n \bmod m)$.

In the course lectures, three algorithms for calculating Fibonacci numbers were discussed. The first algorithm was recursive, the second algorithm was iterative and the third algorithm was based on repeated squaring to compute some power of a matrix. You have to design and implement three algorithms R_{fib} , I_{fib} , $Clever_{fib}$ for the above problem by suitably employing each of these three algorithms respectively.

The aim of this exercise is to see how efficiently R_{fib} , I_{fib} , $Clever_{fib}$ solve the above problem in real time. You have to achieve the following objectives.

There are two tasks in this assignment:

1. Each group has to signup on <http://aca.cse.iitk.ac.in/cs210>, with login-id and team-name as <Roll No. 1> - <Roll No. 2>, for example, 13001_13002.

The problems corresponding to the three algorithms have been given there. Write a program for each of the implementations of the Fibonacci numbers, submit it, and then the online judge will check for its correctness. Each group must have a correct submission for each of the 3 problems, before the end of the deadline.

2. As the value of n increases, some of the above algorithms start taking too much time. The second part of this assignment is, therefore to make you realise the importance of having an algorithm which takes lesser time than the trivial implementation.

You have to experimentally determine the largest possible value of input for each of algorithms R_{fib} , I_{fib} , $Clever_{fib}$ for which you get the answer with in 1 sec, 10 sec, 1 minute, 10 minutes. If you cannot find a value for a particular time, leave it as a blank in the report.

Also, plot the time taken by each of the algorithms R_{fib} , I_{fib} as a function of n , and the time taken by $Clever_{fib}$ as a function of $\log_2 n$.

The determined values and the graph has to be submitted as a **one-page report**. Note that for the purposes of the report, the integer n can be any positive integer of value up to 10^{18} . The tutorial for calculating execution time and plotting the graph has been given on Moodle.

Motivation for Fibonacci numbers:

Fibonacci numbers have many applications in theoretical as well as applied computer science. They are used in pseudo-random number generators, Fibonacci heap data structure, analyzing efficiency of Euclids algorithm etc. Fibonacci numbers are also found in natural patterns like flower petals.