Find the maximum element in an array which is first increasing and then decreasing

Given an array of integers which is initially increasing and then decreasing, find the maximum value in the array.

```
Input: arr[] = {8, 10, 20, 80, 100, 200, 400, 500, 3, 2, 1}
Output: 500

Input: arr[] = {1, 3, 50, 10, 9, 7, 6}
Output: 50

Corner case (No decreasing part)
Input: arr[] = {10, 20, 30, 40, 50}
Output: 50

Corner case (No increasing part)
Input: arr[] = {120, 100, 80, 20, 0}
Output: 120
```

Method 1 (Linear Search)
We can traverse the array and keep track of maximum and element. And finally return the maximum element.

```
#include <stdio.h>

int findMaximum(int arr[], int low, int high)
{
   int max = arr[low];
```

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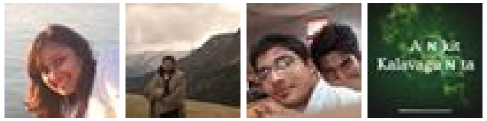

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```
    int i;
    for (i = low; i <= high; i++)
    {
        if (arr[i] > max)
           max = arr[i];
    }
    return max;
}

/* Driver program to check above functions */
int main()
{
    int arr[] = {1, 30, 40, 50, 60, 70, 23, 20};
    int n = sizeof(arr)/sizeof(arr[0]);
    printf("The maximum element is %d", findMaximum(arr, 0, n-1));
    getchar();
    return 0;
}
```

Time Complexity: O(n)

Method 2 (Binary Search)

We can modify the standard Binary Search algorithm for the given type of arrays.
i) If the mid element is greater than both of its adjacent elements, then mid is the maximum.
ii) If mid element is greater than its next element and smaller than the previous element then maximum lies on left side of mid. Example array: {3, 50, 10, 9, 7, 6}
iii) If mid element is smaller than its next element and greater than the previous element then maximum lies on right side of mid. Example array: {2, 4, 6, 8, 10, 3, 1}

```
#include <stdio.h>

int findMaximum(int arr[], int low, int high)
{

   /* Base Case: Only one element is present in arr[low..high]*/
   if (low == high)
     return arr[low];

   /* If there are two elements and first is greater then
      the first element is maximum */
   if ((high == low + 1) && arr[low] >= arr[high])
      return arr[low];
```

Geometric Algorithms

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```
   /* If there are two elements and second is greater then
      the second element is maximum */
   if ((high == low + 1) && arr[low] < arr[high])
      return arr[high];

   int mid = (low + high)/2;   /*low + (high - low)/2;*/

   /* If we reach a point where arr[mid] is greater than both of
     its adjacent elements arr[mid-1] and arr[mid+1], then arr[mid]
     is the maximum element*/
   if ( arr[mid] > arr[mid + 1] && arr[mid] > arr[mid - 1])
      return arr[mid];

   /* If arr[mid] is greater than the next element and smaller than th
    element then maximum lies on left side of mid */
   if (arr[mid] > arr[mid + 1] && arr[mid] < arr[mid - 1])
     return findMaximum(arr, low, mid-1);
   else // when arr[mid] is greater than arr[mid-1] and smaller than a
     return findMaximum(arr, mid + 1, high);
}

/* Driver program to check above functions */
int main()
{
   int arr[] = {1, 3, 50, 10, 9, 7, 6};
   int n = sizeof(arr)/sizeof(arr[0]);
   printf("The maximum element is %d", findMaximum(arr, 0, n-1));
   getchar();
   return 0;
}
```

Time Complexity: O(Logn)

This method works only for distinct numbers. For example, it will not work for an array like {0, 1, 1, 2, 2, 2, 2, 2, 3, 4, 4, 5, 3, 3, 2, 2, 1, 1}.

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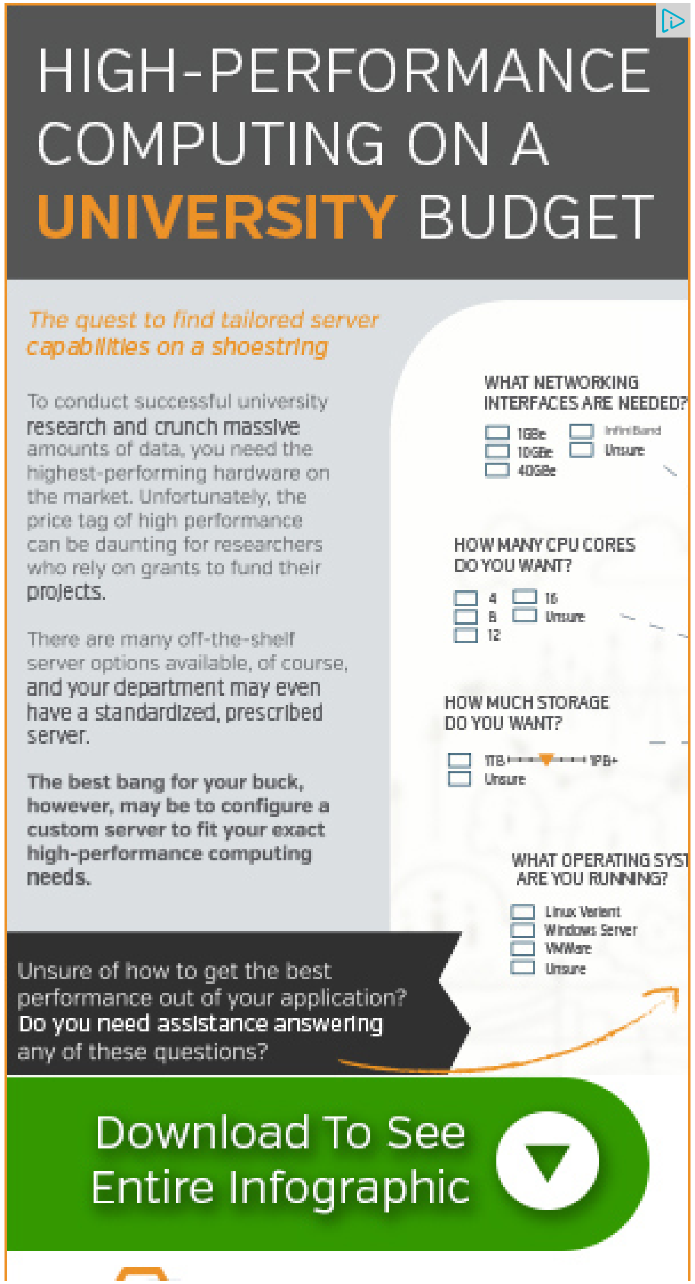

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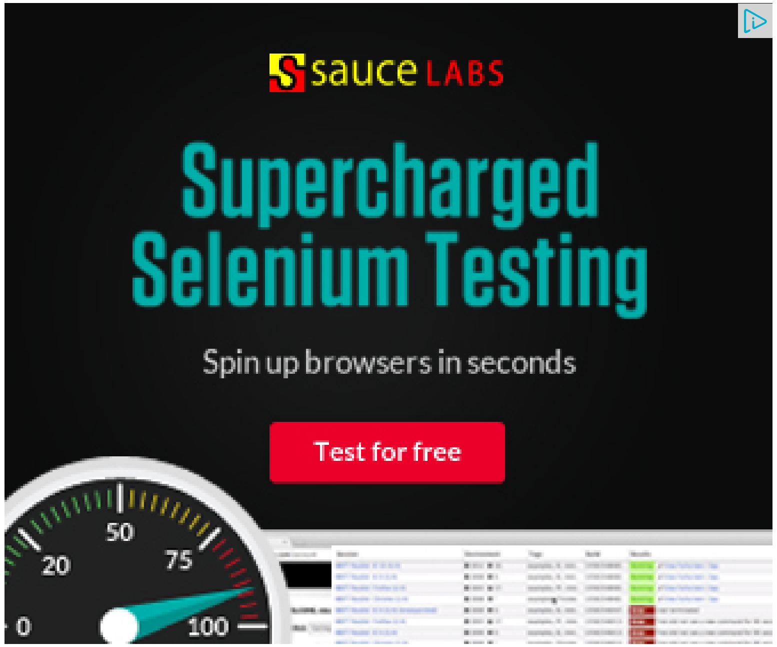

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