

Laboratory #3

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1 Minimum number of inversions

The instance of an array A of size n that you want to order in increasing order that has the minimum number inversions, in other words equal to 0, is the array of the form $A = (1, 2, 3, \dots, n-2, n-1, n)$

1	2	3	...	n-2	n-1	n
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2 Maximum number of inversions

The instance of an array A of size n that you want to order in increasing order that has the minimum number inversions, in other words equal to $n*(n-1)/2$, is the array of the form $A = (n, n-1, n-2, \dots, 3, 2, 1)$

n	n-1	n-2	...	3	2	1
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3 Complexity (worst case number of comparisons) of the brute force counting on A

In the brute force algorithm, the worst-case complexity, when the array is of form $A = (n, n-1, n-2, \dots, 3, 2, 1)$, is $O(n^2)$

4 Complexity (worst case number of comparisons) of the divide and conquer (mergesort) counting on A

In the brute force algorithm, the worst-case complexity, when the array is of form $A = (n, n-1, n-2, \dots, 3, 2, 1)$, is $O(n^2 \log(n))$

5 Run in your local machine the brute force and divide and conquer algorithms in Python 2.7 and calculate the time for the first 10^5 numbers of size instance from Hackearth input and output and for the 10^5 sorted increasing and decreasing numbers.

In the images you can see the number of swaps and the execution time in seconds. The respective codes are attached in txt format

Merge Sort Increasing

```
Python 2.7.14 Shell
File Edit Shell Debug Options Window Help
Python 2.7.14 (v2.7.14:84471935ed, Sep 16 2017, 20:25:58) [MSC v.1500 64 bit (AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: D:\Unal\Algoritmos\MergeSort.py =====
Merge Sort Increasing
2495511184
Execution Time: 2.41499996185
>>> |
```

Ln: 8 Col: 4

Merge Sort Decreasing



A screenshot of a Python 2.7.14 Shell window. The window has a title bar 'Python 2.7.14 Shell' and standard Windows window controls. The menu bar includes 'File', 'Edit', 'Shell', 'Debug', 'Options', 'Window', and 'Help'. The main text area shows the following output:

```
Python 2.7.14 (v2.7.14:84471935ed, Sep 16 2017, 20:25:58) [MSC v.1500 64 bit (AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: D:\Unal\Algoritmos\MergeSortD.py =====
Merge Sort Decreasing
2504438816
Execution Time: 2.40000009537
>>> |
```

The status bar at the bottom right indicates 'Ln: 8 Col: 4'.

Brute Force Increasing



A screenshot of a Python 2.7.14 Shell window. The window has a title bar with the text "Python 2.7.14 Shell" and standard window controls (minimize, maximize, close). Below the title bar is a menu bar with "File", "Edit", "Shell", "Debug", "Options", "Window", and "Help". The main text area contains the following output from a script execution:

```
Python 2.7.14 (v2.7.14:84471935ed, Sep 16 2017, 20:25:58) [MSC v.1500 64 bit (AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: D:\Unal\Algoritmos\BruteForce.py =====
Brute Force Increasing
2495511184
Execution Time: 460.111999989
>>> |
```

The status bar at the bottom right of the window shows "Ln: 8 Col: 4".

Brute Force Decreasing

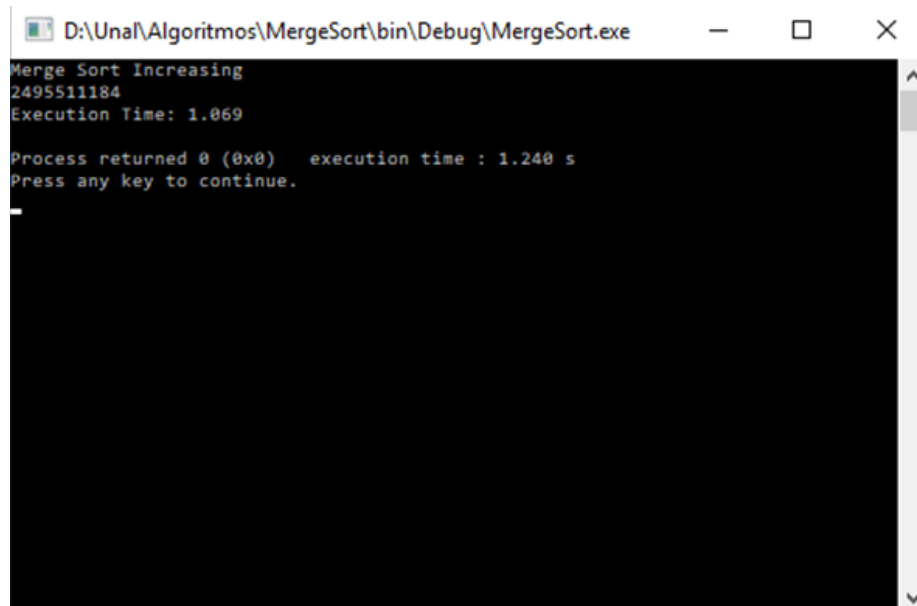


```
Python 2.7.14 Shell
File Edit Shell Debug Options Window Help
Python 2.7.14 (v2.7.14:84471935ed, Sep 16 2017, 20:25:58) [MSC v.1500 64 bit (AMD64)] on win32
Type "copyright", "credits" or "license()" for more information.
>>>
===== RESTART: D:\Unal\Algoritmos\BruteForceD.py =====
Brute Force Decreasing
2504433787
Execution Time: 493.075999975
>>> |
```

- 6 Run in your local machine the brute force and divide and conquer algorithms in C or C++ and calculate the time for the first 10^5 numbers of size instance from Hackearth input and output and for the 10^5 sorted increasing and decreasing numbers.

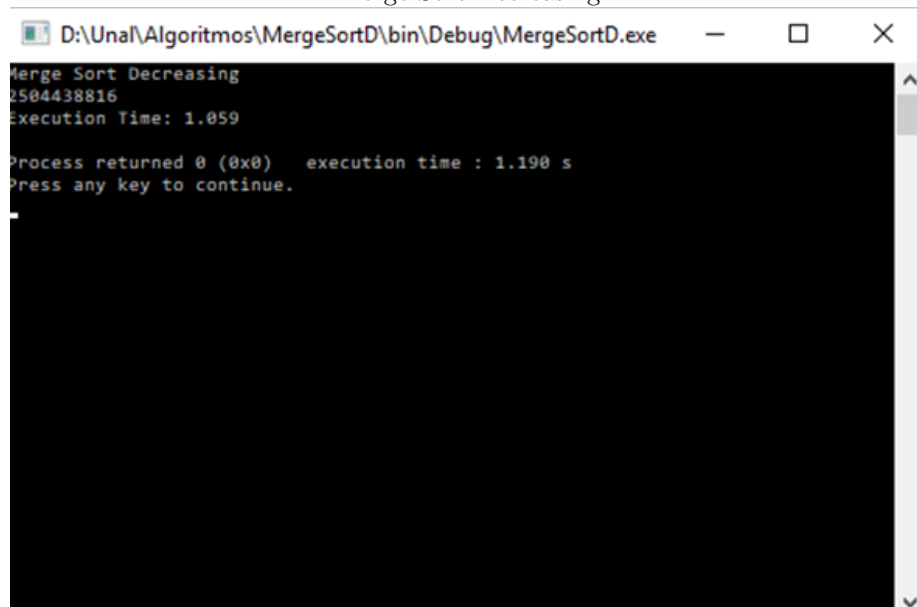
In the images you can see the number of swaps and the execution time in seconds. The respective codes are attached in txt format

Merge Sort Increasing



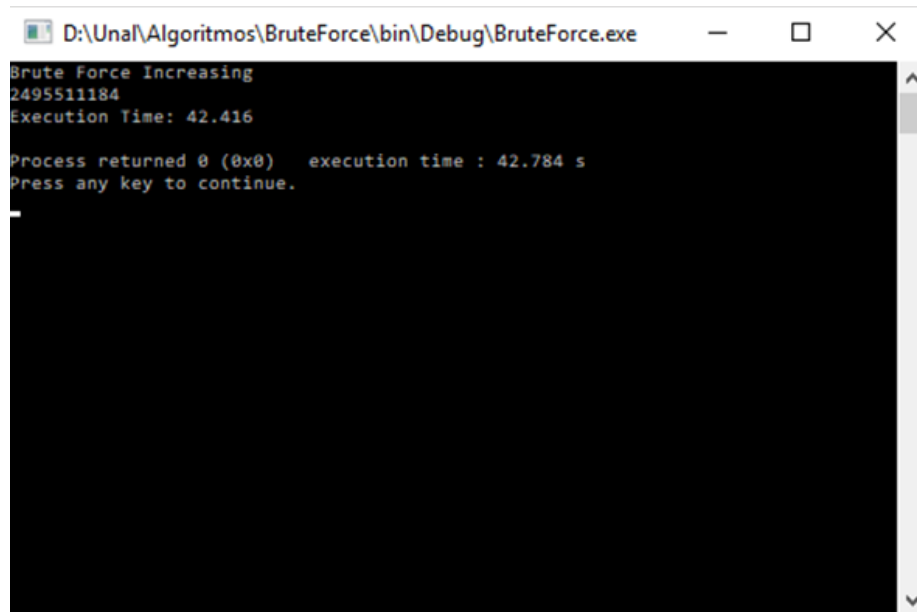
```
D:\Unal\Algoritmos\MergeSort\bin\Debug\MergeSort.exe
Merge Sort Increasing
2495511184
Execution Time: 1.069
Process returned 0 (0x0) execution time : 1.240 s
Press any key to continue.
```

Merge Sort Decreasing



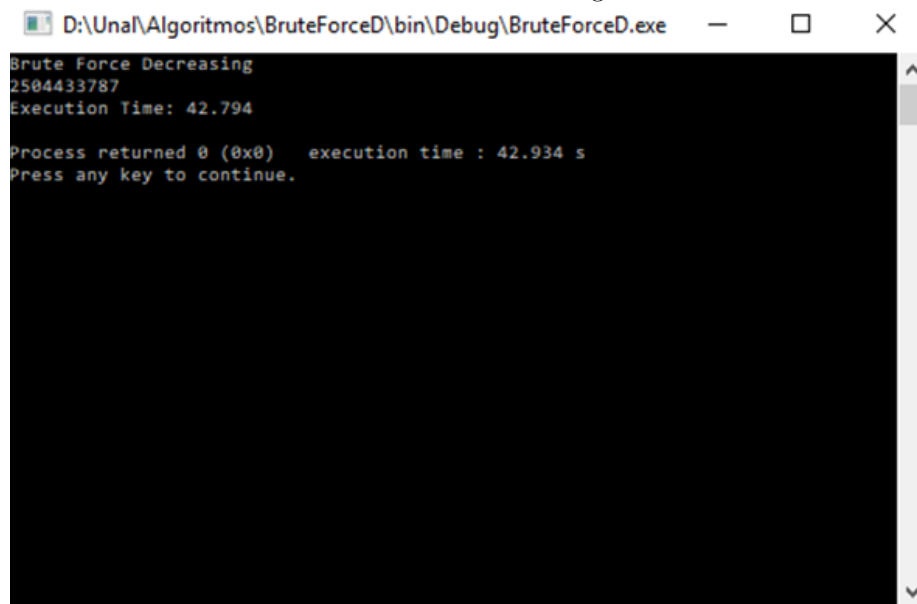
```
D:\Unal\Algoritmos\MergeSortD\bin\Debug\MergeSortD.exe
Merge Sort Decreasing
2504438816
Execution Time: 1.059
Process returned 0 (0x0) execution time : 1.190 s
Press any key to continue.
```

Brute Force Increasing



```
D:\Una\Algoritmos\BruteForce\bin\Debug\BruteForce.exe
Brute Force Increasing
2495511184
Execution Time: 42.416
Process returned 0 (0x0) execution time : 42.784 s
Press any key to continue.
```

Brute Force Decreasing



```
D:\Una\Algoritmos\BruteForceD\bin\Debug\BruteForceD.exe
Brute Force Decreasing
2504433787
Execution Time: 42.794
Process returned 0 (0x0) execution time : 42.934 s
Press any key to continue.
```