CS222: Assignment 4 - Fibonacci numbers using repeated squaring of a matrix

1. Submission deadline: Sunday, 28 February at 11:59 pm.
2. Take $n : 1 \leq n \leq N$. N is a number that depends on your computer's capability. Take it to be at least 40.
3. Follow good coding practices to gain more marks.
4. No copying among the students or from the Internet or any other source.
5. The assignment can be submitted in groups of size ≤ 3.
6. Submit a `.cpp` file and one `.pdf` file.
7. Write the names and roll numbers of the students at the top of each file.
8. The files should be called

   `repeated_squaring_firstRollNumber_secondRollNumber_thirdRollNumber.cpp`,

   `repeated_squaring_firstRollNumber_secondRollNumber_thirdRollNumber.pdf`.
9. The pdf should contain the output obtained when each program was run and the answers to the questions asked.
10. Anusha Devulapally (anusha1913101@iitgoa.ac.in) will be your TA for this assignment.
11. Read, solve and understand Exercise 0.4 of 'Algorithms' by Dasgupta, Papadimitriou, Vazirani. That will help you with this assignment.
12. `https://drive.google.com/file/d/1Qa9hMxiQnYokq1i96fTMYHJOs86g82iM/view?usp=sharing` is a video about repeated squaring.

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1. :

   Recall the Fibonacci series:

$$\begin{aligned} F_0 &= 0, \\ F_1 &= 1, \\ F_n &= F_{n-1} + F_{n-2}, \qquad \forall n \geq 2. \end{aligned}$$

   Implement a function that computes the nth Fibonacci number F_n by repeatedly squaring the matrix:

$$\begin{bmatrix} 0 & 1 \\ 1 & 1 \end{bmatrix}$$

   Compute the first N numbers in the Fibonacci sequence.

   Let $M(n)$ be the time complexity of multiplying two integers of n bits. What is the time complexity of your function in terms of $M(n)$?