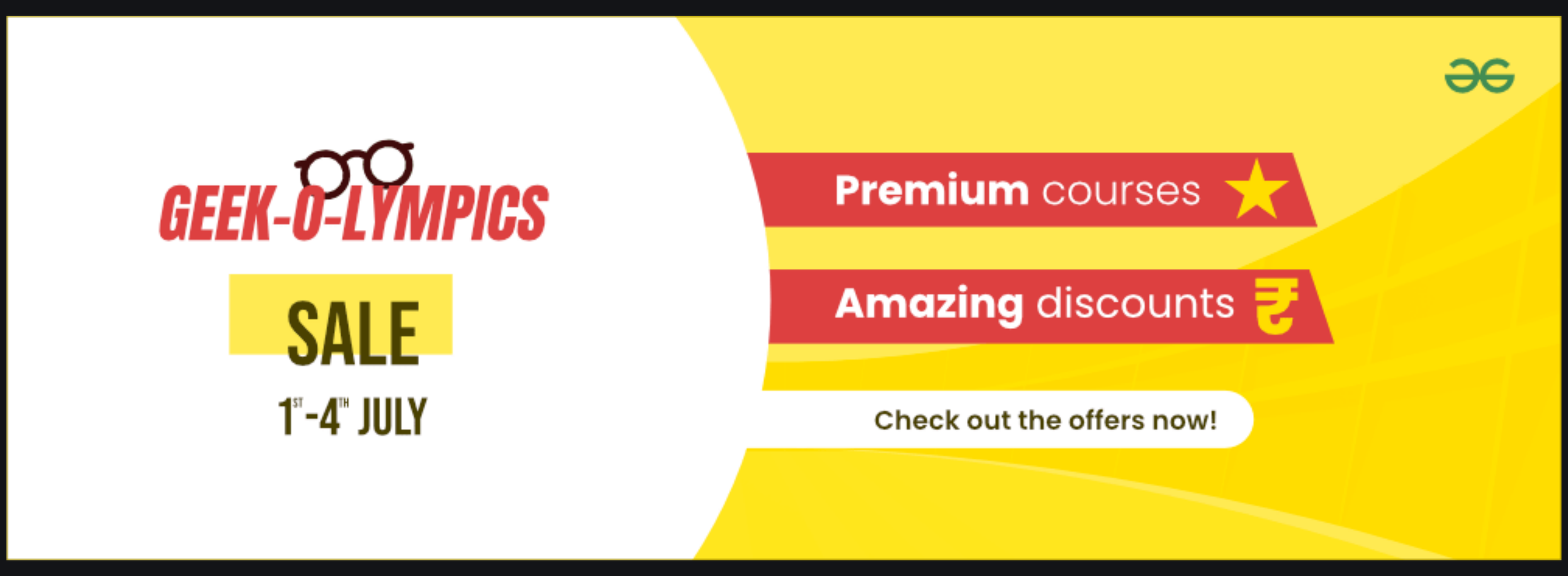
Double factorial

Difficulty Level : Easy • Last Updated : 29 Apr, 2021



Double factorial of a non-negative integer n, is the product of all the integers from 1 to n that have the same parity (odd or even) as n. It is also called as **semifactorial** of a number and is denoted by **!!**. For example, double factorial of 9 is 9*7*5*3*1 which is 945. Note that, a consequence of this definition is 0!! = 1.

Examples:

```
Input: 6
Output: 48
Note that 6*4*2 = 48

Input: 7
Output: 105
Note that 7*5*3 = 105
```

For even n, the double factorial is:

$n!! = \prod_{k=1}^{n/2}(2k) = n(n-2)(n-4).....4*2$

For odd n, the double factorial is:

$n!! = \prod_{k=1}^{n+1/2}(2k-1) = n(n-2)(n-4).....3*1$

Recommended: Please try your approach on **{IDE}** first, before moving on to the solution.

Recursive Solution:
Double factorial can be calculated using following recursive formula.

```
n!! = n * (n-2)!!
n!! = 1 if n = 0 or n = 1
```

Following is the implementation of double factorial.

C++ Java Python3 C# PHP Javascript

```python
# function to find double
# factorial of given number
def doublefactorial(n):

    if (n == 0 or n == 1):
        return 1;
    return n * doublefactorial(n - 2);

# Driver Code
print("Double factorial is",
       doublefactorial(5));

# This code is contributed
# by Smitha
```

Output:

```
Double factorial is 15
```

Iterative Solution:
Double factorial can also be calculated iteratively as recursion can be costly for large numbers.

C++ Java Python3 C# PHP Javascript

```python
# Python3 Program to find double
# factorial of given number

# Function to find double
# factorial of given number
def doublefactorial(n):
    res = 1;
    for i in range(n, -1, -2):
        if(i == 0 or i == 1):
            return res;
        else:
            res *= i;

# Driver Code
print("Double factorial is",
        doublefactorial(5));

# This code is contributed by mits
```

Output:

```
Double factorial is 15
```

Time complexity of the above solutions is O(n).
Important Points :

1. Double factorial and factorial are related using below formula.

```
Note : n!! means double factorial.
If n is even, i.e., n = 2k
   n!! = 2^k k!
Else (n = 2k + 1)
   n!! = (2k)! / 2^k k!
```

2.Double factorial is frequently used in combinatorics. Refer wiki for list of applications. An example application is count of perfect matchings of a complete graph K_{n+1} for odd n.

References:
https://en.wikipedia.org/wiki/Double_factorial
This article is contributed by **Rahul Agrawal**. If you like GeeksforGeeks and would like to contribute, you can also write an article using write.geeksforgeeks.org or mail your article to contribute@geeksforgeeks.org. See your article appearing on the GeeksforGeeks main page and help other Geeks.
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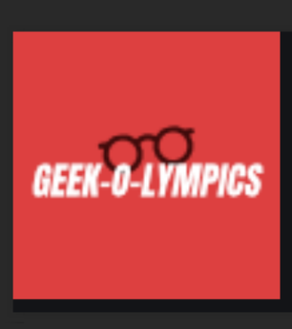
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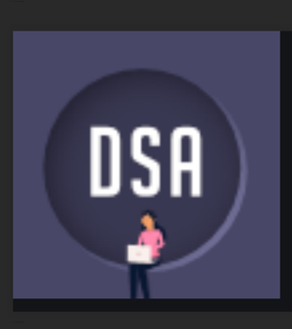

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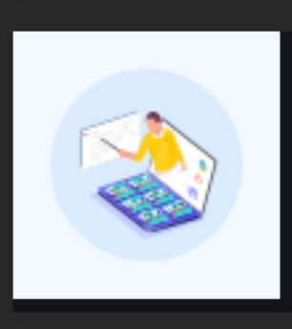
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