Algorithm Task

Project Idea: <u>1</u> (Climbing Stair)

Team Number: <u>12</u>

1- Climbing Stair

You are climbing a stair case. It takes n steps to reach to the top. Each time you can either climb 1 or 2 steps. Design an algorithm that calculate how many distinct ways can you climb to the top? Note: Given n will be a positive integer.

GitHub Link: [AhmedMetwaly12/algorithmtask (github.com)](#)

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Code Number 1:

```c
int main()
{

   int n, f=1, s=1, tmp;
   scanf("%d", &n);

    for(int i=2; i<=n; i++) {
        // fib(n) = fib(n-1) + fib(n-2);
        tmp = f+s;
        f   = s;
        s   = tmp;
    }

    if(n < 1) s = 0; //this condition deals with negative numbers and zero

    printf("The distinct ways i can climb to the top is: %d\n", s);
}
```
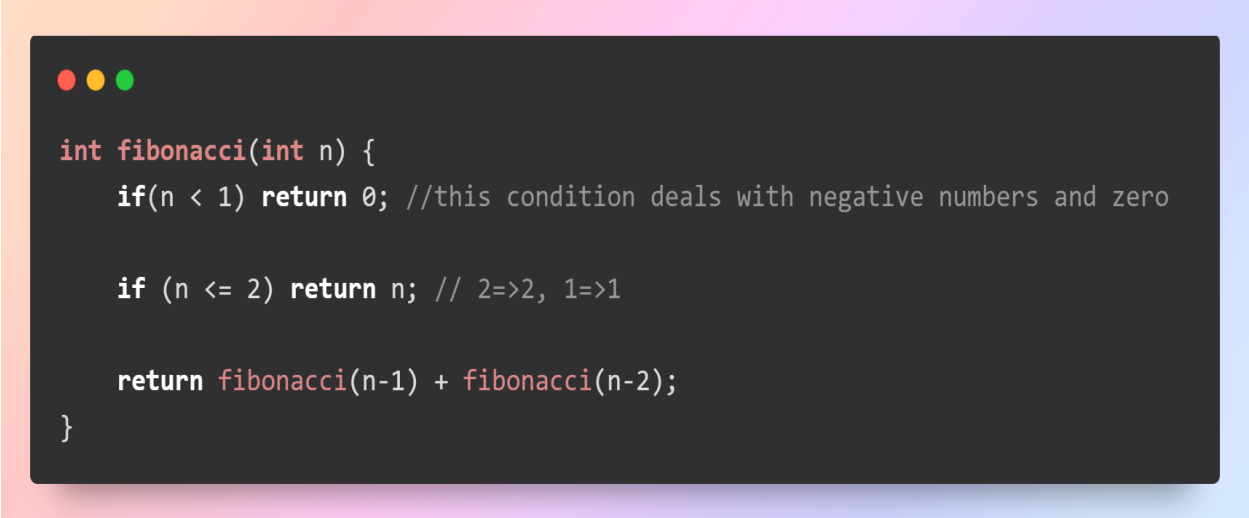
Pseudocode of Code Number 1

```
f := 1
s := 1
Read integer n from the user
for I := 2 to n do {
      tmp := f+s
      f := s
      s := tmp
}
If n < 1 then
      s := 0
print s
```

Analysis of Code Number 1

$$C(n) = \sum_{i=2}^{n} 1 = \text{n-2+1} = O(n)$$

Code Number 2

```
int fibonacci(int n) {
    if(n < 1) return 0; //this condition deals with negative numbers and zero

    if (n <= 2) return n; // 2=>2, 1=>1

    return fibonacci(n-1) + fibonacci(n-2);
}
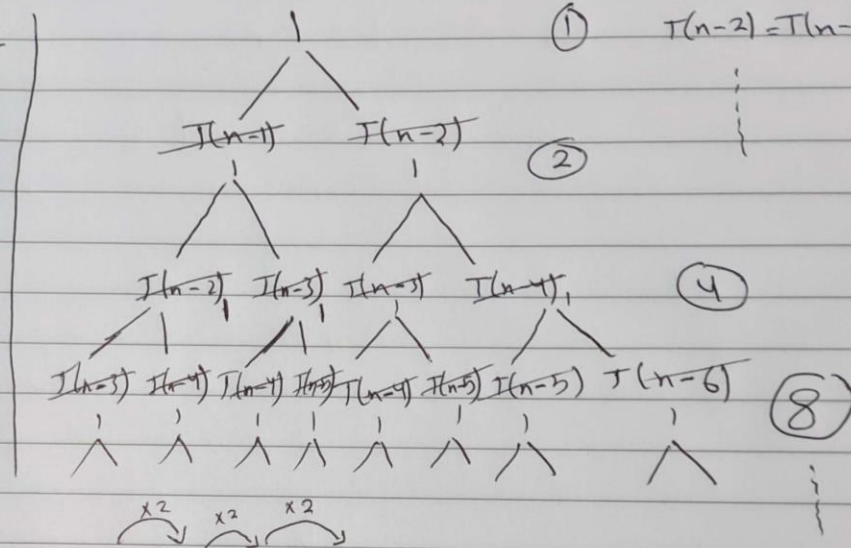```

# Pseudocode of Code Number 2

```
function fibonacci(n)
    if n < 1 then
        return 0
    if n <= 2 then
        return n
    return fibonacci(n-1) + fibonacci(n-2)
```

Analysis of Code Number 2

$$T(n) = T(n-1) + T(n-2) + 1$$

height = n

$T(n-1) = T(n-2) + T(n-3) + 1$

$T(n-2) = T(n-3) + T(n-4) + 1$

$\vdots$

① 1

$T(n-1)$ $T(n-2)$

② 2

$T(n-2)$ $T(n-3)$ $T(n-3)$ $T(n-4)$

④ 4

$T(n-3)$ $T(n-4)$ $T(n-4)$ $T(n-5)$ $T(n-4)$ $T(n-5)$ $T(n-5)$ $T(n-6)$

⑧ 8

$\vdots$

$\times 2$ $\times 2$ $\times 2$

$$T(n) = 1 + 2 + 4 + 8 + \cdots \cdots$$

(geometric)

$a_1 = 1, \quad r = 2, \quad \text{height} = n$

$$T(n) = a_1 \left(\frac{1 - r^{height}}{1 - r} \right) = 1 \left(\frac{1 - 2^{n}}{1 - 2} \right) = \boxed{O(2^n)}$$

Test Run of Codes
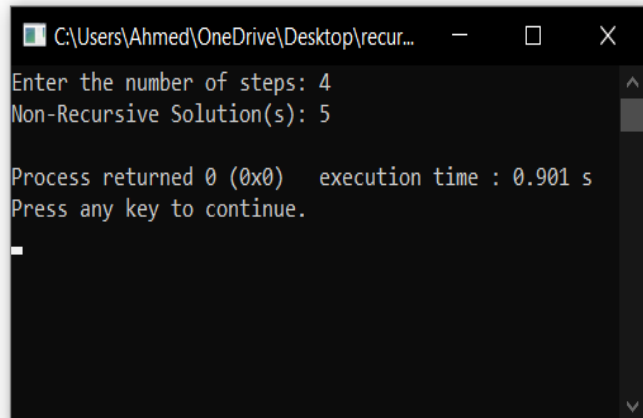
Code 1

```c
#include <stdio.h>
#include <stdlib.h>

int main()
{

    int n, f=1, s=1, tmp;
    printf("Enter the number of steps: ");
    scanf("%d", &n);

    for(int i=2; i<=n; i++) {
        // fib(n) = fib(n-1) + fib(n-2);
        tmp = f+s;
        f   = s;
        s   = tmp;
    }
    if(n < 1) s = 0; //this condition deals with negative numbers and zero
    printf("Non-Recursive Solution(s): %d\n", s);
}
```

```
C:\Users\Ahmed\OneDrive\Desktop\recur...          —    □    X

Enter the number of steps: 4
Non-Recursive Solution(s): 5

Process returned 0 (0x0)   execution time : 0.901 s
Press any key to continue.
```
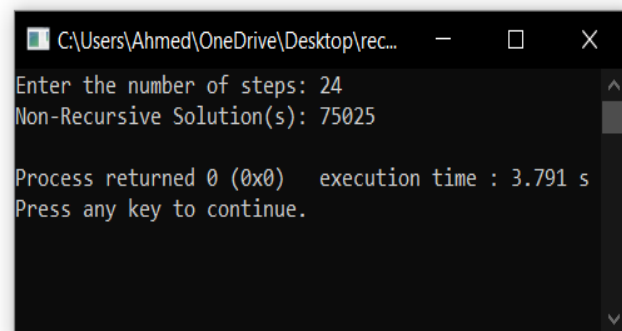
```c
#include <stdio.h>
#include <stdlib.h>

int main(){

    int n, f=1, s=1, tmp;
    printf("Enter the number of steps: ");
    scanf("%d", &n);

    for(int i=2; i<=n; i++) {
        // fib(n) = fib(n-1) + fib(n-2);
        tmp = f+s;
        f   = s;
        s   = tmp;
    }
    if(n < 1) s = 0; //this condition deals with negative numbers and zero
    printf("Non-Recursive Solution(s): %d\n", s);
}
```

```
C:\Users\Ahmed\OneDrive\Desktop\rec...          —    □    X

Enter the number of steps: 24
Non-Recursive Solution(s): 75025

Process returned 0 (0x0)   execution time : 3.791 s
Press any key to continue.
```
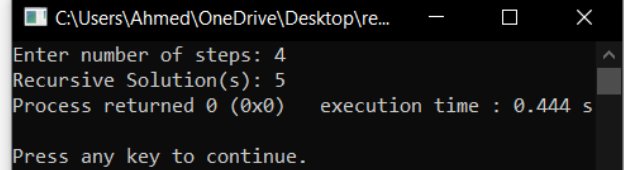
Code 2

```c
#include <stdio.h>
#include <stdlib.h>

int fibonacci(int n) {
    if(n < 1) return 0;
    if (n <= 2) return n; // 2=>2, 1=>1
    return fibonacci(n-1) + fibonacci(n-2);
}

int main()
{

    int n;
    printf("Enter number of steps: ");
    scanf("%d", &n);
    printf("Recursive Solution(s): %d",fibonacci(n));
}
```
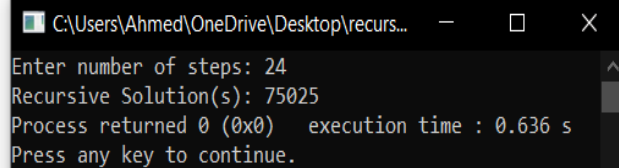
```
C:\Users\Ahmed\OneDrive\Desktop\re...    —    □    ×
Enter number of steps: 4
Recursive Solution(s): 5
Process returned 0 (0x0)    execution time : 0.444 s

Press any key to continue.
```

```c
#include <stdio.h>
#include <stdlib.h>

int fibonacci(int n) {
    if(n < 1) return 0;
    if (n <= 2) return n; // 2=>2, 1=>1
    return fibonacci(n-1) + fibonacci(n-2);
}

int main()
{

    int n;
    printf("Enter number of steps: ");
    scanf("%d", &n);
    printf("Recursive Solution(s): %d",fibonacci(n));
}
```

```
C:\Users\Ahmed\OneDrive\Desktop\recurs...    —    □    ×
Enter number of steps: 24
Recursive Solution(s): 75025
Process returned 0 (0x0)    execution time : 0.636 s
Press any key to continue.
```

Comparison

Code No	Best Case	Worst Case
1	$\Omega(1)$	$O(n)$
2	$\Omega(1)$	$O(2^n)$

Therefore: Code number 1 is better, more time efficient.