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Maximum Product Subarray

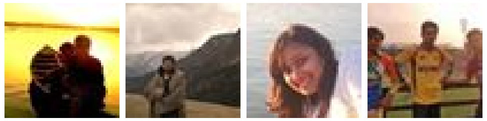
Given an array that contains both positive and negative integers, find the product of the maximum product subarray. Expected Time complexity is O(n) and only O(1) extra space can be used.

Examples:

```
Input: arr[] = {6, -3, -10, 0, 2}
Output:   180  // The subarray is {6, -3, -10}

Input: arr[] = {-1, -3, -10, 0, 60}
Output:   60  // The subarray is {60}

Input: arr[] = {-2, -3, 0, -2, -40}
Output:   80  // The subarray is {-2, -40}
```

The following solution assumes that the given input array always has a positive ouput. The solution works for all cases mentioned above. It doesn't work for arrays like {0, 0, -20, 0}, {0, 0, 0}.. etc. The solution can be easily modified to handle this case.
It is similar to Largest Sum Contiguous Subarray problem. The only thing to note here is, maximum product can also be obtained by minimum (negative) product ending with the previous element multiplied by this element. For example, in array {12, 2, -3, -5, -6, -2}, when we are at element -2, the maximum product is multiplication of, minimum product ending with -6 and -2.

```
#include <stdio.h>

// Utility functions to get minimum of two integers
int min (int x, int y) {return x < y? x : y; }

// Utility functions to get maximum of two integers
```



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```
int max (int x, int y) {return x > y? x : y; }
```

```
/* Returns the product of max product subarray.  Assumes that the
   given array always has a subarray with product more than 1 */
int maxSubarrayProduct(int arr[], int n)
{
    // max positive product ending at the current position
    int max_ending_here = 1;

    // min negative product ending at the current position
    int min_ending_here = 1;

    // Initialize overall max product
    int max_so_far = 1;

    /* Traverse throught the array. Following values are maintained af
       max_ending_here is always 1 or some positive product ending wit
       min_ending_here is always 1 or some negative product ending wit
    for (int i = 0; i < n; i++)
    {
        /* If this element is positive, update max_ending_here. Update
           min_ending_here only if min_ending_here is negative */
        if (arr[i] > 0)
        {
            max_ending_here = max_ending_here*arr[i];
            min_ending_here = min (min_ending_here * arr[i], 1);
        }

        /* If this element is 0, then the maximum product cannot
           end here, make both max_ending_here and min_ending_here 0
           Assumption: Output is alway greater than or equal to 1. */
        else if (arr[i] == 0)
        {
            max_ending_here = 1;
            min_ending_here = 1;
        }

        /* If element is negative. This is tricky
           max_ending_here can either be 1 or positive. min_ending_her
           or negative.
           next min_ending_here will always be prev. max_ending_here *
           next max_ending_here will be 1 if prev min_ending_here is 1
           next max_ending_here will be prev min_ending_here * arr[i]
        else
        {
            int temp = max_ending_here;
            max_ending_here = max (min_ending_here * arr[i], 1);
```

Geometric Algorithms

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```
            min_ending_here = temp * arr[i];
        }

        // update max_so_far, if needed
        if (max_so_far <  max_ending_here)
          max_so_far  =  max_ending_here;
    }

    return max_so_far;
}

// Driver Program to test above function
int main()
{
    int arr[] = {1, -2, -3, 0, 7, -8, -2};
    int n = sizeof(arr)/sizeof(arr[0]);
    printf("Maximum Sub array product is %d", maxSubarrayProduct(arr, 
    return 0;
}
```

Output:

```
Maximum Sub array product is 112
```

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

This article is compiled by **Dheeraj Jain** 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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