Shaun Clarke

CSC6023

Module 1:Assignment 2 Project 1

- big oh class of the sorting algorithm in question, with an explanation

    o The big O class for the bubble sort algorithm is $O(n^2)$. By counting the number of loops, we have a for loop within the while loop. Worst case scenario, the while loop runs n times and the for loop inside it runs n times, which is basically n x n, which would be n^2 comparisons.

- screenshots of the C Profiler

    o Please see below for screenshots.

- graph plotting the size of the random arrays (x axis) and the time taken to sort (y axis)

    o Graph uploaded in an excel file

- your reflections on how the C Profile data relates to what you have learned about algorithmic analysis and in particular to the big oh class of your algorithm.

    o It was interesting to see the difference between each array that was run through the bubble sort algorithm. The one in question has a worst-case time complexity of $O(n^2)$. However, after calling bubble sort on arrays ranging from 1000 elements to 10,000, we confirmed that the execution time grows quadratically with the input size. The screenshots below show that the execution time for bubble sort grew from 0.051 seconds on 1,000 items to 4.751 seconds on 10,000 items.

```
array 1000 first five before sort: [709, 716, 375, 253, 177]
array 1000 first five after sort: [1, 1, 2, 4, 4]
        934 function calls in 0.052 seconds

   Ordered by: standard name

   ncalls  tottime  percall  cumtime  percall filename:lineno(function)
        1    0.000    0.000    0.052    0.052 <string>:1(<module>)
        1    0.051    0.051    0.051    0.051 clarke_shaun_mod1_pa2.py:27(bubble_sort)
        1    0.000    0.000    0.052    0.052 clarke_shaun_mod1_pa2.py:68(main)
        1    0.000    0.000    0.052    0.052 {built-in method builtins.exec}
      927    0.000    0.000    0.000    0.000 {built-in method builtins.len}
        2    0.000    0.000    0.000    0.000 {built-in method builtins.print}
        1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}
```

```
array 2000 first five before sort: [1236, 1154, 1453, 914, 1322]
array 2000 first five after sort: [2, 2, 3, 6, 6]
         1963 function calls in 0.175 seconds

   Ordered by: standard name

   ncalls  tottime  percall  cumtime  percall filename:lineno(function)
        1    0.000    0.000    0.175    0.175 <string>:1(<module>)
        1    0.175    0.175    0.175    0.175 clarke_shaun_mod1_pa2.py:27(bubble_sort)
        1    0.000    0.000    0.175    0.175 clarke_shaun_mod1_pa2.py:68(main)
        1    0.000    0.000    0.175    0.175 {built-in method builtins.exec}
     1956    0.000    0.000    0.000    0.000 {built-in method builtins.len}
        2    0.000    0.000    0.000    0.000 {built-in method builtins.print}
        1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}
```

```
array 3000 first five before sort: [2256, 800, 2579, 510, 2152]
array 3000 first five after sort: [1, 1, 2, 2, 3]
         2843 function calls in 0.397 seconds

   Ordered by: standard name

   ncalls  tottime  percall  cumtime  percall filename:lineno(function)
        1    0.000    0.000    0.397    0.397 <string>:1(<module>)
        1    0.397    0.397    0.397    0.397 clarke_shaun_mod1_pa2.py:27(bubble_sort)
        1    0.000    0.000    0.397    0.397 clarke_shaun_mod1_pa2.py:68(main)
        1    0.000    0.000    0.397    0.397 {built-in method builtins.exec}
     2836    0.000    0.000    0.000    0.000 {built-in method builtins.len}
        2    0.000    0.000    0.000    0.000 {built-in method builtins.print}
        1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}
```

```
array 4000 first five before sort: [1942, 2866, 382, 421, 293]
array 4000 first five after sort: [1, 1, 1, 3, 3]
         3944 function calls in 0.740 seconds

   Ordered by: standard name

   ncalls  tottime  percall  cumtime  percall filename:lineno(function)
        1    0.000    0.000    0.740    0.740 <string>:1(<module>)
        1    0.739    0.739    0.740    0.740 clarke_shaun_mod1_pa2.py:27(bubble_sort)
        1    0.000    0.000    0.740    0.740 clarke_shaun_mod1_pa2.py:68(main)
        1    0.000    0.000    0.740    0.740 {built-in method builtins.exec}
     3937    0.001    0.000    0.001    0.000 {built-in method builtins.len}
        2    0.000    0.000    0.000    0.000 {built-in method builtins.print}
        1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}
```

```
array 5000 first five before sort: [1351, 3739, 176, 2722, 1364]
array 5000 first five after sort: [1, 1, 2, 2, 2]
         4924 function calls in 1.195 seconds

   Ordered by: standard name

   ncalls  tottime  percall  cumtime  percall filename:lineno(function)
        1    0.000    0.000    1.194    1.194 <string>:1(<module>)
        1    1.193    1.193    1.194    1.194 clarke_shaun_mod1_pa2.py:27(bubble_sort)
        1    0.000    0.000    1.194    1.194 clarke_shaun_mod1_pa2.py:68(main)
        1    0.000    0.000    1.194    1.194 {built-in method builtins.exec}
     4917    0.001    0.000    0.001    0.000 {built-in method builtins.len}
        2    0.000    0.000    0.000    0.000 {built-in method builtins.print}
        1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}
```

```
array 6000 first five before sort: [1140, 1972, 2292, 4549, 2238]
array 6000 first five after sort: [6, 6, 8, 9, 9]
        5899 function calls in 1.832 seconds

   Ordered by: standard name

   ncalls  tottime  percall  cumtime  percall filename:lineno(function)
        1    0.000    0.000    1.832    1.832 <string>:1(<module>)
        1    1.831    1.831    1.832    1.832 clarke_shaun_mod1_pa2.py:27(bubble_sort)
        1    0.000    0.000    1.832    1.832 clarke_shaun_mod1_pa2.py:68(main)
        1    0.000    0.000    1.832    1.832 {built-in method builtins.exec}
     5892    0.001    0.000    0.001    0.000 {built-in method builtins.len}
        2    0.000    0.000    0.000    0.000 {built-in method builtins.print}
        1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}
```

```
array 7000 first five before sort: [1637, 6892, 6014, 300, 1437]
array 7000 first five after sort: [1, 1, 3, 3, 4]
        6938 function calls in 2.384 seconds

   Ordered by: standard name

   ncalls  tottime  percall  cumtime  percall filename:lineno(function)
        1    0.000    0.000    2.384    2.384 <string>:1(<module>)
        1    2.382    2.382    2.383    2.383 clarke_shaun_mod1_pa2.py:27(bubble_sort)
        1    0.000    0.000    2.384    2.384 clarke_shaun_mod1_pa2.py:68(main)
        1    0.000    0.000    2.384    2.384 {built-in method builtins.exec}
     6931    0.001    0.000    0.001    0.000 {built-in method builtins.len}
        2    0.000    0.000    0.000    0.000 {built-in method builtins.print}
        1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}
```

```
array 8000 first five before sort: [7421, 6610, 2187, 6711, 5346]
array 8000 first five after sort: [6, 8, 8, 10, 10]
        7726 function calls in 2.964 seconds

   Ordered by: standard name

   ncalls  tottime  percall  cumtime  percall filename:lineno(function)
        1    0.000    0.000    2.964    2.964 <string>:1(<module>)
        1    2.962    2.962    2.964    2.964 clarke_shaun_mod1_pa2.py:27(bubble_sort)
        1    0.000    0.000    2.964    2.964 clarke_shaun_mod1_pa2.py:68(main)
        1    0.000    0.000    2.964    2.964 {built-in method builtins.exec}
     7719    0.002    0.000    0.002    0.000 {built-in method builtins.len}
        2    0.000    0.000    0.000    0.000 {built-in method builtins.print}
        1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}
```

```
array 9000 first five before sort: [6877, 7854, 3499, 7497, 8009]
array 9000 first five after sort: [1, 2, 2, 2, 6]
        8905 function calls in 4.570 seconds

   Ordered by: standard name

   ncalls  tottime  percall  cumtime  percall filename:lineno(function)
        1    0.000    0.000    4.570    4.570 <string>:1(<module>)
        1    4.568    4.568    4.570    4.570 clarke_shaun_mod1_pa2.py:27(bubble_sort)
        1    0.000    0.000    4.570    4.570 clarke_shaun_mod1_pa2.py:68(main)
        1    0.000    0.000    4.570    4.570 {built-in method builtins.exec}
     8898    0.002    0.000    0.002    0.000 {built-in method builtins.len}
        2    0.000    0.000    0.000    0.000 {built-in method builtins.print}
        1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}
```

```
array 10000 first five before sort: [1438, 4651, 3618, 7475, 1280]
array 10000 first five after sort: [3, 4, 5, 6, 7]
        9806 function calls in 4.751 seconds

   Ordered by: standard name

   ncalls  tottime  percall  cumtime  percall filename:lineno(function)
        1    0.000    0.000    4.751    4.751 <string>:1(<module>)
        1    4.749    4.749    4.751    4.751 clarke_shaun_mod1_pa2.py:27(bubble_sort)
        1    0.000    0.000    4.751    4.751 clarke_shaun_mod1_pa2.py:68(main)
        1    0.000    0.000    4.751    4.751 {built-in method builtins.exec}
     9799    0.002    0.000    0.002    0.000 {built-in method builtins.len}
        2    0.000    0.000    0.000    0.000 {built-in method builtins.print}
        1    0.000    0.000    0.000    0.000 {method 'disable' of '_lsprof.Profiler' objects}
```