

Algorithms project

Wiggle Sort

Team no. 162
Task no. 7

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✧ What is Wiggle Sort?

- The Wiggle Sort algorithm takes an array of integers and modifies it in-place to reorder its elements in the wiggle pattern. It does this by iterating over the array and swapping adjacent elements if they do not satisfy the wiggle pattern.

✧ Project 7 instructions:

Given an integer array `nums`,
reorder it such that :

$$\text{nums}[0] < \text{nums}[1] > \text{nums}[2] < \text{nums}[3] \dots$$

You may assume the input array always has a valid answer.

Example 1:

Input: `nums = [1,5,1,1,6,4]`

Output: `[1,6,1,5,1,4]`

Explanation: `[1,4,1,5,1,6]` is also accepted

Example 2:

Input: `nums = [1,3,2,2,3,1]`

Output: `[2,3,1,3,1,2]` .

Constraints:

- $1 \leq \text{nums.length} \leq 5 * 10^4$
- $0 \leq \text{nums}[i] \leq 5000$
- It is guaranteed that there will be an answer for the given input `nums`.

Example 1

Example 1 Pseudo-code:

1. **FOR** each index i in the array from 0 to the second to last index:
2. **IF** i is even **AND** the current number is greater than the next number **OR** i is odd **AND** the current number is less than the next number:
3. **SWAP** the current number with the next number to create the wiggle pattern.
4. Print the sorted array.

Example 1 Analysis:

- The algorithm iterates over the array once and swaps adjacent elements as necessary to create the wiggle pattern.

Therefore, the time complexity of the algorithm is $O(n)$, where n is the size of the input array.

Example 1 Implementation: - Non-recursive implementation

```
#include <stdio.h>

// This Non-recursive implementation function sorts the array in a "wiggle" pattern
void wiggleSort(int* nums, int numsSize) {
    // Loop through the array
    for (int i = 0; i < numsSize - 1; i++) {
        // Check if the current number needs to be swapped with the next number to create the
        wiggle pattern
        if ((i % 2 == 0 && nums[i] > nums[i + 1]) || (i % 2 == 1 && nums[i] < nums[i + 1])) {
            // Swap the current and next numbers
            int temp = nums[i];
            nums[i] = nums[i + 1];
            nums[i + 1] = temp;
        }
    }
}

// This function prints the array
void printArray(int* nums, int numsSize) {
    // Print the opening bracket for the array
    printf("[");
    // Loop through the array
    for (int i = 0; i < numsSize; i++) {
        // Print the current number
        printf("%d", nums[i]);
        // Print a comma after the number, except for the last number
        if (i != numsSize - 1) {
            printf(",");
        }
    }
    // Print the closing bracket for the array and a newline character
    printf("]\n");
}

int main() {
    int nums1[] = {1, 5, 1, 1, 6, 4};
    int numsSize1 = 6;

    printf("Input array: ");
    printArray(nums1, numsSize1);

    wiggleSort(nums1, numsSize1);

    printf("Output array: ");
    printArray(nums1, numsSize1);

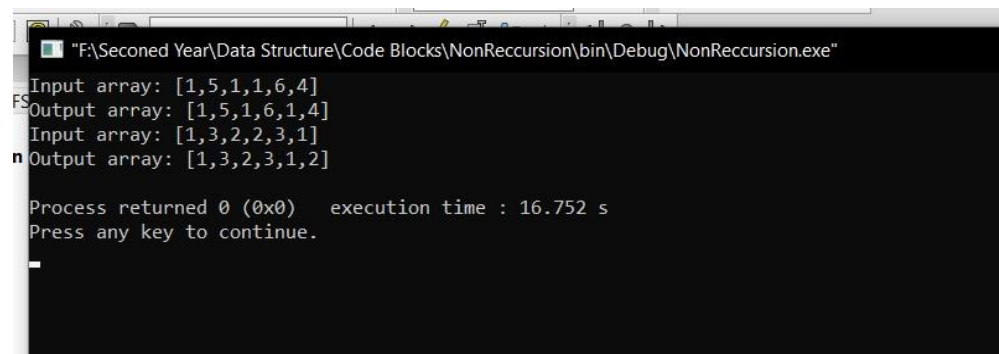
    int nums2[] = {1, 3, 2, 2, 3, 1};
    int numsSize2 = 6;

    printf("Input array: ");
    printArray(nums2, numsSize2);
```

```
wiggleSort(nums2, numsSize2);

printf("Output array: ");
printArray(nums2, numsSize2);

return 0;
}
```



```
"F:\Seconed Year\Data Structure\Code Blocks\NonReccursion\bin\Debug\NonReccursion.exe"
Input array: [1,5,1,1,6,4]
Output array: [1,5,1,6,1,4]
Input array: [1,3,2,2,3,1]
Output array: [1,3,2,3,1,2]

Process returned 0 (0x0)   execution time : 16.752 s
Press any key to continue.
_
```

Example 2

Example 2 Pseudo-code:

1. Check if the input array size is less than or equal to 1.
If yes, return.
2. Divide the input array into two halves (left and right).
3. Recursively call the wiggle sort function on the left half and the right half.
4. Merge the two sorted halves into a wiggle sorted array as follows:
 - a. If the current element of the left half is greater than the next element, swap them.
 - b. If the current element of the right half is less than the next element, swap them.
5. Return the wiggle sorted array.

Example 2 Analysis:

- The time complexity of this algorithm is $O(n \log n)$, where n is the size of the input array.
- This is because the algorithm uses a recursive divide-and-conquer approach, with each level of recursion splitting the array in half and performing two linear passes over each half until the base case is reached.
- Then, the two halves are merged and sorted using two for loops that have $O(n)$ time complexity each.

Therefore, the overall time complexity of the algorithm is $O(n \log n)$.

Example 2 Implementation: - Recursive implementation

```
#include <stdio.h>

//Recursive implementation
// function to sort the array in a wiggle pattern
void wiggleSort(int* nums, int numsSize) {

    // if the size of the array is 1 or 0, return
    if (numsSize <= 1) {
        return;
    }

    // divide the array into two halves and sort them separately
    int mid = numsSize / 2;
    wiggleSort(nums, mid);
    wiggleSort(nums + mid, numsSize - mid);

    // swap adjacent elements to create a wiggle pattern
    for (int i = 0; i < numsSize - 1; i++) {
        if ((i % 2 == 0 && nums[i] > nums[i+1]) || (i % 2 != 0 && nums[i] < nums[i+1])) {
            int temp = nums[i];
            nums[i] = nums[i+1];
            nums[i+1] = temp;
        }
    }
}

// function to print the elements of the array
void printArray(int* nums, int numsSize) {
    printf("[");
    for (int i = 0; i < numsSize; i++) {
        printf("%d", nums[i]);
        if (i < numsSize - 1) {
            printf(", ");
        }
    }
    printf("]\n");
}

// main function to demonstrate the wiggleSort function
int main() {
    int nums1[] = {1, 5, 1, 1, 6, 4};
    int numsSize1 = sizeof(nums1) / sizeof(nums1[0]);
    printf("Input array: ");
    printArray(nums1, numsSize1);
    wiggleSort(nums1, numsSize1);
    printf("Output: ");
    printArray(nums1, numsSize1);

    int nums2[] = {1, 3, 2, 2, 3, 1};
    int numsSize2 = sizeof(nums2) / sizeof(nums2[0]);
```

```
    printf("Input array: ");
    printArray(nums2, numsSize2);
    wiggleSort(nums2, numsSize2);
    printf("Output: ");
    printArray(nums2, numsSize2);

    return 0;
}
```

```
Input array: [1, 5, 1, 1, 6, 4]
Output: [1, 5, 1, 6, 1, 4]
Input array: [1, 3, 2, 2, 3, 1]
Output: [1, 3, 1, 3, 2, 2]
Process returned 0 (0x0)   execution time : 9.112 s
Press any key to continue.
```


Comparison Between Example 1 and Example 2:

Example 1:

The first algorithm is a non-recursive implementation of wiggle sort.

The **wiggleSort** function iterates through the input array `nums` and checks if each pair of adjacent elements meets the wiggle condition.

If the condition is not met, the function swaps the elements to create the wiggle pattern.

The **printArray** function simply prints the input and output arrays.

The time complexity of this algorithm is $O(n)$, where n is the length of the input array `nums`. This is because the algorithm only iterates through the input array once.

Example 2:

The second algorithm is a recursive implementation of wiggle sort. It uses a divide-and-conquer approach.

The **wiggleSort** function recursively divides the input array `nums` into two halves until each subarray has a length of 1 or 0.

The function then performs the wiggle sort on each subarray and merges them back together to produce the final Output array.

The **printArray** function simply prints the input and output arrays.

The time complexity of this algorithm is $O(n \log n)$, where n is the length of the input array `nums`.

This is because the algorithm recursively divides the input array in half until each subarray has a length of 1 or 0, which takes $O(\log n)$ time.

After the recursion, the algorithm performs the wiggle sort on each subarray, which takes $O(n)$ time.

The total time complexity is therefore $O(n \log n)$.

In comparison, the non-recursive implementation of wiggle sort (**Example 1**) has a time complexity of $O(n)$, which is faster than the recursive implementation (**Example 2**). However, the recursive implementation is better in if the input array is very large.