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Subarray/Substring vs Subsequence and Programs to Generate them

Subarray/Substring

A subarray is a **contiguous** part of array. An array that is inside another array. For example, consider the array [1, 2, 3, 4], There are 10 non-empty sub-arrays. The subarrays are (1), (2), (3), (4), (1,2), (2,3), (3,4), (1,2,3), (2,3,4) and (1,2,3,4). In general, for an array/string of size n, there are $n*(n+1)/2$ non-empty subarrays/substrings.

How to generate all subarrays?

We can run two nested loops, the outer loop picks starting element and inner loop considers all elements on right of the picked elements as ending element of subarray.

```
/* C++ code to generate all possible subarrays/subArrays
Complexity- O(n^3) */
#include<bits/stdc++.h>
using namespace std;

// Prints all subarrays in arr[0..n-1]
void subArray(int arr[], int n)
{
    // Pick starting point
    for (int i=0; i <n; i++)
    {
        // Pick ending point
        for (int j=i; j<n; j++)
        {
            // Print subarray between current starting
            // and ending points
            for (int k=i; k<=j; k++)
                cout << arr[k] << " ";

            cout << endl;
        }
    }
}

// Driver program
int main()
{
    int arr[] = {1, 2, 3, 4};
    int n = sizeof(arr)/sizeof(arr[0]);
    cout << "All Non-empty Subarrays\n";
    subArray(arr, n);
    return 0;
}
```

Run on IDE

Output:

All Non-empty Subarrays

```
1
1 2
1 2 3
1 2 3 4
2
2 3
2 3 4
3
3 4
4
```

Subsequence

A subsequence is a sequence that can be derived from another sequence by zero or more elements, without changing the order of the remaining elements.

For the same example, there are 15 sub-sequences. They are (1), (2), (3), (4), (1,2), (1,3),(1,4), (2,3), (2,4), (3,4), (1,2,3), (1,2,4), (1,3,4), (2,3,4), (1,2,3,4). More generally, we can say that for a sequence of size n , we can have $(2^n - 1)$ non-empty sub-sequences in total.

A string example to differentiate: Consider strings "geeksforgeeks" and "gks". "gks" is a subsequence of "geeksforgeeks" but not a substring. "geeks" is both a subsequence and subarray. Every subarray is a subsequence. More specifically, **Subsequence is a generalization of substring.**

How to generate all Subsequences?

We can use [algorithm to generate power set](#) for generation of all subsequences.

```
/* C++ code to generate all possible subsequences.
   Time Complexity O(n * 2^n) */
#include<bits/stdc++.h>
using namespace std;

void printSubsequences(int arr[], int n)
{
    /* Number of subsequences is (2**n -1)*/
    unsigned int opsize = pow(2, n);

    /* Run from counter 000..1 to 111..1*/
    for (int counter = 1; counter < opsize; counter++)
    {
        for (int j = 0; j < n; j++)
        {
            /* Check if jth bit in the counter is set
               If set then print jth element from arr[] */
            if (counter & (1<<j))
                cout << arr[j] << " ";
        }
        cout << endl;
    }
}

// Driver program
int main()
{
```

```
int arr[] = {1, 2, 3, 4};  
int n = sizeof(arr)/sizeof(arr[0]);  
cout << "All Non-empty Subsequences\n";  
printSubsequences(arr, n);  
return 0;  
}
```

[Run on IDE](#)

All Non-empty Subsequences

```
1  
2  
1 2  
3  
1 3  
2 3  
1 2 3  
4  
1 4  
2 4  
1 2 4  
3 4  
1 3 4  
2 3 4  
1 2 3 4
```

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Pause with the perfect ...



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Tejas Joshi • 2 days ago

The method for subsequence would work till $n=8*\text{sizeof}(\text{int})-1$ only.

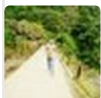
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Pooja • 2 months ago

Is there a difference between subsequence and subset?

^ | v • [Reply](#) • [Share](#) >



Dixit Singla • 5 months ago

I tested the logic, it's working perfectly but I did not understand one thing why we are right shifting the J variable by 1??

Could you please explain the reason?

^ | v • [Reply](#) • [Share](#) >



Harshit Gupta → [Dixit Singla](#) • 4 months ago

Sure.

See 1st or all the value of counter is ranging from 1 to $2^n - 1$. So, for this example it is from 1 to 15 which essentially mean that there are 15 subsequence.

We will run a loop on j from 0 to n (4 here). If it satisfies the if condition the arr[j] would be printed.

Now for counter = 1(0001) , j=1(0001) and $1 \& 1 = 1$. So, arr[0] is printed which is the 1st subsequence.

Then, counter = 2(0010), for j=2(0010), if condition is satisfied. So arr[1] is printed

Then, counter = 3(0011) for j=1(0001) & j=2(0010), if condition is satisfied, So arr[0] and arr[1] is printed.

.
.

.

counter = 15(1111) for j=1(0001) & j=2(0010) & j=4(0100) & j=8(1000) , if condition is satisfied, so all the array indexes are printed.

Note that :

$1 \ll 0 = 1$

$1 \ll 1 = 2$

$1 \ll 2 = 4$

$1 \ll 3 = 8$

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subhi → Harshit Gupta • 3 months ago

you have explained the code ...what is logic behind using this approach to calculate the subsequences....

2 ^ | v • Reply • Share >



sumit007 → subhi • a month ago

Logic is simple binary AND operation of string with the counter.

Let's say string is: 'BOLD'

We will generate counter in binary from 1 to 15 ($2^4 - 1$) just to get all possible numbers.

Now, just go on ANDing your string with this binary sequence, you will get all your possible subsequences:

BOLD & 0001 = D

BOLD & 0010 = L

BOLD & 0011 = LD

BOLD & 0100 = O

..

..

..

BOLD & 1110 = BOL

BOLD & 1111 = BOLD

The same logic is implemented in code by just ANDing counter (0001,

[see more](#)

1 ^ | v • Reply • Share >

**Parminder Singh** • 6 months ago

I didn't get the bitwise part. Can someone explain please?

^ | v • Reply • Share >

**Gaurav Roy** → Parminder Singh • 5 months ago

lets take counter = 2, which is 0010, so we shift 0001 to left by j bits, so if j=0 or j=1 the condition will become false, and when j=2 the condition will be true so it will print a[j] that is 2.. lets take counter = 5, which means 0101, so it will print a[1] and a[3]. similar for all. Its a nice way actually

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**Prabhat Kumar** • 7 months ago

<http://code.geeksforgeeks.org/...>

Python Code for printing all the subsequence.

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**Saurabh Bansal** • 8 months ago

How will Subsequence program behave if n exceeds normal integer width (32 or 64) ? It also assumes that $(2^n - 1)$ is under unsigned int limits for computing opsize.

1 ^ | v • Reply • Share >

**New_Guy** • 8 months ago

Great code and great example , but at the comment

```
/* Run from counter 000..0 to 111..1*/
```

should it be

```
/* Run from counter 000..01 to 111..1*/ ???
```

1 ^ | v • Reply • Share >

**GeeksforGeeks** Mod → New_Guy • 8 months ago

Thanks for pointing this out. We have updated the comment.

1 ^ | v • Reply • Share >

**Vinayak** • 8 months ago

All elements of the array must be unique or duplicates are allowed?

^ | v • Reply • Share >

**Harshit Gupta** → Vinayak • 8 months ago

Obviously Unique. If duplicates are present it might produce the same

Obviously Unique. If duplicates are present, it might produce the same substring/subsequence more than once

^ | v • Reply • Share ›



Venkatesh • 8 months ago

Complexity: $O(n^2)$ for substring, $O(2^n)$ for sub sequence

^ | v • Reply • Share ›



GeeksforGeeks Mod → Venkatesh • 8 months ago

Please take a closer look. There are $O(n^2)$ substrings and to print every string, we need $O(n)$ time.

^ | v • Reply • Share ›



Kataria Deepak • 8 months ago

Lovely...!!

^ | v • Reply • Share ›



Sonu Sharma • 8 months ago

Topic should be:

Subarray/Substring vs Subsequence and Programs to Generate them..

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GeeksforGeeks Mod → Sonu Sharma • 8 months ago

Thanks for pointing this out. We have updated the title.

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