Find subarray with given sum

Given an unsorted array of nonnegative integers, find a continous subarray which adds to a given number.

Examples:

```
Input: arr[] = {1, 4, 20, 3, 10, 5}, sum = 33
Ouptut: Sum found between indexes 2 and 4

Input: arr[] = {1, 4, 0, 0, 3, 10, 5}, sum = 7
Ouptut: Sum found between indexes 1 and 4

Input: arr[] = {1, 4}, sum = 0
Output: No subarray found
```

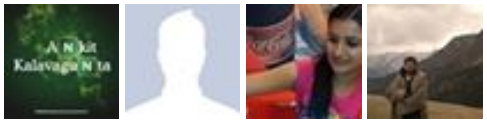
There may be more than one subarrays with sum as the given sum. The following solutions print first such subarray.

Source: Google Interview Question

Method 1 (Simple)
A simple solution is to consider all subarrays one by one and check the sum of every subarray. Following program implements the simple solution. We run two loops: the outer loop picks a starting point i and the inner loop tries all subarrays starting from i.

```
/* A simple program to print subarray with sum as given sum */
#include<stdio.h>

/* Returns true if the there is a subarray of arr[] with sum equal to
```

```
   otherwise returns false.  Also, prints the result */
int subArraySum(int arr[], int n, int sum)
{
    int curr_sum, i, j;

    // Pick a starting point
    for (i = 0; i < n; i++)
    {
        curr_sum = arr[i];

        // try all subarrays starting with 'i'
        for (j = i+1; j <= n; j++)
        {
            if (curr_sum == sum)
            {
                printf ("Sum found between indexes %d and %d", i, j-1)
                return 1;
            }
            if (curr_sum > sum || j == n)
                break;
           curr_sum = curr_sum + arr[j];
        }
    }

    printf("No subarray found");
    return 0;
}

// Driver program to test above function
int main()
{
    int arr[] = {15, 2, 4, 8, 9, 5, 10, 23};
    int n = sizeof(arr)/sizeof(arr[0]);
    int sum = 23;
    subArraySum(arr, n, sum);
    return 0;
}
```

Output:

```
Sum found between indexes 1 and 4
```

Time Complexity: O(n^2) in worst case.

Method 2 (Efficient)

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Initialize a variable curr_sum as first element. curr_sum indicates the sum of current subarray. Start from the second element and add all elements one by one to the curr_sum. If curr_sum becomes equal to sum, then print the solution. If curr_sum exceeds the sum, then remove trailing elemnents while curr_sum is greater than sum.

Following is C implementation of the above approach.

```
/* An efficient program to print subarray with sum as given sum */
#include<stdio.h>

/* Returns true if the there is a subarray of arr[] with sum equal to
   otherwise returns false.  Also, prints the result */
int subArraySum(int arr[], int n, int sum)
{
    /* Initialize curr_sum as value of first element
       and starting point as 0 */
    int curr_sum = arr[0], start = 0, i;

    /* Add elements one by one to curr_sum and if the curr_sum exceeds
       sum, then remove starting element */
    for (i = 1; i <= n; i++)
    {
        // If curr_sum exceeds the sum, then remove the starting eleme
        while (curr_sum > sum && start < i-1)
        {
            curr_sum = curr_sum - arr[start];
            start++;
        }

        // If curr_sum becomes equal to sum, then return true
        if (curr_sum == sum)
        {
            printf ("Sum found between indexes %d and %d", start, i-1)
            return 1;
        }

        // Add this element to curr_sum
        if (i < n)
          curr_sum = curr_sum + arr[i];
    }

    // If we reach here, then no subarray
    printf("No subarray found");
    return 0;
}
```

```
// Driver program to test above function
int main()
{
    int arr[] = {15, 2, 4, 8, 9, 5, 10, 23};
    int n = sizeof(arr)/sizeof(arr[0]);
    int sum = 23;
    subArraySum(arr, n, sum);
    return 0;
}
```

Output:

```
Sum found between indexes 1 and 4
```

Time complexity of method 2 looks more than O(n), but if we take a closer look at the program, then we can figure out the time complexity is O(n). We can prove it by counting the number of operations performed on every element of arr[] in worst case. There are at most 2 operations performed on every element: (a) the element is added to the curr_sum (b) the element is subtracted from curr_sum. So the upper bound on number of operations is 2n which is O(n).

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