Space and time efficient Binomial Coefficient

Write a function that takes two parameters n and k and returns the value of Binomial Coefficient C(n, k). For example, your function should return 6 for n = 4 and k = 2, and it should return 10 for n = 5 and k = 2.

We have discussed a O(n*k) time and O(k) extra space algorithm in this post. The value of C(n, k) can be calculated in O(k) time and O(1) extra space.

```
C(n, k) = n! / (n-k)! * k!
        = [n * (n-1) *....* 1]  / [ ( (n-k) * (n-k-1) * .... * 1) *
                                    ( k * (k-1) * .... * 1 ) ]
After simplifying, we get
C(n, k) = [n * (n-1) * .... * (n-k+1)] / [k * (k-1) * .... * 1]

Also, C(n, k) = C(n, n-k)  // we can change r to n-r if r > n-r
```

Following implementation uses above formula to calculate C(n, k)

```
// Program to calculate C(n ,k)
#include <stdio.h>

// Returns value of Binomial Coefficient C(n, k)
int binomialCoeff(int n, int k)
{
    int res = 1;

    // Since C(n, k) = C(n, n-k)
    if ( k > n - k )
        k = n - k;

    // Calculate value of [n * (n-1) *---* (n-k+1)] / [k * (k-1) *----
```


```
    for (int i = 0; i < k; ++i)
    {
        res *= (n - i);
        res /= (i + 1);
    }

    return res;
}

/* Drier program to test above function*/
int main()
{
    int n = 8, k = 2;
    printf ("Value of C(%d, %d) is %d ", n, k, binomialCoeff(n, k) );
    return 0;
}
```

```
Value of C(8, 2) is 28
```

Time Complexity: O(k)
Auxiliary Space: O(1)

This article is compiled by Aashish Barnwal and reviewed by GeeksforGeeks team. Please write comments if you find anything incorrect, or you want to share more information about the topic discussed above.

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Alok Kumar • a month ago

Good to know, but not practical. In most of the cases overflow is certain.

K.kaushik • 11 months ago

The above program gives negative result for 100 C 15 or 100 C 18 or 100 C 19 C 20 or 100 C 25. Why this strange behaviour ?

```
/* Paste your code here (You may delete these lines if not writing co
```

1 ^ | v ·

GeeksforGeeks ➚ K.kaushik · 11 months ago

The reason for negative values seems to be integer overflow. The prog

^ | v ·

geekguy ➚ GeeksforGeeks · 11 months ago

Use Java's BigInteger ! :)

Easiest Solution !

^ | v ·

Aashish ➚ K.kaushik · 11 months ago

This is because 100 C 15 > 100 C 25. The former shows the negative
Please do some paper work.

^ | v ·

Anuj Siroi ➚ Aashish · 11 months ago

```
 How is 100 C 15 > 100 C 25 ?? If so then
100 C 15 > 100 C 25
=> 100! / 15! * 85! > 100! /25! * 75!
=> 15! * 85! < 25! * 75!
=> 85 * 84 * ..... * 76 < 25 * 24 * ..... * 16

Is it possible ????
```

^ | v ·

K.kaushik ➚ Aashish · 11 months ago

yes obviously 10 C 15 < 10 C 25. So 10 C 25 may show negati
15 is showing negative, not 10 C 25. In java iterative implement

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datatype 'long&#039 instead of 'int&#039. but still I
positive. Please clear the confusion.

Aashish ➚ K.kaushik • 11 months ago

Apologies. Please see the updated comment.

Swapnil • 2 years ago

Just a small error.You can't define int inside for(). you need to define it before t

```
/* Paste your code here (You may delete these lines if not writing c
```

Aashish ➚ Swapnil • 2 years ago

According to c-99 standard, you can define a variable inside loops alsc
Check here: https://ideone.com/pOWZM

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